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Site-Wide Project Work Plan — Part III

Revised
Site-Wide Conceptual Site Model and Screening Levels Prudhoe Bay Facility

Prudhoe Bay Facility, Alaska
Administrative Order on Consent
RCRA-10-2007-0222

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REVISED
SITE-WIDE CONCEPTUAL SITE MODEL AND SCREENING LEVELS
PRUDHOE BAY

Prepared for:

BP EXPLORATION (ALASKA) INC.
P.O. Box 196611
Anchorage, Alaska 99519-6611

This document has been prepared by SLR International Corporation. The material and data in this report were prepared under the supervision and direction of the undersigned.

Mark E. Stelljes

Dr. Mark Stelljes
Director of Risk Assessment and Toxicology

Andrew Dimitriou

Andrew Dimitriou
Project Manager

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ACRONYMS

1,1,1-TCA	1,1,1-Trichloroethane
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AL	action level
AOC	area of concern
ARCO	Atlantic Richfield Company
ASTM	American Society for Testing and Materials
AUF	area use factor
AWQC	ambient water quality criteria
AWQS	Alaska Water Quality Standards
bgs	below ground surface
BPXA	BP Exploration (Alaska) Inc.
BTEX	benzene, toluene, ethylbenzene, and xylenes
CL	cleanup level
CMS	Corrective Measures Study
COI	Chemicals of Interest
C_{sat}	soil-saturation limit
CSM	conceptual site model
DQO	data quality objective
DS	drill site
DSM	Drum Storage Maintenance
EC_{50}	effective concentration to 50% of a population
Eco-SSL	ecological soil screening level
EOA	Eastern Operating Area
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERM	ERM Alaska, Inc.
g/day	grams per day
HHRA	human health risk assessment
IRIS	Integrated Risk Information System
L/m^3	liter per cubic meter
LC_{50}	lethal concentration to 50% of a population
LD_{50}	lethal dose to 50% of a population
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effect concentration
LOEL	lowest observed effect level
MCL	maximum contaminant level
MDL	method detection limit

ACRONYMS (CONTINUED)

µg/L	micrograms per liter
mg/kg	milligrams per kilogram
MTCA	Model Toxics Control Act
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NOEL	no observed effect level
NSC	North Slope Crude
OASIS	OASIS Environmental, Inc.
ODEQ	Oregon Department of Environmental Quality
Order	Administrative Order on Consent
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbons
PBU	Prudhoe Bay Unit
PG	Project Group
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RAPM	Risk Assessment Procedures Manual
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RI/FS	remedial investigation/feasibility study
RO-COPC	RCRA Order-defined Constituent of Potential Concern
SL	screening level
SLR	SLR International Corporation
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TRV	toxicity reference value
UF	uncertainty factor
VOC	volatile organic compounds
WDOE	Washington State Department of Ecology

GLOSSARY

Active Layer Water: Water present between the ground surface and the permafrost, to the depth of seasonal thaw.

ADEC Corrective Action: An Alaska Department of Environmental Conservation (ADEC) requirement to take the necessary action to stop the migration, determine the extent, and undertake recovery of petroleum after its unpermitted release; clean up affected soil and groundwater, and stabilize the site of the release to prevent or remove hazards to public health or the environment.

Area: Refers to a geographic region.

Area of Concern (AOC): Any area of the Site where a release to the environment of hazardous waste or hazardous constituents has occurred, is suspected to have occurred, or may occur, regardless of the frequency or duration of the release.

Chemicals of Interest (COIs): Chemicals identified in an approved Work Plan that have been derived from both the Core lists of regulated constituents of potential concern and the Comprehensive Standardized Laboratory Analyte List. Agency-approved lists will be tailored to individual solid waste management units (SWMUs)/AOCs, Project Areas, and Project Groups, using applicable location-specific information and regulatory requirements. Broader lists will be used for “exceptional sites”.

Chemicals of Potential Concern: Constituents of potential concern to be considered for baseline human health risk assessment.

Chemicals of Potential Ecological Concern: Constituents of potential concern to be considered for a baseline ecological risk assessment.

Corrective Measure: Any U.S. Environmental Protection Agency (EPA)-selected measures or actions to control, prevent, or mitigate the release or potential release of hazardous wastes and/or hazardous constituents in the environment at or from the Site.

Corrective Measures Study (CMS): The investigation and evaluation of potential remedies that will protect human health and/or the environment from the release or potential release of hazardous waste and/or hazardous constituents into the environment at or from the Site.

Data Quality Objectives (DQOs): Quantitative and qualitative statements designed to ensure that data of known and appropriate quality are obtained for their intended use(s).

Qualitative and quantitative statements derived from the outputs of each step of the DQO process that (1) clarify the study objective, (2) define the most appropriate types of data to collect, (3) determine the most appropriate conditions from which to collect the data, and (4) specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision.

Developed Area: An area within the boundaries of a pit, pad, road, airstrip, or landfill, or any other area where physical changes have been made to the terrain as part of PBU operations.

GLOSSARY (CONTINUED)

Facility: An abbreviated reference to the Prudhoe Bay facility operated by BP Exploration (Alaska) Inc. (BPXA).

Hazardous Constituents: Resource Conservation and Recovery Act (RCRA) regulations define hazardous constituents based on the list of chemicals in 40 CFR 261, Appendix VIII, or the groundwater monitoring list chemicals in40 CFR 264, Appendix IX.

Interim Measures: Those actions initiated in advance of implementation of final Corrective Measures to control or abate immediate threats to human health and/or the environment and to prevent or minimize the potential release or spread of hazardous waste and/or hazardous constituents into the environment at or from SWMUs or AOCs throughout the implementation of the Order, while long-term Corrective Measures alternatives are evaluated.

Mineral Soil: Soil composed of sandy silts and/or other materials with low organic matter content relative to tundra soil.

Off-Pad: Refers to areas that are not located atop or contained within a gravel pad or berm.

On-Pad: Refers to areas located atop or contained within a gravel pad or berm.

Order: Administrative Order on Consent RCRA-10-2007-0222, issued October 3, 2007.

Pad Porewater: Water that exists within the man-made gravel pads that support the Site activities. The Pad Porewater zone is typically less than two (2) feet in thickness within the gravel pad. For purposes of interpreting the Order, EPA regulation, and guidance for Work under this Order, Pad Porewater shall be treated as groundwater. Pad Porewater may have the potential to migrate to surface water, but it is not a direct source of drinking water.

Portfolio: A group of SWMUs or AOCs to be evaluated in a particular risk assessment.

Project Area: The physical area of a Project Group or, where distinct conditions exist, the physical area of individual SWMUs or AOCs within the Project Group.

Project Group (PG): A Project Group from the Project Group List required under Attachment D (RCRA Order), Scope of Work for Site-Wide Project Work Plan. These Project Groups are SWMUs and AOCs from the list in Attachment C that have been organized into manageable groups.

Prudhoe Bay facility (Site): The contiguous land, and structures, other appurtenances, and improvements on the land in the area depicted in Attachment A of the Order. This area contains the SWMUs and AOCs investigated under this Order. The defined area of the facility does not include six (6) square miles of the Eastern Operating Area (EOA) of the Prudhoe Bay Unit (PBU) that are not under control of BPXA.

Prudhoe Bay Unit (PBU): Describes the oil field, oil field operations, and oil field ownership. Synonymous with Prudhoe Bay oil field or Prudhoe Bay field.

RCRA Facility Investigation (RFI): Any required investigation and characterization of hazardous wastes and/or hazardous constituents and the nature and extent including, but not limited to, the direction, rate, movement, and concentration of those hazardous wastes and/or hazardous constituents that have been, or are likely to be, released into the environment at or from the Site.

Receptors: Those humans, animals, or plants and their habitats that are or may be affected by releases of hazardous waste and/or hazardous constituents to the environment at or from the Site.

RO-COPC: A constituent (contaminant, chemical) of potential concern as defined under the RCRA Order (Attachment D, Part II) for which screening levels (SLs) have been developed.

Sediment: The Alaska Water Quality Regulations, Title 18 of the Alaska Administrative Code Chapter 70 (18 AAC 70) define sediment as “solid material of organic or mineral origin that is transported by, suspended in, or deposited from water; including chemical and biochemical precipitates and organic material, such as humus.” More simply, sediments are loose particles of sand, clay, silt, and other substances that settle at the bottom of a freshwater, estuarine, or marine water body.

Site: That portion of the physical area of the Prudhoe Bay facility shown in Attachment A of the Order. This defined area does not include six (6) square miles of the EOA of the PBU that are not under the control of BPXA.

Solid Waste Management Unit (SWMU): Any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous wastes, including those areas of, or at, the facility where solid waste has been treated, stored, disposed of, managed, or released.

Suprapermafrost Groundwater: Water in the active layer above permafrost. Hydrogeology at the Site is dominated by permafrost, which is perpetually frozen soil and/or strata extending from a depth of about three (3) feet below ground surface (bgs) to about two thousand (2,000) feet bgs. The depth of seasonal thaw is termed the “active layer.” Water in the active layer is typically referred to as Suprapermafrost Groundwater, although the flow is limited and bounded by the permafrost at shallow depths. Suprapermafrost Groundwater is not a source of drinking water.

Surface Water: Open water present at the ground surface. Surface water features include lakes, ponds, thermokarst troughs filled with water, streams, and rivers.

Tier I Screening Level: The proposed Site screening levels based on EPA-accepted risk-based sources and developed in consideration of both human health and ecological receptors. Tier I SLs represent the lowest available health-based levels identified from a variety of regulatory sources and as such represent generic conservative Tier I Screening Levels.

Tier II Action Level: A risk-based chemical concentration based on Site-wide exposure assumptions.

Tundra Soil: Organic-rich surficial silts consisting at least partially of decayed or decaying plant material and/or other organic matter. This term may also be used to describe soils in the native tundra.

GLOSSARY (CONTINUED)

Undeveloped Area: An area that does not consist of or contain man-made structures that do not occur naturally. Undeveloped areas include native tundra with natural, intact habitats.

1. INTRODUCTION

Under the Resource Conservation and Recovery Act (RCRA), owners or operators of facilities who are subject to cleanup under the RCRA Corrective Action Program must evaluate releases of hazardous wastes and hazardous constituents from solid waste management units (SWMUs), and implement cleanup activities as needed to protect human health and the environment. An Administrative Order on Consent ([Order]; EPA Docket No. RCRA-10-2007-0222) for corrective action, executed between the U.S. Environmental Protection Agency (EPA) and BP Exploration Alaska, Inc. (BPXA) on October 3, 2007, requires evaluation and remediation of SWMUs and Areas of Concern (AOCs) at the Prudhoe Bay facility (Facility; the Site).

This document develops an overall Site-wide conceptual site model (CSM) for both human and ecological exposures from potential releases to the environment of hazardous constituents from SWMUs and AOCs at the Prudhoe Bay facility (Site). The CSM is intended to show the primary ways in which chemicals can move through the environment and contact human or ecological receptors across the Site. This CSM document is a required deliverable under Part III of the Site-Wide Project Work Plan. This revision was prepared to update screening level calculations and incorporate comments from EPA and the Alaska Department of Environmental Conservation (ADEC), received in final form in May 2011 (EPA, 2011a).

Given its remoteness and Site-wide security measures, the Site is predominantly used by oilfield workers and authorized visitors, all of whom are required to comply with health and safety standards that preclude significant exposure to contaminated areas. It is BPXA's intention to ensure that long-term residential or recreational use will not occur as long as BPXA controls production activities at the Site. Given the anticipated lifetime of the field, the current use will be maintained at least 50 years into the future. The area of the Prudhoe Bay Unit (PBU) is predominantly owned by the State of Alaska, with some parcels owned by the oil production companies and other third parties. Land use is designated as "oil and gas production," which precludes residential development. However, a hypothetical residential land use scenario is considered herein as required by EPA Region 10 (EPA, 1996c) guidance. Current subsistence use of the Site is non-residential and limited to hunting-related activities in a few areas along the coastline, but a future resident subsistence user is evaluated to fulfill the requirement of evaluating a resident.

Consistent with EPA guidance (EPA, 1989, 1998), this document describes a tiered risk evaluation framework. Tiered risk evaluations promote efficiency because initial phases of the evaluation tend to be relatively simple, conservative (i.e., health-protective), and inexpensive. More complex, realistic, and expensive evaluations are only performed as needed.

This document presents generic, conservative, Tier I screening levels (Tier I SLs) based on protection of human health and ecological receptors. These Tier I SLs represent the lowest available risk-based concentrations (as required by EPA [2009a]) identified from a variety of regulatory sources, including EPA, the ADEC, the National Oceanic and Atmospheric Administration (NOAA), the states of Oregon and Washington, and Oak Ridge National Laboratory (ORNL). In some situations these concentrations may not be solely risk-based. For human health, the Tier I SLs include soil and water values protective of residents, industrial workers, and subsistence user receptors. Tier I SLs have been developed for soil and water for the list of RCRA Order-Constituents of Potential Concern (RO-COPCs) submitted to EPA in

May 2015 (ERM, 2015). The human health Tier I SL concentration for each RO-COPC is a regulatory standard (e.g., maximum contaminant level [MCL]) or a risk-based value adjusted to a target hazard quotient of 0.1 and/or an excess lifetime cancer risk of $1x10^{-6}$ based on conservative, generic exposure assumptions. For ecological receptors, the lowest values from the sources cited above (EPA, 2005, 2015a; ORNL, 2015; Oregon Department of Environmental Quality [ODEQ], 1998) were used directly as Tier I SLs, regardless of relevance to the North Slope.

Tier II action levels (Tier II [ALs]) are also developed in this document. Tier II ALs are calculated risk-based concentrations protective of Site-wide human and ecological receptors specific to the North Slope, and use some Site-specific exposure factors. These Tier II ALs incorporate some of “the unique environmental characteristics of the North Slope” as described in the RCRA Order. Similar to the Tier I SLs, Tier II ALs for human health target a hazard quotient of 0.1 and a cancer risk of $1x10^{-6}$. For ecological receptors, the ALs are developed for representative species present in the Greater Prudhoe Bay area.

The SWMUs and AOCs at the Site are grouped into ten Project Groups (PGs), as outlined in Attachment C of the Order. Tier I SLs and Tier II ALs will be used to assist in risk evaluations and decisions regarding the need for, and extent of, additional investigative work at specific PGs, SWMUs, and AOCs. SLs and ALs will often be used in screening-level risk evaluations to focus the group of chemicals that will be evaluated in a baseline risk assessment.

A summary of the types of PGs containing the SWMUs and AOCs included in the Order is presented in Section 2 to provide context for the CSM, along with an overview of the environmental setting of the region. A technical overview of the CSM and risk assessment process is presented in Section 3, followed by a discussion of the Site-wide CSM in Section 4. The Tier I SLs are presented in Section 5, followed by the Tier II calculation methods and resulting Site-specific ALs in Section 6. A few additional considerations regarding Tier I SLs and Tier II ALs are presented in Section 7. References are listed in Section 8.

2. REGIONAL AND SITE SETTING AND PROJECT GROUP IDENTIFICATION

To provide context for the CSM, this section briefly describes the regional setting and PGs that have been developed as part of the Order.

2.1 REGIONAL AND SITE SETTING

The Site is located on the Arctic coastal plain along the North Slope of the Brooks Range in Alaska, 250 miles north of the Arctic Circle, 175 miles west of the Alaska-Canada border, and 1,300 miles south of the true North Pole. The North Slope of Alaska is located within an Arctic tundra biome. The tundra is water-saturated in many locations during the summer and becomes ice-rich frozen ground at the onset of winter. Summer thawing creates a heterogeneous thin layer of suprapermafrost groundwater perched above the frozen substrate, progressing to its maximum extent by September. The region is underlain by a continuous layer of permafrost that extends to a depth of approximately 2,000 feet below ground surface (bgs) near Prudhoe Bay.

The North Slope has a low topographic relief covered by numerous depressions and thermokarst troughs (i.e., land-surface configurations that result from seasonal freeze/thaw cycles in a region underlain by permafrost) that have formed surface water bodies of varying sizes and depths, many of them small and shallow. In the Prudhoe Bay region of the North Slope that encompasses the Site, over 40 percent of the landscape is comprised of ponds, lakes, and wetlands (Derksen et al., 1981). The most common type of wetland is termed “flooded tundra.” This wetland type includes shallow ponds and depressions that fill with water during the spring thaw, but are often dry by late summer. The bottoms of most wetlands are a consolidated mat of tundra and wetland vegetation. Only some of the deeper perennial lakes have bottoms made up of unconsolidated sediment (Derksen et al., 1981). Rivers and some lakes on the North Slope support fish such as Arctic char (*Salvelinus alpinus*), broad whitefish (*Coregonus nasus*), Dolly Varden (*Salvelinus malma*), and Arctic grayling (*Thymallus arcticus*). However, most ponds are shallow (less than 2 meters in depth), dry up in summer and/or freeze solid in winter, and do not support fish.

The Arctic coastal tundra is mainly a detritus-based trophic system that includes many animals that rely on dead organic matter as an energy source (MacLean, 1980). The area supports a relatively simple plant community that includes several grasses, sedges, willows, mosses, and flowering plants. Over 90 percent of the annual primary production enters the pool of dead organic matter where it is consumed by microorganisms and invertebrate detritivores in the tundra soil. In general, decomposition rates are low and dead organic matter accumulates in a layer of peat. Soils adjacent to surface water typically exhibit a thicker horizon of organic material. At specific locations surficial mineral soils may be present.

2.2 PROJECT GROUPS

SWMUs and AOCs at the Site were organized into PGs based on operational history. As outlined in Attachment C of the Order, BPXA has identified ten PGs containing SWMUs and AOCs:

1. Inactive Production Reserve Pits (PG I)

2. Inactive Exploration Sites (PG II)
3. Inactive Oily Waste Cells (PG III)
4. Tuboscope (PG IV)
5. Alaska Charter Sites (PG V)
6. Non-Charter Sites (PG VI)
7. Old Landfill Sites (PG VII)
8. Other Inactive Impoundments (PG VIII)
9. Active Operational Sites where Releases may have Occurred, Potential AOCs (PG IX)
10. Other Active Operational Sites (Solid Waste Cells) (PG X).

Detailed information regarding the history, sources, releases, chemicals, and remediation status for each of the ten PGs is provided in Parts I and II of the Site-Wide Project Work Plan (OASIS Environmental, Inc. [OASIS], 2008a, 2008b; ERM, 2015).

A brief discussion of each of the ten PGs is provided below to provide context for the Site-wide CSM. The release and transport mechanisms described in this section are incorporated into the Site-wide CSM. Refer to OASIS (2008a) for more information on the PGs and/or individual SWMUs and AOCs.

2.2.1 PROJECT GROUP I SWMUS: INACTIVE PRODUCTION RESERVE PITS

PG I contains the greatest amount of land by area covered in the Order. A total of 44 production pads contain inactive production reserve pits within the PBU. Drilling wastes have been removed from many of these pits. The drilling waste stored in, or removed from, the production reserve pits consist of drilling muds and cuttings generated when production wells were first drilled in the Prudhoe Bay field. The content of drilling muds present in the wastes has varied historically by date and use. Constituents present in drilling muds may include elemental metals such as aluminum, arsenic, barium, calcium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, mercury, nickel, potassium, sodium, strontium, and zinc. Inorganic constituents potentially present in drilling wastes include sodium hydroxide, hydrogen sulfide, salts, and additional elemental metals present in Alaskan soils. Organic constituents that may be present in drilling wastes include petroleum from oil-based drilling mud, crude oil, and other produced fluids from the subsurface formations.

Production reserve pit pads generally consist of a relatively flat 5- to 6-foot-thick gravel pad constructed directly on top of the native tundra mat. Mineral soils are generally present 12 to 18 inches below the bottom of the compressed tundra mat. Production reserve pits were often constructed along the edge of production pads or by encircling such areas with a roadway berm, and were not typically lined. Pad porewater migration through the pad or roadway berm is characteristically slow due to the limited volume of North Slope precipitation and short duration of the summer season.

Excavation of waste from reserve pits typically creates a pit floor that is below tundra grade. Water may accumulate in the pits from precipitation and snowmelt or if the adjacent tundra is water-saturated. A seasonally occurring layer of suprapermafrost groundwater within the active tundra soil zone overlies permafrost. The permafrost limits the vertical migration of hazardous constituents. For most PG I SWMUs, nearby surface water and tundra soils are likely the primary receiving medium of concern.

The most likely mechanisms for chemicals to reach tundra soil or surface water from excavated reserve pits include direct transport through culverts, where present (i.e., Drill Sites [DSs] 9, 16, and 17), and dispersion via pad porewater flow through pit walls. An additional, though rare, potential transport mechanism can involve failure of berms or overtopping of the pits during spring breakup prior to dewatering. The latter two mechanisms are also relevant for unexcavated reserve pits.

2.2.2 PROJECT GROUP II SWMUS: INACTIVE EXPLORATION SITES

A total of 43 inactive exploration pads are present within the Site where exploration activities took place but no production activities were initiated. Exploration sites are typically composed of a gravel pad, with a reserve pit similar to that described in Section 2.2.1 and a pit designed to contain a flare header (flare pit). Flare pits are discussed as part of PG VIII. Occasionally, a gravel road or runway is also present. Drilling wastes have been removed from many of the exploration reserve pit SWMUs. However, in some instances, drilling wastes remain in place. Drilling waste at these exploration sites contains elemental metals and petroleum constituents similar to those identified in Section 2.2.1. An inactive exploration pad generally consists of a relatively flat 5- to 6-foot-thick gravel pad constructed directly on top of the native tundra mat. Mineral soils are generally present 12 to 18 inches below the bottom of the compressed tundra mat. Porewater migration through the pad and other gravel features is characteristically slow due to the limited volume of North Slope precipitation and short duration of the summer season.

The most likely mechanism for chemicals to reach tundra soil or surface water from inactive exploration reserve pit SWMUs is dispersion via pad porewater flow through pit walls immediately adjacent to tundra.

2.2.3 PROJECT GROUP III SWMUS: INACTIVE OILY WASTE CELLS

The PG III SWMUs include four oily waste cells (one at Pingut Pad and three at Pad 3). The waste streams placed into these lined oily waste cells contained petroleum products, produced fluids, and drilling muds. Only the capped Pingut Pit still contains buried waste materials. These materials are frozen back into the subsurface permafrost. Oily waste cell contents, surrounding liners, and contaminated soils have been excavated and removed from the three waste cells at Pad 3. Petroleum product oily wastes within a cell may include:

- Storage tank washing wastes;
- Production separator sludge paraffins;
- Natural gas liquids;
- Oil-based drilling muds;
- Lost circulation material wastes from drilling;
- Wastes from well maintenance (workovers, wire line operations, and pigging pipes), and/or
- Petroleum-contaminated snow and gravel.

Elemental metals and petroleum constituents, as identified in Section 2.2.1, are present in the limited amount of drilling waste that has been placed in these waste cells.

The waste cells were constructed similar to a production or exploration reserve pit in a gravel pad, except that each of the oily waste cells was constructed with a containment liner to preclude migration of oil waste constituents to clean soils outside the cell, or to pad porewater. All four waste cells were located in close proximity to the edge of their respective pads.

Constituents in oily waste are contained and unlikely to migrate out of waste cells. Constituents could only migrate out of waste cells if both the waste thaws and liners fail. Under this type of unlikely scenario, constituents could potentially migrate from the pits via pad porewater flow through the active layer. No impounding of surface water occurs at these SWMUs (OASIS, 2008a).

2.2.4 PROJECT GROUP IV SWMU: TUBOSCOPE

PG IV consists of a single SWMU, a release area at the former Tuboscope facility. Interim measures began in 2000 and are ongoing at this SWMU, which is associated with a release of 1,1,1-trichloroethane (1,1,1-TCA) and related volatile organic compounds (VOCs). Interim measures include a recovery trench and a curtain liner to contain pad porewater for treatment and offsite disposal, and to preclude migration of pad porewater containing 1,1,1-TCA to the off-pad environment. This site has a different contaminant signature than those of sites in PGs I through III, and includes chlorinated solvents, diesel fuel, and lead associated with operations at the former Tuboscope building. Potential impacts from drilling mud makeup-ingredients, including the elemental metals identified in Section 2.2.1, may also represent a concern due to the location and operation of a nearby former drilling mud plant. Some structures on the pad are located near the area of VOC contamination that may allow for the added transport mechanism of volatilization of chemicals from the subsurface to indoor air, which is relevant for industrial workers occupying slab-on-grade buildings. Otherwise, transport mechanisms are expected to be limited to a subset of those discussed for PG I sites, due to the absence of culverts. In addition, overland flow and snow removal activities could transport chemicals from the pad to the tundra.

2.2.5 PROJECT GROUP V SWMUS: ALASKA CHARTER SITES

PG V contains 15 AOCs primarily associated with releases of crude oil, refined petroleum products, or solvents onto gravel pads. Remediation is to be completed after pad abandonment, as outlined in the Charter Agreement executed between BPXA, Atlantic Richfield Company (ARCO), and ADEC in 1999 (State of Alaska, 1999). One of these AOCs, the ARCO Drum Storage Maintenance (DSM) Shop, is associated with a release of both petroleum products and chlorinated solvents. Another AOC, ARCO Point McIntyre PM-1, resulted from releases of crude oil, petroleum products, and limited amounts of drilling muds. The majority of PG V sites have either already been remediated, or are undergoing remediation or monitoring per ADEC requirements, regardless of the current pad status. Several of the PG V sites have either received closure from ADEC or are awaiting closure.

Potential transport mechanisms are expected to be limited to a subset of those discussed for PGs I through IV, including potential vapor intrusion in areas where buildings are present directly atop the pad and VOCs have been released. Potential chemical transport is predominantly through pad porewater migration and includes petroleum constituents such as polycyclic aromatic hydrocarbons (PAHs) and benzene, toluene, ethylbenzene, and xylenes

(BTEX). Expanded thaw bulbs beneath heated buildings that sit on top of impacted areas may influence pad porewater transport. The ARCO DSM Shop contains slab-on-grade structures above the VOC contamination. This may allow for volatilization from the subsurface to indoor air, which is relevant for human receptors.

2.2.6 PROJECT GROUP VI SWMUS: NON-CHARTER SITES

PG VI SWMUs include primarily petroleum-related releases from locations such as fueling islands (upland on pads), loading docks (near Prudhoe Bay), and releases to pits (various VOCs contained in a spilled registered product) or tundra (pipeline spill). These spill sites are not included in the Charter Agreement. Remedial measures have been completed at several sites and are ongoing at others.

The petroleum releases at these SWMUs include both refined products and crude oil. Additionally, the registered product (Therminol) release at one SWMU includes light-end hydrocarbons. Constituents in all PG V releases include PAHs and BTEX compounds.

In at least one case (VOC spill), impact to vegetation on the tundra is suspected. The other most likely mechanism for chemicals to reach tundra surface water and soil is migration via pad porewater flow through the active layer in the walls of pits, pads, or other gravel structures.

2.2.7 PROJECT GROUP VII SWMUS: OLD LANDFILL SITES

PG VII contains five old landfill SWMUs (Sand Dunes Landfill, the former Pad 13 Waste Pile, Surfcote Waste Pile, ARCO Hanger Site, and C Pad) that primarily contain metal and debris from a variety of historic operations. Three of the five SWMUs (ARCO Hanger Site, C Pad, and Sand Dunes Landfill) also contain/contained ash from historical burning operations, and/or crushed and buried drums.

Suspected waste buried at the Sand Dunes Landfill may include:

- Construction project scrap metal;
- Empty and crushed drums, pipes, valves, conduit, and wire;
- Drilling mud;
- Oil field chemicals;
- Fuel-contaminated materials;
- Wrecked vehicles and aircraft;
- Tires;
- Used lead-acid batteries;
- Ash from on site and from the main camp waste and sewage burning/incineration activities, and
- Insulation.

The specific materials buried at former Pad 13 are largely unknown; however, ferrous metal debris is known to be present in the subsurface at this location.

These sites are anticipated to have the widest variety of potential contaminants and have been termed “exceptional sites”. A wider spectrum of Chemicals of Interest (COIs; e.g., VOCs, semivolatile organic compounds [SVOCs], and metals) will be applied to these sites. When warranted, additional groups of chemicals, including dioxins and polychlorinated biphenyls (PCBs), may also be identified as COIs at the old landfill sites.

Potential transport mechanisms at these sites will have some similarity to the PG I through VI sites, but some will include their own unique characteristics. Two of the landfill sites (Pad 13 Waste Pile and Sand Dunes Landfill) are located in close proximity to the Sagavanirktok River and may have unique transport mechanisms associated with their location. These include potential transport to the river through seeps or overland flow. Portions of Sand Dunes Landfill have an atypical surface soil lithology relative to other SWMUs (i.e., unconsolidated sand). Wind erosion and enhanced permeability could be significant transport mechanisms here.

2.2.8 PROJECT GROUP VIII SWMUS: OTHER INACTIVE IMPOUNDMENTS

PG VIII consists of four types of inactive impoundments (flare pits, seawater displacement pits, relief pits, and drill rig wastewater lagoons) consisting of more than 74 SWMUs. These impoundments are generally constructed similar to exploration and production reserve pits within or adjacent to a production or operation pad. Investigation activities have not been conducted at these SWMU sites, so the nature of potential contaminants has not been identified. Many may never have been used. If releases did occur, it is anticipated that transport mechanisms would be similar to those identified for PG I sites. Constituents that may be present will be primarily associated with complex hydrocarbon mixtures containing PAH and BTEX compounds. In addition to the petroleum constituents, relief pits may also contain freeze protection chemicals such as methanol and corrosion inhibitor, or biocide compounds, which can include various aldehydes and metals such as aluminum, arsenic, and zinc.

2.2.9 PROJECT GROUP IX AOCS: ACTIVE OPERATIONAL SITES WHERE RELEASES MAY HAVE OCCURRED, POTENTIAL AREAS OF CONCERN

PG IX contains the largest number of individual AOCs of any of the ten PGs. There are approximately 1,560 well cellars located at 51 pads within the Site included in this PG. This PG also includes three fire training grounds and nine flare pit SWMUs. Flare pits are similar in structure to inactive reserve pits and may be located on- or off-pad. Therefore, the discussion regarding chemical fate and transport provided for PG I sites is also relevant for the pits included in this group. Dispersion of chemicals to off-pad locations is not anticipated from the well cellars due to their small footprints and the relatively large distances from the edges of the pad. The well cellars do provide a potential for occasional short-term indoor air inhalation by workers. These areas are confined spaces and are managed as such. Hazardous constituents associated with flare pits and the well cellars are also primarily those constituents associated with produced oil and gas including PAHs and BTEX compounds. Additional well cellar constituents may include freeze protection chemicals such as methanol, corrosion inhibitors, biocide compounds such as aldehydes, and metals such as aluminum, arsenic, or zinc.

Although fire training grounds may additionally contain persistent and bioaccumulative substances, they should have similar release and transport mechanisms to those previously identified for PG I sites, with the exception of the Eastern Operating Area (EOA) fire training ground located within the boundary of the Sand Dunes Landfill. Potential transport mechanisms at this fire training ground may be affected by the landfill setting and the unique sand dunes soil lithology, as discussed in Section 2.2.7. Overland flows of firefighting water also may be a transport mechanism here.

2.2.10 PROJECT GROUP X SWMUS: OTHER ACTIVE OPERATIONAL SITES (SOLID WASTE CELLS)

PG X includes five active lined solid waste storage cells on separate pads within the PBU. These cells consist of pits located either within or atop gravel pads, or former inactive production reserve pits. Surface water monitoring occurs annually at each location for BTEX and metal constituents, with the exception of West Pit at Pad 3. Potential transport mechanisms are expected to be consistent with those previously discussed for PG III pits because of similarities in pit liner construction and the structure and maintenance of the pads.

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3. TECHNICAL OVERVIEW

This section presents an overview of the Ecological Risk Assessment (ERA) and Human Health Risk Assessment (HHRA) processes to be implemented under the Order. The intent is to be consistent with federal EPA and Region 10 guidance, as well as fulfilling the expectations of ADEC under their *Risk Assessment Procedures Manual* (RAPM) (ADEC, 2015). The focus of this discussion is on the CSM portion of the process, consistent with the goals of this document.

The EPA has developed HHRA and ERA guidance for the Superfund program (EPA, 1989, 1998), which is also considered to be relevant under RCRA (EPA, 1996a). Therefore, the Superfund-based approach and guidance documents are typically incorporated into the RCRA process, as described by EPA (1996a). EPA Region 10 has published regional supplemental human health and ERA guidance, which is consistent with this overall approach (EPA, 1996c, 1997). Also, Region 10 has published the *Interim Final Guidance: Developing Risk-Based Cleanup Levels at Resource Conservation and Recovery Act Sites in Region 10 (Guidance)* (EPA, 2001a) and specific guidance on the evaluation of trichloroethylene (TCE) (EPA, 2012a). These guidance documents are used as the framework for the technical approach outlined herein, augmented by more recent EPA documents including but not limited to *Risk Assessment Guidance for Superfund, Part E* (dermal; EPA, 2004), *Exposure Factors Handbook* (EPA, 2011b), and regional screening level (RSL) tables, equations, and assumptions (EPA, 2015b,c). State of Alaska guidance was also consulted and incorporated into the technical approach (ADEC, 2010, 2015).

A CSM is a description of how chemicals released into the environment can interact across media and lead to potential exposure by humans or ecological receptors. A CSM typically includes schematic diagrams that show how chemicals may be released and transported, and ultimately reside, in the environment, and the different ways in which people and animals (i.e., receptors) may be exposed to chemicals at a given site (e.g., direct contact with soil by an industrial worker). In this report individual CSM diagrams are presented for ecological and human health exposure scenarios. The Site-wide ecological CSM diagram is presented on Figure 1. The Site-wide human health CSM diagram is shown on Figure 2. The Site-wide CSM is described in Section 4, with specific details regarding ecological receptors in Section 4.6 and human receptors in Section 4.7.

3.1 APPROACH AND OBJECTIVES

The intent of this portion of the document is to present a Site-wide CSM that covers the primary chemical fate and transport mechanisms, receptors, and exposure routes relevant across most SWMUs. The Site-wide CSM addresses both ecological and human health exposure scenarios. By necessity, the Site-wide CSM is designed to incorporate the variability of exposure routes and receptors across SWMUs and AOCs. This Site-wide CSM can be adapted to represent the subsets of exposure scenarios potentially relevant to any SWMU, AOC, or PG, although in some instances it may be necessary to add exposure scenarios or modify existing ones based on individual site considerations. It is expected that in some cases multiple SWMUs can be grouped together for evaluation based on their similarities using a subset of this overall CSM. Risk assessments could then be performed as needed on each group of similar SWMUs (i.e., a "portfolio" of SWMUs).

The overall objective of risk assessment is to identify potential hazards, assess probable exposures, quantify dose-response functional relationships between levels of exposure to chemicals and environmental effects, and characterize the overall magnitude of risk. These risk assessments will be decision-making tools that will contribute to proper remedy selection. In some cases, this may result in additional remediation or operational/institutional controls, while for other units the outcome may be that no further actions are needed.

Due to the nature of the undeveloped North Slope environment, invasive activities (e.g., removal and/or replacement of topsoil and the associated plant community on the native tundra) should be carefully considered relative to other activities, because long-term negative physical impacts to the habitat may outweigh impacts from chemical exposures. For example, some of the tundra plant communities in the North Slope take over 100 years to develop. In addition, over-excavation could result in creation of artificial ponds/lakes where moist or wet tundra formerly existed. Recovery time (including the effects of any mitigating measures such as importation of local fill/topsoil, transplant plots of native vegetation, etc.) needs to be weighed against potential risk from chemical exposure in the absence of remediation, and risk management decisions should be considered in that light.

By using the portfolio-based approach (i.e., grouping similar SWMUs into a single risk assessment) described above, the number of risk management decisions will also be reduced because a single decision can be applied to sites with similar risk characteristics. There may be a need to include smaller groups of SWMUs or AOCs in a portfolio if a specific set within a PG has unique features that require separate evaluation (e.g., closed inactive reserve pits with culverts through the berms).

Figure 3 presents a schematic cross-section of the common site elements discussed in Section 2 and the features discussed above. This schematic cross-section shows the relative elevations of pads, pits, tundra ponds/lakes, and upland tundra, and provides an indication of the relative depth of suprapermafrost groundwater and pad porewater during annual freeze and thaw cycles. This serves as the basis of much of the discussion provided in Section 4. Further information is provided in OASIS (2008a, 2008b) and ERM (2015).

3.2 CONCEPTUAL SITE MODEL DEVELOPMENT GUIDANCE

Both EPA and ADEC identify development of a CSM as one of the key first activities in the risk assessment process. EPA (1989) describes the CSM (referenced as a Conceptual Evaluation Model) as follows:

> “The risk assessor should formulate a conceptual model of the site that identifies all potential or suspected sources of contamination, types and concentrations of contaminants detected at the site, potentially contaminated media, and potential exposure pathways, including receptors.”

This is part of Stage 1 of the data quality objective (DQO) process, as outlined by EPA (1987), and is designed to be conducted at the start of the Superfund remedial investigation/feasibility study (RI/FS) process using existing information. Analogously, this would be conducted during the initial RCRA Facility Investigation (RFI) and Corrective Measures Study (CMS) steps of the RCRA Corrective Action process.

ADEC provides more details on CSMs in their *Draft Guidance for Developing Conceptual Site Models* (ADEC, 2010). In addition to a description similar to that quoted above from the EPA, they identify the following as criteria to be included in a CSM:

- Routes the chemicals may take as they move through soil, groundwater, and/or surface water (migration routes);
- Possible types of people or animals who could be exposed (potential receptors), and
- Present and future ways people or animals may be exposed (exposure pathways).

ADEC also states that a CSM guides the site characterization process, because it helps identify DQOs, the need for additional sampling, and risk management decisions at a site. ADEC requires submission of a graphical or pictorial CSM as the key deliverable, with supporting text describing each element of the diagram.

The CSM development process has been formalized in a method developed by the American Society for Testing and Materials (ASTM International; ASTM, 2014), which includes the following basic activities:

1. Identification of potential contaminants;
2. Identification and characterization of the source(s) of contamination;
3. Delineation of potential chemical migration pathways through environmental media such as groundwater, surface water, soils, sediment, biota, and air;
4. Identification and characterization of potential environmental receptors, and
5. Determination of the limits of the system boundaries (e.g., on-pad, or “developed land,” and off-pad, or “undeveloped land” areas).

These activities are consistent with those listed as “common elements” in human and ecological CSMs by ADEC (2010), which include:

- Source;
- Release mechanism;
- Impacted media;
- Transport mechanisms;
- Exposure media; and
- Exposure routes and receptors.

The ASTM activities list is more comprehensive than that provided by ADEC; therefore, the ASTM categories were used as a convenient way to discuss the separate components of the CSM. The Site-wide CSM discussed in Section 4 is organized consistent with the five ASTM activities.

Although some exposure scenarios presented in the Site-wide CSM may not lead to significant exposure, such decisions are made later in the process when the CSM is refined as additional data are collected and data gaps addressed. In this report, the goal is to develop a set of exposure scenarios potentially relevant across the Site that will comprise the Site-wide CSM.

The Site-wide CSM can subsequently be amended or refined to reflect the conditions at a specific PG, SWMU, or AOC, so that differentiation between significant, insignificant, and incomplete exposure scenarios can be made with a greater degree of confidence.

Additional or modified exposure scenarios that may be uniquely applicable to an individual SWMU, AOC, or PG, but are not presented in the Site-wide CSM, will be presented in relevant individual site investigation work plans and reports. A key concept in this CSM is the differentiation between on-pad (i.e., developed) and off-pad (i.e., undeveloped) locations. Essentially all human activities associated with oil-field operations at the Site occur on raised pads or in bermed pits. Current human activities are associated with activities occurring at these locations, which by definition are developed areas. Areas outside of pads (and pits) are native tundra with no human development. For HHRA these descriptions are important to distinguish between areas reasonably accessible and not easily accessible to current industrial workers. For ecological risk assessment, the descriptions are important for distinguishing natural, intact habitats from operationally disturbed areas. As shown on the CSM, different uses and characteristics of on-pad and off-pad environments are incorporated into the identification of appropriate receptors and exposure scenarios.

A tiered approach is presented for risk assessment, beginning with a conservative, generic risk-based screening evaluation using Tier I SLs. This may be followed by a Tier II evaluation using Tier II ALs that are relevant to the Site and subsequently are appropriate for a particular SWMU (SLR, 2014). These different tiers of evaluation are placed into context in the following discussion of the regulatory framework under which the work is being conducted.

3.3 RISK ASSESSMENT GUIDANCE FRAMEWORK

The risk assessment process, as practiced by EPA and ADEC, is comprised of several activities, some of which can be conducted concurrently, while others are sequential. Generally, the process is iterative. Initial conservative screening methods are used to identify which chemicals, receptors, and exposure scenarios may be relevant for further evaluation; these are then further evaluated in more detail in a risk assessment.

3.3.1 ECOLOGICAL RISK ASSESSMENT

The overall eight-step process for ERA under EPA guidance is presented on Figure 4 (EPA, 1998). The first two steps incorporate a conservative screening evaluation to identify if more rigorous evaluation is necessary. Step 3, “Problem Formulation,” is where the scope of the assessment is identified based on the results of the initial screening evaluation. The CSM is part of this step, and can be iterative. Step 4 involves study design to answer the questions asked in the Problem Formulation, with the baseline risk assessment continuing in Steps 5 through 7. Development of SLs and ALs can be incorporated into Steps 1, 2, and 3.

The EPA has further compartmentalized the screening process encompassing Steps 1 and 2 in an Eco Update (EPA, 2001b). The first step in this more detailed description is the *Screening-Level Problem Formulation and Ecological Effects Characterization* (EPA, 2001b). Step 1 includes the following components:

- Identification of environmental setting and preliminary contaminants of concern;
- Determination of contaminant fate and transport pathways;

- Description of contaminant mechanisms of ecotoxicity and categories of receptors likely affected;
- Identification of complete exposure pathways and selection of generic assessment endpoints;
- Selection of screening ecotoxicity values, and
- Evaluation of uncertainties.

This demonstrates that Tier I SLs are relevant for inclusion in Step 1 (selection of screening ecotoxicity values). The first four of the components listed above are incorporated into the Site-wide CSM.

The Site-wide CSM serves as a basis for the scope and nature of the ERAs that may need to be conducted under the Order. CSM development under the ADEC is outlined in *Policy Guidance for Developing Conceptual Site Models* (ADEC, 2010) and *Ecoscoping Guidance* (ADEC, 2014). For ecological receptors, this is generally consistent with both the ASTM and EPA procedures.

As shown on Figure 5 (adapted from EPA, 1997), the initial screening activities (Steps 1 and 2) feed into Steps 3 and 4, which both are incorporated into the work plan, sampling and analysis plan, and site investigation. The data collected in these steps are then used to conduct the baseline risk assessment (Steps 5 through 7).

Use of Tier I SLs is analogous to the first iteration of the problem formulation (i.e., Step 1 of the screening evaluation), and use of the Tier II Site-specific ALs is analogous to the second iteration of the problem formulation component of an ERA (i.e., Step 3, CSM development). Figures 4 and 5 present an overview of where ERA fits into the RI/FS (or RFI/CMS process) and where CSM development fits into that process for ERA.

3.3.2 HUMAN HEALTH RISK ASSESSMENT

The human health process is similar in design to ERA as shown on Figure 6, which presents the process under ADEC (2015) guidance. The initial step is a scoping meeting, similar to EPA's Step 1 for ERA, in which the presence or absence of habitat and receptors is identified. The next step is preparation of the CSM, which is the primary purpose of this document. The approach applied to address human health risk is provided in detail in the EPA *Risk Assessment Guidance for Superfund* (RAGS) documents (EPA, 1989), in supplemental guidance from Region 10 (EPA, 1996c), and in other more recent EPA documents as previously cited. Other more recent EPA documents are cited in the relevant sections in which they are used. In addition, ADEC has a separate but comparable risk assessment process, as presented in the RAPM (ADEC, 2015). Under both approaches, development of a CSM is an initial objective, and both approaches are similar with respect to how a CSM is developed.

Because both EPA and ADEC guidance are relevant for this site, and nomenclature differs between the two organizations, it is useful to identify the relevant phases of the project in relation to each set of guidance documents. Use of Tier I SLs under EPA guidance is analogous to the Method 2 HHRA process under ADEC, in that the adjustments made to the Method 2 CLs to consider cumulative risks from multiple chemicals are incorporated into the Tier I SLs. The Tier II AL evaluation is mostly analogous to Method 3 under ADEC, in that exposure assumptions are adjusted based on Site-specific factors, but otherwise is consistent with a Method 2-level evaluation. The Tier II ALs incorporate cumulative risks as is done in Tier I by targeting a hazard quotient of 0.1 (rather than the individual chemical target of 1.0) and a cancer risk of $1x10^{-6}$ (rather than the individual chemical target of $1x10^{-5}$). Implementation of “baseline assessments” is analogous to the Method 4 process within ADEC. ADEC allows both Tier I and site-specific levels (e.g., Tier II ALs) to be incorporated into a Method 4 evaluation, as long as work plans have been approved.

4. SITE-WIDE CONCEPTUAL SITE MODEL

A CSM is developed to facilitate the analysis of potentially complete exposure pathways at a contaminated site. As an important preliminary step in the exposure portion of a risk assessment, the CSM schematically represents the relationship between chemical sources and receptors at a site, and identifies potentially complete and significant pathways through which receptors may be exposed. Site-wide CSM diagrams (Figures 1 and 2) address ecological and human health exposure scenarios, respectively. The first three parts of the CSM that discuss the chemicals, exposure areas, and contaminant transport mechanisms for a site are relevant to both the ecological and human health portions of a CSM. These components of the Site-wide CSM are discussed in the following sections, followed by separate discussions of the receptors and exposure scenarios specific to the ecological and human health CSMs.

4.1 IDENTIFICATION AND CHARACTERIZATION OF CHEMICALS

Hazardous constituents relevant to the Site considered in the Site-wide CSM, and for SL and AL development, can be primarily divided into three general categories:

- Petroleum products (including BTEX and PAHs);
- Metals, and
- Non-petroleum based VOCs.

Occasionally, other types of chemicals may be encountered (e.g., phenols, solvents, SVOCs). Over 60 substances were initially identified as RO-COPCs, as documented in Part I of the Site-Wide Project Work Plan (ERM, 2015). Detailed information on the identification and characterization of these constituents is contained in the ERM (2015) report. The final list of RO-COPCs has not been formally approved by EPA; therefore, the chemicals for which Tier I SLs and Tier II ALs are developed are subject to change.

4.2 IDENTIFICATION AND CHARACTERIZATION OF CHEMICAL SOURCES

North Slope Crude (NSC) oil and diesel refined from NSC oil are the primary sources of hydrocarbons released from SWMUs, AOCs, or PGs. Total petroleum hydrocarbons (TPH) and associated BTEX and petroleum PAHs are assumed to originate from these sources. The primary source of hydrocarbons by volume is drilling or workover fluids and muds, which are present primarily in reserve pits (inactive production and exploration). Other potential sources of contamination are oily waste cells, drill site relief pads, well cellars, and flare pits. Drilling fluids/muds contain a mixture of chemicals. Reserve pits contain drilling muds generated during well drilling, development, and production. Additional chemical sources include landfilled wastes, spill and release sites, and storage cells.

The types of chemicals expected to be encountered were described by individual PG in Section 2. Part II of the Site-Wide Work Plan (Identification of Constituents of Potential Concern; ERM, 2015) provides details about chemicals that may be encountered and their sources across the Site.

4.3 DETERMINATION OF LIMITS OF THE STUDY AREA

Study areas typically include a source (or suspected source) area (e.g., SWMU, AOC, or a portfolio comprised of multiple similar sources) and surrounding lands where released constituents may have been transported (i.e., exposure areas and media). Study areas are defined by the limits of contamination and may extend beyond the physical site boundaries. Study areas may include both “developed” and “undeveloped” areas. These geographical distinctions are also referred to as “on-pad” and “off-pad”. “Developed” areas are defined as within the boundaries of a pit, pad, road, airstrip, or landfill, or any other area where physical changes have been made to the terrain as part of PBU operations. “Undeveloped” areas are generally defined as the native tundra. Therefore, all “developed” scenarios include disturbed areas, while “undeveloped” scenarios include undisturbed areas. Some sites have had activities occur outside the pad or pit areas (e.g., stabilizing berms or backfilled gravel areas that have gone beyond the current pad or pit footprint). In these cases, such disturbed off-pad areas would still be referred to as “developed” to differentiate them from native tundra. For HHRA these descriptions are important to distinguish between areas reasonably accessible and not easily accessible to current industrial workers (Figure 2). For ecological risk assessment the descriptions are important for distinguishing natural, intact habitats from operationally disturbed areas (Figure 1).

4.4 DELINEATION OF MIGRATION PATHWAYS

Many SWMUs and AOCs consist of pads and/or pits. By area, reserve pits (PG I and II sites) represent the largest potential source of chemicals. Pits, pads, landfills, and the other sources described in Section 2 contain primary source media, which may become exposure media and/or represent the starting point for chemical migration pathways. In large part, migration pathways for chemicals through and across pads will be similar to those for chemicals contained within pits on pads.

Based on the variety of sites included under the Order, the following primary release mechanisms and fate and transport mechanisms were identified:

- Primary Release Mechanisms:
    - Direct release to tundra (soil and surface water)
    - Direct release to gravel pad, pit, or impoundment
- Primary Fate and Transport Mechanisms:
    - Partitioning (i.e., solubilization and adsorption) and dispersion
    - Volatilization
    - Wind erosion

Each of the potentially significant primary transport pathways listed above is associated with a somewhat different degree of potential chemical transport. All of these primary release mechanisms and transport processes are depicted on the Site-wide CSM diagrams (Figures 1 and 2), and each is discussed in more detail below. Other less common potential transport processes are described in Section 4.4.9. This Site-wide CSM is intended to be comprehensive, but it is possible that some SWMUs will have unique release mechanisms or transport processes not described in this CSM. These will be addressed on a project-specific basis in the project-specific RFI and updated as needed in the project-specific RFI report.

Prior to discussing the primary release mechanisms and transport pathways listed above, several terms are defined as they pertain to the Site-wide CSM.

Active layer water within pads is referred to as pad porewater, while active layer water beneath tundra, or within the tundra underlying a pad or pit, is referred to as suprapermafrost groundwater. For pits located within pads where the pit bottom extends to the tundra, the area beneath the pit may contain suprapermafrost groundwater. For pits that are completely contained within pads, water within the pit walls and floor is considered pad porewater. Examples of these features are illustrated on Figure 3.

Surface water impounded within a pit is referred to as pit impoundment surface water, while surface water in the tundra (e.g., ponds, lakes, rivers, and other surface water features) is referred to as tundra surface water.

The material used to construct man-made features such as pads, roads, and pit berms is composed primarily of gravel and may contain finer particles integrated in a gravel/soil matrix. For the Site-wide CSM, this material is referred to as gravel (also known as pad material).

The term soil is used broadly to represent the mineral matrix supporting most of the vegetation in the PBU (both upland and wetland). The material within pits is also considered soil, even though this material may sometimes be covered with water. Most of the tundra surface water body and wetland bottoms have a matrix consisting of consolidated tundra vegetation that is structurally similar to upland tundra vegetation. Given that the upland and wetland tundra communities that dominate the landscape have similar ecological structure and function, the mineral matrix supporting all of these various communities is evaluated as soil.

Sediment is defined as loose particles of sand, clay, silt, and other substances that settle at the bottom of a water body. As mentioned above, water bodies within developed areas such as reserve pits are considered to contain soil, not sediment. Although some wet tundra areas may consist of soil that is perennially saturated with water, these areas typically do not have unconsolidated bottoms and are also considered to contain soil rather than sediment.

4.4.1 DIRECT RELEASE TO TUNDRA

This release mechanism involves spills or other releases directly to tundra soil or surface water. This can range from a spill off-pad to failure of a berm through thermokarsting and mass movement of material from pits or pads directly to the tundra. A direct release to tundra is a rare occurrence across the PBU due to maintenance activities and operational requirements (e.g., annual removal of impounded water).

4.4.2 DIRECT RELEASE TO GRAVEL PAD, PIT, OR IMPOUNDMENT

This release mechanism involves spills or other releases directly to a pad, pit, or impoundment.

4.4.3 PARTITIONING

Partitioning processes such as solubilization and adsorption occur as equilibrium is established in the subsurface. These processes allow for chemical phase transitions (e.g., chemicals adsorbed to soil can become dissolved in water), which can result in substantial inter-media transfer over time. After solubilization, dispersion (diffusion and advection) can transport chemicals dissolved in suprapermafrost groundwater or in pad porewater, as described further below.

4.4.4 VOLATILIZATION TO AIR

Volatilization from soil or water to indoor and outdoor air can occur when VOCs are present. Most operational buildings in the PBU are constructed atop posts that provide several feet of separation from the ground surface, and chemical transport to indoor air is not expected to be a complete transport mechanism for these structures. Volatile chemicals in the other developed portions of sites may, however, be transported to indoor air when buildings are located directly atop gravel pads, such as well houses and slab-on-grade buildings. There are few slab-on-grade buildings in the PBU, and even fewer cases where VOCs are present in soil or pad porewater near to or beneath such buildings.

Chemicals may also volatilize to indoor air during domestic use of surface water such as showering, dishwashing, etc. This transport mechanism would only be significant in a hypothetical future residential scenario (including potential residence by future subsistence users). Volatilization to outdoor air is considered to be a potentially complete and significant pathway.

4.4.5 WIND EROSION

Wind erosion can lead to short-term suspension and transport of surface particulates in the atmosphere, followed by deposition to soil. However, due to the climate in the North Slope, soils are often frozen or covered with snow or ice, reducing the potential for this transport mechanism to result in substantial movement of particulates. At some sites, such as the Sand Dunes Landfill, this may be a more substantial transport mechanism as evidenced by the presence of sand dunes.

Suspension of surface particulates due to wind erosion can also result in fugitive dust in outdoor air, which may be inhaled by outdoor receptors. In most cases this is not expected to result in significant chemical exposures, but wind erosion may be an important transport mechanism near roads or pads with heavy traffic, and in areas where dust generation is significant on a regular basis.

4.4.6 SECONDARY/TERTIARY SOURCE MEDIA

Through the release/transport mechanisms described above, chemicals move into what are referred to as secondary source media, including the following:

- Surface water (in pits and/or on the tundra, including tundra ponds, lakes, and rivers, as well as other surface water features such as thermokarst troughs);
- Pad porewater or suprapermafrost groundwater beneath pads or pits;
- Suprapermafrost groundwater (in tundra);
- Sediment (in tundra);
- Soil (in pits, pads, or tundra);
- Air (indoor and/or outdoor, through volatilization), and

- Air (outdoor, through adsorption to dust particles that are mobilized through wind erosion).

Constituents in these secondary media can be transported to other media through secondary and/or tertiary transport mechanisms. These are essentially the same processes described above, but now serve to provide additional mechanisms for chemical transport through and between developed and undeveloped areas, and between different media. Following transport to secondary/tertiary source media, additional transport mechanisms such as suprapermafrost groundwater discharge, dust deposition, and uptake to biota can also occur. Each of these is summarized on Figures 1 and 2. Transport from pits and via pad porewater and suprapermafrost groundwater are further discussed below.

4.4.7 TRANSPORT THROUGH CULVERTS, BERM REMOVAL, OR PIT OVERTOPPING

Three of the production reserve pits excavated and closed under ADEC and EPA oversight have been culverted to allow for direct flow of surface water to the tundra. Culverts have been installed at DS9, DS16, and DS17. Surface water from each pit is directed to a culvert that drains to the native tundra just outside the berm. This reduces the water level in the pit, which in turn reduces the hydraulic head, migration through pit walls, and severity of overland flow during breakup. Reserve pit soil is unlikely to be discharged via this process as the discharge culvert is generally located approximately two feet above the top of pit soil. Therefore, there is a low probability of soil discharging through the pipe.

Transport through culverts is more likely to lead to direct discharge of chemicals to surface water in the tundra, because some culverts outlet into wet areas. Such discharge provides a direct transport mechanism for chemicals present in pit impoundment water to contact the tundra at the end of the pipe.

Another potential way to transport excavated production reserve pit impoundment water to the tundra is partial berm removal. In the event that berm removal is implemented as part of a final remedy in the future, reserve pit impoundment water and/or soil could also be transported to the tundra via this mechanism.

Pit overtopping by impoundment surface water was considered as an additional transport mechanism. Because annual dewatering is required by ADEC to prevent overtopping, this transport mechanism is considered extremely unlikely to occur. Such transport should only occur if a culvert becomes plugged, if annual pit dewatering is significantly delayed, or if a catastrophic breach of the pit berm has occurred. The effects should be the same as those resulting from flow through culverts or berm removal. Because this would be a rare event, it is not expected to contribute appreciable exposure to receptors.

4.4.8 SUPRAPERMAFROST GROUNDWATER TRANSPORT/PAD POREWATER TRANSPORT

Chemicals dissolved in suprapermafrost groundwater or pad porewater may be transported within the active layer by dispersion (diffusion and advection). The active layer often extends 1.5 to 3 feet below the ground (or pad) surface, although this can be deeper at some locations. When pad porewater or suprapermafrost groundwater is in direct communication with surface water, dispersion may transport dissolved chemicals from the subsurface to surface water. In some situations, chemicals may also be transported to sediment or saturated soil through suprapermafrost groundwater.

4.4.9 ADDITIONAL TRANSPORT MECHANISMS

Additional potential transport mechanisms were identified, but were not included in the CSM diagrams (Figures 1 and 2) due to their relatively minor potential to contribute to contaminant transport and receptor exposure. These mechanisms will be evaluated when they occur at a project site and are discussed below.

Surface Sheet-Flow

Surface flow can transport contaminants across the pad surface to the surrounding tundra, or to pits contained within the pad. This flow is expected to be minimal at most pads because of the affinity of pad materials to absorb water as pad porewater. Most of the flow associated with chemicals contained in gravel pads would be through pad porewater and then through pad berms to the surrounding tundra, or through suprapermafrost groundwater transport, as discussed in Section 4.4.8. This transport mechanism is not shown on the CSM diagrams.

Water Erosion

Water erosion has been observed at sites located adjacent to rivers or to the coast, resulting in potential chemical transport from these sites to surface water and/or sediment via gullies or intermittent streams. This can occur wherever there is a sufficient change in topography. However, there are very few SWMUs and AOCs where this process could be significant.

Groundwater Transport

Additional transport mechanisms that would normally be included in a CSM, such as percolation and dispersion to groundwater aquifers, are not relevant due to the year-round presence of permafrost. For most of the year, the permafrost extends upward to the ground surface, and even in the summer months, the extent of thawing in the soil is typically less than one meter. The mechanisms typically associated with groundwater are only relevant in terms of suprapermafrost groundwater or pad porewater, as discussed above.

4.5 EXPOSURE PATHWAYS

For an exposure pathway to be complete, chemicals from source media must be transported to a receptor that is both exposed to and able to absorb the chemical. The EPA (1989) describes a complete exposure pathway in terms of four components:

1. A source and mechanism of chemical release (e.g., a surface spill at the pad edge);
2. A retention or transport medium (e.g., shallow soil);
3. A receptor at a point of potential exposure to a contaminated medium (e.g., plant growing in soil), and
4. An exposure route at the exposure point (e.g., root uptake).

If any of these four components are not present, then a potential exposure pathway is considered incomplete and is not evaluated further. If all four components are present, a pathway is considered potentially complete.

The EPA (1989) further divides potentially complete exposure pathways into two groups: potentially complete and significant, and potentially complete but insignificant. These divisions are used to classify the pathways depicted on Figure 1 and Figure 2. Potentially complete and significant exposure pathways are those expected to result in the majority of exposure to a particular medium and location (i.e., exposure point), and are typically quantitatively evaluated in risk assessments. Potentially complete but insignificant pathways are those likely to result in minimal or insignificant exposure (and thus, risk) relative to significant pathways, and may be eliminated from quantitative evaluation. EPA (1989) identifies the following scenarios under which the identification of a complete pathway as insignificant may be justified:

- The exposure resulting from the pathway is much less than that from another pathway involving the same medium at the same exposure point;
- The potential magnitude of exposure from a pathway is low, or
- The probability of the exposure occurring is very low and the risks associated with the occurrence are not high).

The decision to identify a pathway as complete but insignificant should be based on professional judgment and experience, and the reasons for the decision should be clearly documented (EPA, 1989).

The first two components of a complete exposure pathway identified above (i.e., source/release mechanisms and retention/transport media) were described in the preceding sections of the CSM discussion (Section 4.2: chemical sources and Section 4.4: delineation of migration pathways). The other two components (receptors and exposure routes) are discussed separately for the ecological and human health CSMs in the following sections. Since the chemical release mechanisms and transport pathways identified in the previous discussion are relevant for both the ecological and human health CSMs, the identification of exposure pathways as incomplete, potentially complete but insignificant, or potentially complete and significant as discussed in the following sections is also based on the potential presence of receptors and the potential likelihood of the various exposure routes through which receptors could be exposed to chemicals in impacted media.

4.6 IDENTIFICATION AND CHARACTERIZATION OF POTENTIAL ECOLOGICAL RECEPTORS AND EXPOSURE PATHWAYS

The Site-wide CSM for ecological receptors is divided into terrestrial and aquatic habitats, comprised primarily of the following habitat types:

- Terrestrial (Upland)
  - Dry/moist tundra
  - Wet tundra
- Surface water
  - Ponds and lakes
  - Streams and rivers.

Terrestrial receptors are present in dry/moist and wet tundra habitats, while aquatic receptors are present in surface water (ponds, lakes, streams, and rivers). Terrestrial plant communities are largely structured by soil moisture gradients, which are influenced by topography. Elevation differences of only a few centimeters can result in soil moisture regimes that support different types of plant communities, which define the different habitats. As a result, a mosaic of small and patchy dry/moist and wet tundra communities are distributed over much of the tundra. Many terrestrial wildlife species use resources in both types of terrestrial habitat. Since only two types of terrestrial (upland) habitats dominate the PBU (i.e., dry/moist and wet tundra), this may substantially reduce the number of risk assessments that need to be conducted to evaluate undeveloped areas.

4.6.1 RECEPTORS

As discussed above, ecological receptors are divided into terrestrial and aquatic (surface water) for purposes of conducting an ERA. Developed features such as gravel pads do not provide habitats of sufficient quality to support ecological receptors. Intensive use of developed areas (e.g., pads) generally prevents the establishment of natural ecological systems, and most ecological receptors are expected to have minimal contact with media in developed areas. Reserve pits or other impoundments containing surface water are an exception, because these developed features can be waters of the state (i.e., DS9, DS16, DS17), and can contain aquatic organisms such as phytoplankton and zooplankton. Categories of ecological receptors that may contact constituents in surface water, soil in the tundra, or sediment in the tundra, include:

- Terrestrial plants (e.g., mosses, lichens, vascular plants);
- Birds (terrestrial, semi-aquatic, and aquatic);
- Mammals (terrestrial and semi-aquatic);
- Soil invertebrates (e.g., nematodes, arthropods);
- Aquatic plants (e.g., emergent macrophytes);
- Algae (e.g., phytoplankton);
- Zooplankton (e.g., copepods, cladocerans);
- Benthic invertebrates (e.g., arthropods); and
- Fish.

For purposes of ERA, the first four ecological receptors listed above are typically associated with terrestrial habitats (i.e., areas that are not submerged), while the latter five are relevant only for aquatic communities (e.g., ponds, lakes, or rivers). The exception to this is aquatic birds, which feed primarily in aquatic habitats. Soil invertebrates are not included as assessment endpoints. Instead, they are included as vectors for dietary exposure by higher trophic level species. However, soil invertebrates are included as part of the initial conservative Tier I assessment discussed in Section 5.

Terrestrial plants present at the Site are comprised primarily of grasses and sedges, including cottongrass *(Eriophorum angustifolium* and *E. scheuchzeri*), water sedge (*Carex aquatilis*), and tundra grass (*Dupontia fisheri*). Mosses and willows are also present in moist/dry upland areas. These terrestrial primary producers are assumed to provide habitat and food for herbivorous birds, mammals, and invertebrates. The specific plant species relevant at a given SWMU, or group of SWMUs, may vary depending on the nature of the habitats near the site.

Approximately 30 species of birds nest in the Prudhoe Bay region (Armstrong, 1980). Upland birds in the area include several songbirds, willow ptarmigan (*Lagopus lagopus*), and raptors. A number of semi-aquatic waterfowl (e.g., geese and ducks) nest in the area. Similarly, several primarily aquatic birds (e.g., Arctic loon/*Gavia arctica*), and various shorebirds (e.g., red phalarope/*Phalaropus fulicarius*) are present in the region. The willow ptarmigan, raven (*Corvus corax*), and snowy owl (*Bubo scandiacus*) are the only potential year-round avian residents on the North Slope.

Mammals that may visit SWMUs or AOCs include several herbivores (e.g., voles, lemmings, ground squirrels, and caribou), invertivores (shrews), and carnivores (e.g., fox, wolverine, and brown bears/*Ursus arctos*). Most of the mammals in the area are considered terrestrial, although semi-aquatic species, such as the river otter, may be a rare visitor. Soil invertebrates are typically grouped together in an ERA, particularly at the screening stage of the process. These organisms represent a food source for some consumers. Rather than identify this group of organisms as assessment endpoints, they are instead considered as exposure media for uptake by consumers (receptors) that are assessment endpoints (illustrated as “biota ingestion” on Figure 1). The other terrestrial (upland) groups discussed (i.e., mammals, birds, and plants) are separately depicted on the ecological CSM diagram (Figure 1).

Aquatic communities include groups that inhabit the water column such as algae (particularly phytoplankton) and zooplankton (e.g., copepods), sediment-dwelling benthic invertebrates (e.g., chironomids), and macrophytes (e.g., red pond grass/*Arctophila fulva*). Specific taxa can be identified for evaluation of groups of SWMUs, as appropriate. As designed, the CSM allows for any or all of these groups to be incorporated into a specific assessment, as necessary and appropriate. Fish and aquatic birds may also be present in some aquatic habitats, as discussed below.

Fish populations are considered to be potentially present in rivers and in water bodies that meet certain criteria. Fish populations are absent from most water bodies across the North Slope due to their shallow depth and annual freezing. Many surface water features dry up completely in the summer, precluding the presence of fish populations. For fish to be a potential receptor, the depth of the water body must be sufficient to preclude freezing to the bottom, and encompass enough area to support a population. No mapping of such water bodies has been done across the Site, but only three large lakes are known to not freeze to the bottom in winter. Fish may represent a portion of the aquatic community at sites where large, deep lakes are present and at SWMUs connected by streams or gullies to adjacent rivers. Different fish species are likely present at different locations and water body types. Fish populations will be considered on a SWMU-, AOC-, or PG-specific basis.

Similarly, aquatic birds such as the Arctic loon require open water bodies to feed. Such birds may be present at sites where larger water bodies that could support aquatic populations as a food source for these receptors are present. Aquatic birds will also be considered on a SWMU-, AOC-, or PG-specific basis.

4.6.2 EXPOSURE ROUTES AND PATHWAYS

Five exposure routes have been identified across all of the SWMUs and AOCs for ecological receptors. Some exposure routes are unique to an environmental medium (i.e., immersion in water, inhalation of air), while others are not (e.g., ingestion of soil or water). Each is clearly depicted on Figure 1:

1. Immersion;
2. Ingestion;
3. Dermal contact;
4. Inhalation, and
5. Dietary ingestion (biota).

Each of these exposure routes, and their associated exposure pathways, are discussed for the relevant ecological receptors in more detail below.

As discussed previously in Section 4.8.1, most ecological receptors are expected to have minimal contact with media in developed areas with the potential exception of algae and zooplankton that may be present in impoundment surface water. Therefore, with the exception of immersion in impoundment surface water for these two receptors, all potentially complete exposure pathways are identified as insignificant for ecological receptors in developed areas.

Immersion is relevant for aquatic organisms and includes exposure to the body (dermal uptake) and respiratory surfaces (including gills). This exposure route is relevant for surface water, either within a pit or in the tundra (including lakes, ponds, rivers, and other surface water features). Exposure to contaminants through immersion in surface water is identified as a potentially complete and significant exposure pathway for algae, zooplankton, and fish (undeveloped areas), as shown on Figure 1. For fish, this pathway is relevant only for tundra lakes and rivers that consistently support a fish population. Water ingestion is another potential exposure route for most animals, although it is generally less significant than immersion. Surface water ingestion is therefore identified as a potentially complete but insignificant exposure pathway for algae, zooplankton, and fish.

Ingestion of and dermal contact with sediment are relevant pathways for some aquatic and terrestrial receptors in undeveloped areas (i.e., off pad in the tundra) where sediment may be present. Sediment ingestion and dermal contact are considered incomplete for zooplankton because these receptors reside in the water column. Fish may ingest or contact sediment while feeding on sediment-dwelling biota, but this exposure pathway would be insignificant relative to biota ingestion, except for demersal fish species. Sediment ingestion was identified as a potentially complete and significant exposure pathway for benthic invertebrates in locations where sediment may be present. For terrestrial (upland) birds and mammals, exposure pathways involving sediments (through both the ingestion and dermal contact exposure routes) are expected to be potentially complete but insignificant.

For birds and mammals, ingestion can include soil, sediment (undeveloped areas only), surface water (e.g., pond water), and/or dietary ingestion. As described above, sediment ingestion is considered to be a potentially complete but insignificant exposure pathway for birds and mammals. Dietary ingestion is discussed separately below. Birds and mammals mainly contact soil in the tundra. Gravel is typically found on pads, not in the tundra, and gravel ingestion by ecological receptors is unlikely to occur. There may be some SWMUs where ecological receptors can directly contact soil/gravel in developed areas through ingestion (soil) and/or dermal contact (soil and gravel), but in general, contact with soil/gravel in developed areas (e.g., pads) is expected to be minimal. Soil ingestion is therefore identified as a potentially complete but insignificant exposure route for ecological receptors in developed areas, and gravel ingestion is identified as an incomplete exposure pathway for these receptors. Dermal contact is considered insignificant for both media, as discussed later in this section. For small mammals and birds in undeveloped areas, soil ingestion represents a direct exposure pathway that can be significant relative to dietary exposure. Small mammals and birds may also be exposed to chemicals in surface water during ingestion, but this represents an insignificant pathway relative to soil ingestion and dietary ingestion for the majority of chemicals. However, since this route can be significant for some chemicals, surface water ingestion is identified on Figure 1 as potentially complete and significant for birds and mammals in undeveloped areas.

Dietary ingestion of impacted biota (i.e., plants and animals) represents the other significant exposure pathway for terrestrial wildlife. This mechanism involves uptake of hazardous constituents from soil or water into plant or animal tissues. Subsequent ingestion of such food materials by avian or mammalian receptors can then lead to the distribution of constituents into the food chain. In undeveloped areas, this exposure pathway is considered potentially complete and significant for small mammals and birds with small foraging areas, and is identified as such on Figure 1. For example, certain plants (e.g., *Arctophila fulva*) in surface water features can attract geese, which can lead to exposure via plant ingestion. However, the duration of exposure, the nature of some hazardous constituents, the relatively weak persistence of many hazardous constituents, and the large size of the home range of most resident arctic animals, relative to the size of a contaminated area, reduces potential bioaccumulation at most locations.

Dietary ingestion of impacted biota is also relevant for some aquatic receptors. For fish, exposure through dietary ingestion may be a more significant exposure route than immersion. Dietary ingestion was therefore identified as a potentially complete and significant exposure pathway for fish. Although some zooplankton and other invertebrates are predators, the majority are filter feeders and dietary ingestion is considered insignificant for these water column-dwelling invertebrates relative to exposure through immersion in surface water. Similarly, biota ingestion is considered a potentially complete exposure pathway for benthic invertebrates in sediment, but is considered insignificant relative to sediment ingestion since most benthic organisms are primarily detritivores. At some SWMUs or AOCs, this exposure pathway may also be potentially complete and significant for aquatic birds that feed on aquatic biota.

Root uptake is the mechanism by which chemicals from the soil can be transported to terrestrial plants. In a few places where aquatic macrophytes (e.g., aquatic vascular plants) are present, chemicals in surface water or sediment may be transported to aquatic plants. This potentially complete and significant exposure pathway is shown on Figure 1 as ingestion of soil, surface water, or sediment.

Although birds and mammals will receive some dermal exposure to chemicals in soil, gravel, sediment, or surface water, relative to other potentially complete exposure routes, dermal exposure is considered insignificant for these receptors. Dermal exposure is not quantified, and the dermal exposure pathways (including surface water immersion) are shown as potentially complete but insignificant for birds and mammals on Figure 1. The inhalation pathway is generally not quantified for mammalian or avian receptors due to inherent uncertainties associated with quantifying exposure, and the minor exposure expected via this route, relative to other pathways. Inhalation pathways are therefore shown as potentially complete but insignificant for mammals and birds (Figure 1).

For terrestrial plants and emergent macrophytes, it is possible that leaves could adsorb chemicals bound to dust particles that become deposited on the leaf surface. However, this pathway (shown as inhalation on Figure 1) is also considered potentially complete but insignificant for plants, relative to root uptake exposure routes.

Although constituents may be present in the active suprapermafrost groundwater layer or in pad porewater during the warmer months, active layer water is not an exposure medium because receptors are not anticipated to be present in this ephemeral subsurface. Rather, pad porewater and suprapermafrost groundwater are considered as media that provide chemical transport mechanisms. In areas where suprapermafrost groundwater discharges to surface water, chemicals may be transported to soil, sediment, or surface water via this mechanism. Benthic invertebrates may then be exposed to waterborne chemicals in the soil or sediment pore spaces. Other receptors may also be exposed to chemicals in soil, sediment, or surface water where suprapermafrost groundwater discharge has occurred, through the exposure pathways described throughout this section.

Ecological receptors and exposure pathways are illustrated on Figure 1.

4.7 IDENTIFICATION AND CHARACTERIZATION OF POTENTIAL HUMAN RECEPTORS AND EXPOSURE PATHWAYS

4.7.1 RECEPTORS

The long-term presence of human populations, such as residents or recreators, is not anticipated in most of the North Slope area in the foreseeable future. In addition, current human activity in the PBU is restricted to workers who are required to follow specific health and safety requirements that minimize potential contact with contaminants. In consideration of hypothetical future land use changes, the following potential human receptors are further discussed in this section:

- Future residential receptors;
- Current and future industrial receptors; and
- Current and future subsistence user receptors.

Other receptors, such as a recreator, may be occasionally present at the PBU after decommissioning. However, such receptors are expected to have lower exposures to chemicals, relative to hypothetical future subsistence or residential receptors.

4.7.1.1 Hypothetical Future Residential Receptors

Residential use is unlikely at the Site while the field remains operational. Further, all land within the Facility is zoned as resource development, not residential. However, as required by EPA (2011a), future residents are included in the CSM diagram (Figure 2). Despite the lack of anticipated residential land use at the Site over the next 50 years, future residential land use was considered in the Tier I screening process, as required by EPA Region 10 (EPA, 1995). Presently, and for the foreseeable future, residential exposures represent an incomplete exposure scenario everywhere at the Site.

4.7.1.2 Industrial Worker Receptors

Workers at the Facility include commercial workers (e.g., food service and housekeeping staff) and industrial workers (e.g., pad operators). For purposes of this CSM all workers are considered to be industrial workers. Commercial workers are typically limited to the indoor environment and do not work outdoors on industrial sites. In contrast, industrial workers work outdoors and are generally expected to have much greater exposure than commercial workers. If a commercial worker exposure scenario was expected to occur at a particular site (e.g., a slab-on-grade building where vapor intrusion to indoor air could potentially occur) then this scenario would be evaluated on a site-specific basis. The Site-wide CSM focuses on industrial workers, since these are the only workers with potentially complete exposure scenarios at the majority of sites across the Facility. Industrial workers are currently present and will be present at the Site into the foreseeable future. Therefore, they are identified as relevant current and future receptors at the Site. Generally, these receptors will be located on developed areas of the Site (e.g., pads) and will not spend time on the native tundra.

4.7.1.3 Current Nonresident Subsistence User Receptors

Several native communities embrace a subsistence lifestyle on the North Slope. The two closest communities to the Prudhoe Bay facility that incorporate a subsistence lifestyle are Nuiqsut, located approximately 60 miles southwest of the Site, and Kaktovik, located about 110 miles southeast of the Site. Both the North Slope Borough (NSB) and members of the Nuiqsut community have expressed interest in ensuring that subsistence use be adequately addressed and protected. Therefore, background research was conducted to identify the extent to which subsistence use may currently occur at and near the Site.

Historically, the subsistence use range for the Nuiqsut community included a wide area from the Chipp River west of Smith Bay, to just east of the Sagavanirktok River valley, and extending south of Umiak. Development of the oilfield at Prudhoe Bay has modified this historical area to exclude the PBU, with substantive increase in the use of areas west and south of the PBU. Whale-hunting areas have been little affected by development, but caribou hunting mostly has been done in areas removed from the PBU for at least the past 15 years. As long as the field continues to operate, this recent pattern is likely to continue. As a result, little subsistence use is anticipated within the PBU during the life of the field. Current subsistence use is limited to hunting; there are no subsistence users that currently reside at the Site.

Based on this research and preliminary discussions with local native community members, some subsistence users traverse portions of the PBU for hunting trips and may travel through the PBU in winter, but subsistence users do not currently frequent the Site for sources of food. The only anticipated subsistence use is the current and future opportunistic hunting of caribou and waterfowl along the narrow strip of coastline contiguous with the PBU, which typically occurs during whaling trips. Because subsistence use does occur along this strip of coastline, this current subsistence use hunting scenario is considered potentially complete and significant, as shown on Figure 2. Additional information on subsistence use patterns compiled from available sources is provided in Appendix A and OASIS (2008a).

4.7.1.4 Future Resident and Nonresident Subsistence User Receptors

As discussed above, subsistence use is unlikely to occur at the Site while the field remains operational, with the possible exception of hunting along the narrow coastal strip during whaling season. However, subsistence use could occur anywhere at the Site in the future following the end of field life and a change in land use classification. This includes potential residential as well as nonresidential subsistence use. For the purposes of this CSM, a future scenario is assumed to include a subsistence user that lives on the Site and hunts for food on the Site.

4.7.2 EXPOSURE PATHWAYS

Four potential soil and water exposure routes were identified for hypothetical human receptors. These include the following:

- Ingestion;
- Dermal contact;
- Inhalation, and
- Dietary ingestion (biota).

These exposure routes and the associated exposure pathways are discussed separately in the following sections for each of the three receptor groups identified above.

4.7.2.1 Hypothetical Future Residential Exposure Routes and Pathways

It is likely in the event of future residential development that homes would be built on the pads, but off-pad unrestricted tundra use cannot be precluded. Hypothetical future residents could be exposed to chemicals in soil or water, as discussed below.

Soil

In developed (i.e., on-pad) areas, incidental ingestion of, and dermal contact with, soil (e.g., pits) and gravel (e.g., pad) represent potential exposure routes that could result in significant exposure for hypothetical future residential receptors. Inhalation of vapors from soil or gravel in indoor air would be unlikely to occur because homes would be built on posts, as are living quarters for current industrial workers at the Site. Inhalation of dusts or vapors in outdoor air represents a potentially complete exposure pathway. In most cases this is not expected to result in significant chemical exposure. Inhalation of vapors (for volatile chemicals) or dusts (for non-volatile chemicals) is, however, included in the soil screening levels compiled for residential receptors. Dietary ingestion is not a complete pathway for this receptor; this pathway is evaluated only for the subsistence user receptor. Potentially complete and significant residential exposure pathways for soil and gravel in developed areas therefore include soil/gravel ingestion, dermal contact with soil/gravel, and inhalation of dusts or vapors from soil/gravel in outdoor air.

Off-pad soil exposure pathways are anticipated to be the same as those identified above for on-pad scenarios, with the exclusion of exposure to gravel on pads.

Water

It is assumed that surface water both on-pad (e.g., in pits) and off-pad could be used for domestic purposes by future residents. This assumption requires that the water body is both large enough to support long-term domestic use (i.e., water withdrawal is not greater than water influx) and does not freeze to the bottom, which would preclude its utility as a sustainable domestic water source. The majority of water bodies across the North Slope freeze to the bottom in the winter, and many are pothole-type water bodies that are small and dry up as the summer progresses. Ingestion and dermal contact represent potential exposure routes for surface water used as a domestic water source by the hypothetical future resident receptor.

Final determination of the completeness of exposure pathways involving these routes would be made based on a SWMU-specific evaluation.

Dermal exposure is not included in most regulatory screening levels (EPA, 2009b, 2015a; ADEC, 2008c, 2012), because water ingestion would result in the majority of chemical exposures and because dermal permeability is difficult to predict for many chemicals. However, since dermal contact with surface water is included in the tap water RSLs, it is identified as a potentially complete and significant exposure pathway on Figure 2. Surface water ingestion as drinking water and inhalation of chemicals volatilized from surface water during domestic use (i.e., showering, dishwashing, etc.) also represent potentially complete and significant exposure pathways for the hypothetical future residential receptor in both on-pad and off-pad environments. Inhalation of vapors in outdoor air also represents a potentially complete exposure pathway, but is considered insignificant relative to inhalation resulting from domestic use of surface water. As described above for soil, dietary (i.e., fish) ingestion is not a complete exposure pathway for the residential receptor; this pathway is evaluated for the subsistence user receptor.

4.7.2.2 Industrial Worker Exposure Routes and Pathways

Soil

Industrial workers are assumed to contact chemicals in soil or gravel in developed areas through incidental ingestion, dermal contact, and inhalation of vapors or dust (Figure 2). Health and safety requirements that must be followed by all workers on the North Slope are likely to limit worker exposures to chemicals in soil or gravel.

Most structures in the PBU are elevated above grade, which eliminates potential vapor intrusion for all but slab-on-grade buildings. In addition, most buildings maintain positive pressure year-round due to weather conditions; positive pressure prevents vapor intrusion from representing a significant transport mechanism. Vapor intrusion may occur where slab-on-grade structures are present and overlie VOCs in the subsurface, and at “indoor” well cellars which may be visited sporadically by workers equipped with appropriate personal protective equipment (PPE). Well cellars are considered confined spaces, and PPE and atmospheric monitoring are required to enter these areas. Outside of well cellars, such scenarios are uncommon throughout the Facility, and would be evaluated on a SWMU, AOC, or PG specific basis where relevant (e.g., PG IV, PG IX). For these reasons, vapor intrusion and subsequent indoor air inhalation is shown on the CSM diagram (Figure 2) as a potentially complete but insignificant exposure pathway for the industrial worker receptor.

Workers at the Facility are not expected to perform routine work off-pad, and generally are not present in the tundra for any appreciable amount of time. Since it is possible that workers could visit the tundra sporadically and for short time periods (to perform pipeline work, for example), several potentially complete exposure pathways are identified below for off-pad areas. These are, however, considered insignificant relative to on-pad exposures.

In off-pad areas, indoor air inhalation is an incomplete exposure route due to a lack of industrial structures on the tundra. Also, gravel-related pathways are not relevant in off-pad areas. Soil-based exposure routes are otherwise the same as for on-pad locations, and the same exposure pathways (except for indoor air inhalation) are potentially complete, but are identified as insignificant rather than significant, as shown on Figure 2.

Industrial workers are not anticipated to hunt for food on the North Slope, so biota ingestion is considered to represent an incomplete exposure route for this receptor, as shown of Figure 2. If such a worker receptor were to participate in hunting and fishing for consumption outside of work shifts, they would be evaluated as a subsistence user receptor.

Water

Industrial workers are assumed to have sources of water available at their workplace and are therefore assumed to not utilize surface water (or porewater or suprapermafrost groundwater) for any domestic purposes, except for the two lakes used for domestic water supply. Workers may, however, contact water during excavation or dewatering activities. Such activities are only expected to occur in on-pad areas. Dermal contact with impoundment surface water is therefore identified as a potentially complete and significant exposure pathway for workers in developed areas.

4.7.2.3 Subsistence User Exposure Routes and Pathways

Current and hypothetical future subsistence users could be exposed to chemicals in soil or water, as discussed below.

Subsistence users are assumed to live entirely off the land and, therefore, will ingest biota that may have been exposed to impacted soils or surface water. This dietary ingestion of plants, animals, and fish reflects the most significant exposure route for this receptor. Based on information compiled from the literature and interviews with subsistence users, caribou and fish are their primary dietary components. Dietary ingestion is discussed in more detail below.

Although subsistence hunting would take place off-pad, it is possible that subsistence users could either stage their hunt from a pad or even hypothetically live on a pad in the future. Incidental ingestion of, and dermal contact with, soil (e.g., pits) and gravel (e.g., pad) therefore represent potential exposure routes for future subsistence users in developed (i.e., on-pad) areas. This receptor may also be expected to directly contact surface water (and soil in off-pad areas) during the course of their activities, and may also be exposed to vapors or dust particles in outdoor air through inhalation. Inhalation of vapors in indoor air following vapor intrusion is generally not a complete exposure pathway for this receptor, as discussed previously for the resident receptor. Domestic use of surface water both on-pad (e.g., in pits) and off-pad is also a potentially complete exposure pathway for the future subsistence user, where the requirements necessary to support long-term domestic use are met, as described in Section 4.7.2.1 for the resident receptor. Dermal exposure to surface water is also quantitatively addressed for this receptor in Tier I SL development, as described in Section 5. Therefore, potentially complete and significant exposure pathways for the future subsistence user receptor are the same as those for the future resident, with the addition of dermal surface water contact and dietary ingestion. Dietary ingestion is discussed further below.

Fishing, which is only relevant for off-pad water bodies, is limited to rivers and deep lakes that support fish populations. These are water bodies that do not freeze to the bottom in winter, and therefore tend to be the largest of the water bodies since these are typically the deepest and have sufficient volume to cool only gradually throughout the winter, retaining enough heat to prevent freezing near the bottom. Similar depth and volume requirements would need to be met in order to support domestic use of surface water. Therefore, the identification of these exposure scenarios as potentially complete will be made on a SWMU-specific basis, consistent with the approach described in the ecological CSM (Section 4.6) for fish.

Although hunting would occur in off-pad areas, the terrestrial biota ingestion exposure pathway is considered potentially complete for on-pad areas as well because terrestrial game animals are mobile and could be exposed to contaminants in on-pad areas as they move about the Facility. As discussed above and shown in Table 7, caribou comprise the majority of the terrestrial biota in the subsistence diet; quantitative evaluation of this pathway will therefore focus on caribou ingestion. As described in Section 4.6.1, for ecological receptors, contact with soil/gravel in developed areas (e.g., pads) is expected to be minimal. Terrestrial biota ingestion is therefore considered potentially complete but insignificant for subsistence users in developed areas.

As discussed previously, the only current subsistence use is the opportunistic hunting of caribou and waterfowl along the narrow undeveloped strip of coastline contiguous with the PBU during whaling trips. Although unlikely, it was also conservatively assumed that freshwater fishing could occur in this area during these trips. Potentially complete and significant exposure pathways identified for the current subsistence user receptor include dietary biota ingestion and other pathways that could occur during such opportunistic use, including direct contact with soil and surface water and inhalation of dust/vapors in outdoor air. Dietary ingestion was identified as potentially complete but insignificant for on-pad (developed) areas, as described above for the future subsistence user. Outdoor air inhalation was also identified as potentially complete but insignificant for these areas since opportunistic hunting could take place near developed areas. Other exposure pathways for the current subsistence user are only relevant for off-pad (undeveloped) areas, as shown on Figure 2.

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5. TIER I SCREENING LEVELS

Based on agreements between BPXA and EPA, screening values were developed using a two-tiered approach. As required by EPA (2009a), Tier I SLs include the lowest of a set of generic SLs, compiled from a variety of regulatory sources, and risk-based values calculated for North Slope receptors based on EPA and ADEC guidance. Tier II ALs incorporate Site-specific exposure assumptions and consider the “unique environmental characteristics of the North Slope”, which is a requirement of screening levels as described in the Order. Tier I values for both human and ecological receptors are discussed in the following sections.

5.1 ECOLOGICAL SCREENING LEVELS

Ecological screening levels and other values were compiled from the following sources:

- Ecological Soil Screening Levels (EcoSSLs; EPA, 2005);
- ORNL ecological toxicity benchmarks for soil and surface water (Efroymson et al., 1997a, 1997b; Suter and Tsao, 1996);
- EPA Region 4 soil and surface water screening values for hazardous waste sites (EPA, 2015d);
- EPA Region 3 Biological Technical Assistance Group freshwater screening benchmarks (EPA, 2006);
- Ambient water quality criteria (AWQC) for freshwater (EPA, 2015a);
- Alaska water quality criteria (aquatic life) for freshwater (ADEC, 2008c), and
- Oregon Department of Environmental Quality Level II Screening Benchmark Values for soil contact and surface water ingestion by birds and mammals (ODEQ, 1998).

Tier I SLs were identified for soil and surface water as described below. Note that for chemicals that are regulated only by ADEC and not by EPA, the Tier I values will preferentially be those derived from the ADEC source cited above. For chemicals only regulated under the Alaska Water Quality Standards (AWQS; 18 AAC 70) (e.g., aluminum, manganese), the Tier I values (relevant for water only) will be the Alaska Water Quality Criteria (ADEC, 2008c) for freshwater aquatic life.

The benchmarks considered for SLs are based on compilation and analysis of published studies and values from regulatory bodies. Values from ORNL and regional and federal U.S. sources are compiled in the Risk Assessment Information System (RAIS) maintained by the ORNL, but some of the parent sources have been updated more recently than the RAIS. Values from the most current versions of the sources included in the RAIS compilation were therefore considered in the SL selection process as described below for soil and water.

As required by EPA, the Tier I ecological SLs for soil and surface water were the lowest values identified for each medium across the applicable references provided above, regardless of relevance to the North Slope. Tier I SLs for ecological receptors are provided in Tables 1a (soil) and 1b (water). Identification of these SLs is discussed separately below for soil and water.

5.1.1 SOIL

Ecological Soil Screening Levels (EcoSSLs) published by EPA resulted from an extensive literature search and rigorous selection process, and are considered the most comprehensive of the SLs included in the selection process. Level II screening levels from ODEQ (1998) for birds and mammals were additionally included in the process. As discussed above, benchmark value sources included in the RAIS compendium were also included in the SL selection process for soil, as described below.

Sources of ecological benchmarks for soil included in the RAIS include EPA regional offices (i.e., Regions 4, 5, and 6), EcoSSLs, and ORNL documents (Efroymson et al,, 1997a, 1997b). Of these sources, EPA Region 4 and ORNL values were included in the SL selection process for soil. EcoSSLs were also included, but the EcoSSL documents were used directly as the sources for these values. The EPA Region 5 ecological soil SLs are out of date and cannot be independently verified with information now available to the public, and were therefore not considered as candidate SLs. EPA Region 6 uses either EPA EcoSSLs or ORNL values, both of which were included as candidate SLs. Therefore, Region 6 values were not separately included in the SL selection process.

ODEQ also uses the ORNL values for plants and invertebrates, making these values redundant. ODEQ values were therefore only included for birds and mammals. Washington State Department of Ecology (WDOE) Model Toxics Control Act (MTCA) soil screening values (WDOE, 2007) were also included in the initial review, but these values were not selected as Tier I SLs and are not included in Table 1a. The WDOE MTCA values were not selected because other sources provided equal or lower screening numbers for the RO-COPCs. Tier I ecological SLs for soil are provided in Table 1a.

5.1.2 SURFACE WATER

Similar to the EcoSSLs for soil, the AWQC developed by EPA resulted from an extensive literature search and rigorous selection process, and are considered the most comprehensive of the SLs included in the selection process for water. Alaska water quality criteria were also included in the process. For a few chemicals, the risks to wildlife from water ingestion may be high relative to other sources (e.g., dietary uptake). To ensure these few chemicals with relatively high risks from water ingestion were adequately evaluated in the Tier I screen, ODEQ (1998) surface water ingestion-based screening values were included in the table of values used to identify the SLs. As discussed above, benchmark value sources included in the RAIS compendium were also included in the SL selection process for water, as described below.

Sources of ecological benchmarks for water included in the RAIS include EPA regional offices (i.e., Regions 3, 4, 5, and 6) and ORNL documents (Suter and Tsao, 1996). Of these sources, EPA Region 3 and Region 4 values and ORNL values were included in the SL selection process for water. As described above for soil, the EPA Region 5 values in RAIS are not considered candidate SLs because they are relatively old and the methods explaining their derivation are not available to the general public. The EPA Region 6 SLs include AWQC and ORNL secondary chronic values (SCVs), which are redundant. Region 6 also includes outdated Region 4 SLs and Texas surface water quality standards that incorporate a hardness of 50 mg/L. The EPA Region 6 values were therefore not included in the SL selection process for water. Values included in the ORNL documents include AWQC, secondary chronic values (SCVs), and taxon-specific lowest chronic values (LCVs) and 20 percent effect concentrations (EC20s), as well as additional threshold values developed by the EPA's Office of Solid Waste and Emergency

Response (OSWER) and EPA Region 4 screening values. The OSWER AWQC and OSWER Tier II SCVs are either outdated or redundant with other candidate SLs, and were not included as candidate SLs. The AWQC and EPA Region 4 values provided in Suter and Tsao (1996) are also redundant and/or outdated; current sources (i.e., EPA, 2015a, 2015d) were instead used to compile these values. NOAA screening values were also reviewed, but none represented the lowest value for a chemical, so these were not incorporated into Table 1b.

ADEC (2008c) provides equations and input values to calculate water quality criteria for some metals (cadmium, chromium [III], copper, lead, nickel, silver, and zinc) based on hardness. For these metals, the Site-wide overall median hardness value of 105 mg/L (OASIS, 2005) was used to calculate water quality criteria for total metals. Total/dissolved phase conversion factors were not included in these calculations. The equations in the ADEC (2008c) document are the same as those used by EPA (2015a) to derive AWQC values. The AWQC from EPA (2015a) were not adjusted for hardness or fraction; instead, the default values for dissolved metals (based on a hardness of 100 mg/L) were incorporated directly into the Tier I SL table. Tier I ecological SLs for surface water are provided in Table 1b.

5.2 HUMAN HEALTH-BASED SCREENING LEVELS

Tier I human health-based screening levels were compiled from the following sources:

- AWQC for human health (EPA, 2015a);
- MCLs (EPA, 2009b);
- EPA regional screening levels (RSLs) for soil and tap water (EPA, 2015b);
- ADEC Method 2 Soil Cleanup Levels for the Arctic Zone (combined into a single multi-pathway value) and Table C Groundwater Cleanup Levels (ADEC, 2012);
- Alaska water quality criteria (ADEC, 2008c); and
- Calculated values using EPA (1991, 2004, and 2015c) and ADEC (2008b) equations.

Although other sources were also reviewed (e.g., states of Washington and Oregon), these other sources did not provide lower values than those listed above and are not included. Tier I SLs were identified for soil and surface water as described below.

Tier I SLs target a lifetime excess cancer risk of $1x10^{-6}$ and a hazard quotient of 0.1 to incorporate potential additivity of exposure to multiple chemicals in the screening process. Values compiled from the sources listed above have been adjusted to these target risk and hazard levels. The EPA (2015b) provides RSLs based on these target levels, so no adjustment was necessary for RSL values. Values calculated for industrial worker and subsistence user receptors also incorporate these target risk and hazard levels. These target risk and hazard levels, combined with the process used to develop the SLs, should be considered conservative.

As discussed previously for ecological values, for chemicals that are regulated only by ADEC and not by EPA, the Tier I numbers will preferentially be those from the ADEC sources cited above. For chemicals only regulated under the AWQS (18 AAC 70; e.g., aluminum, manganese), the Tier I numbers (relevant for water only) will be the Alaska Water Quality Criteria (ADEC, 2008c) applicable to human health.

As required by EPA, the Tier I human health SLs for soil and surface water were based on the lowest value for each medium across the applicable references provided above. Tier I soil SLs for residential, industrial, and future subsistence user receptors are shown in Table 2, while water SLs are shown in Table 3. Tier I SLs for human health are separately discussed by receptor below.

In addition to the Tier I SLs provided in Tables 2 and 3 that are protective of chronic exposures, EPA Region 10 has developed additional media-specific TCE concentrations protective of short-term exposure concerns, as described in EPA (2012a). When TCE is detected in any medium, it will be evaluated consistent with EPA (2012a) recommendations.

5.2.1 RESIDENTIAL SCREENING LEVELS

5.2.1.1 Soil

For each constituent, the lower of the risk- and hazard-adjusted ADEC Method 2 soil CLs for the Arctic Zone for residential receptors, and the EPA RSLs for residential receptors, were identified as the Tier I SLs for residential land use. The lookup values and adjusted values are provided in Table 2. ADEC (2012) provides separate Method 2 CLs for the direct contact and inhalation exposure pathways. Where values were available for both pathways, they were combined into a single multi-pathway value in Table 2, consistent with EPA (1989) guidance. ADEC Method 2 inhalation CLs based on the ADEC (2012) C_{sat} values were replaced with the risk-based concentrations from Appendix B of ADEC (2008b). The combined multi-pathway values were then adjusted to the target risk and hazard levels discussed previously by dividing each value by ten. Some soil SLs may be greater than the chemical-specific soil saturation limit (Csat). At concentrations above the Csat, the chemical may be present in the free phase. For volatile chemicals with inhalation-based SLs above the Csat concentration, SLs may be overly protective because a basic principle of the volatilization model is not applicable when free phase chemical is present (EPA, 2015c). Such SLs are therefore identified in Table 2; if detected chemical concentrations are above the Csat, more sophisticated modeling may be necessary on a site-specific basis. SLs above the ceiling limit of 1×10^5 milligrams per kilogram (mg/kg), or ten percent by weight of the soil sample, may also require additional evaluation on a site-specific basis because at such concentrations the assumptions for soil contact may be violated due to the presence of the chemical as a pure substance (EPA, 2015c). SLs above the ceiling limit are therefore also identified in Table 2.

5.2.1.2 Surface Water

Tier I SLs for water were identified for the hypothetical future resident receptor through selection of the lowest of ADEC Table C groundwater CLs, ADEC water quality criteria, EPA tap water RSLs, EPA AWQC values, and MCLs. The Table C CLs were adjusted to a target cancer risk of $1x10^{-6}$ and a hazard quotient of 0.1 prior to selection of the lowest value as the Tier I SL for residential land use. The residential Tier I SLs include ingestion of water, inhalation of volatiles during domestic water use, dermal contact with water (RSLs only), and aquatic biota ingestion (EPA AWQC only) as complete exposure routes. Although aquatic biota ingestion is not a complete exposure pathway for residential receptors, EPA AWQC values are available for only two scenarios; ingestion of water and aquatic biota, and ingestion of aquatic biota only. The values based on the first scenario (ingestion of water + biota), which are protective of the surface water ingestion pathway, were therefore included in the screening level selection process.

5.2.2 INDUSTRIAL WORKER AND FUTURE SUBSISTENCE USER VALUES

Tier I soil SLs for industrial workers are the industrial soil RSLs from EPA (2015b). The industrial soil RSLs incorporate the direct contact (i.e., incidental ingestion and dermal contact) and inhalation exposure routes and are based on a target lifetime excess cancer risk of $1\text{x}10^{-6}$ and hazard quotient of 0.1. Screening levels are not readily available in the literature for industrial worker water exposures or for subsistence users. Tier I SLs were therefore calculated for industrial workers (water) and for hypothetical future subsistence users (soil and water). Detailed discussions of the methods used to calculate SLs for these receptors are provided in the following sections. However, several common elements of the calculations are discussed here.

The hierarchy used to select toxicity values for screening level calculations is described first. Toxicity values from EPA's RSLs (EPA, 2015b), which incorporate values in the EPA's Integrated Risk Information System (IRIS) and other sources, were used preferentially. The hierarchy of toxicity values used for the RSLs is described in the RSL User's Guide (EPA, 2015c). Specific toxicity values from EPA (1999a and 2007) were used for the noncancer effects of trimethylbenzenes (specifically, for ingestion of 1,2,4-trimethylbenzene and inhalation of 1,3,5-trimethylbenzene) and the carcinogenic effects of naphthalene inhalation, respectively, as requested by ADEC. Dermal toxicity values were calculated from oral values, when necessary. Toxicity values used to calculate Tier I SLs are provided in Table 4.

For carcinogens, toxicity values are provided separately for cancer and noncancer effects. For each medium and receptor, the lower of the cancer and noncancer based screening values was selected as the Tier I SL for each chemical.

Screening value calculations based on the inhalation pathway differ between volatile and non-volatile chemicals. Therefore, the criteria set forth in the EPA (2015e) *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* were used to identify volatile constituents. For these constituents, chemical-specific soil volatilization factors were calculated based on equations in ADEC (2008b), using input parameters from ADEC (2008b), EPA (2015b), and ORNL (2015). These values are calculated in Table B-1 of Appendix B and presented in Table 4. For non-volatile chemicals, a particulate emission factor (PEF) of $4.63\text{x}10^{9}$ m^3/kg from the EPA (1991) *RAGS: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)* was used (Table 4). This value is recommended for surfaces with unlimited erosion potential and was therefore considered more appropriate than the value recommended in the *RSL User's Guide* (EPA, 2015c), which is specific to an urban/suburban setting.

Tier I surface water screening levels for the industrial worker were calculated for dermal contact with surface water based on EPA (2004) guidance. This is the only potentially complete surface water exposure pathway identified for the industrial worker, as discussed previously in Section 4.7.2.2.

Future subsistence user soil screening levels were calculated based on ADEC (2008b) guidance, and include the direct contact, inhalation, and food ingestion exposure routes. Water SLs for the subsistence user were calculated based on EPA (1991, 2004, and 2015c) guidance, and include the ingestion, dermal contact, inhalation, and fish ingestion exposure routes. In all cases, the lowest value (between cancer and noncancer based values) for each constituent in each medium was identified as the Tier I SL for the specified land use (industrial or subsistence). If values were not available for a specific exposure route for a given constituent, then that route was excluded from the SL calculation for that constituent.

Soil SLs above the ceiling limit, and inhalation-based soil SLs above the Csat, are identified in Table 2 and Appendix B as described in Section 5.2.1.1.

For water SLs, EPA (2004) does not recommend quantification of dermal risk due to water exposure when the properties of a chemical are outside the effective prediction domain of the EPA model used to estimate dermal permeability coefficients (EPA, 2004). Dermal water contact SLs were therefore not calculated for chemicals outside of the predictive domain, as identified based on EPA (2004). These chemicals include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and phenanthrene.

The equations used to calculate industrial worker and subsistence user SLs are provided in Appendix B, along with further details documenting the derivation of the values. Equation terms, input values, and sources are defined in Tables 5 and 6 for industrial worker and future subsistence user SLs, respectively. Chemical-specific parameters (including toxicity values) used to calculate Tier I SLs are provided in Table 4.

Additional details specific to each set of calculated values are discussed separately for each receptor and medium in the following sections.

5.2.2.1 Industrial Worker Screening Levels

As discussed previously, soil SLs for the industrial worker are the industrial soil RSLs from EPA (2015b). The surface water SLs for the industrial worker were calculated based on EPA (2004) *RAGS Part E (Supplemental Guidance for Dermal Risk Assessment)*. The EPA (2004) guidance document provides equations for dermal exposure of residential receptors to surface water or groundwater. The EPA equations were used to calculate surface water SLs for the industrial worker. Industrial worker exposure assumptions from ADEC (2015) and EPA (2015c), along with chemical-specific parameters from EPA (2004 and 2015b) and ORNL (2015) and Site-specific information, were used as input values for the calculations. Dermal water contact is the only exposure pathway included in the industrial worker water Tier I SLs, as described previously.

All water SL equations for the industrial worker are shown in Table B-2 of Appendix B, along with derivation details.

5.2.2.2 Future Resident Subsistence User Screening Levels

The sources and basis of exposure assumptions, intake rate adjustments, equations, and input values specific to the calculation of future subsistence user SLs for soil and water are discussed in the following sections.

For carcinogens, age-adjusted intake rates are used to account for chemical exposures occurring in both the child and adult life stages. Age-adjusted intake rates were used to calculate subsistence user SL values for soil and water based on the ingestion, dermal, and dietary ingestion exposure routes as described in the following sections. Inhalation rates are not included in the subsistence user SL equations (these are incorporated into the toxicity values for inhalation); therefore, the inhalation components of the soil and water SL equations were not age-adjusted for carcinogens. Separate age-adjustments were made for mutagens (methylene chloride, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, indeno[1,2,3-cd]pyrene, chromium [VI]), trichloroethene, and vinyl chloride as described in the *RSL User's Guide* (EPA, 2015c). The age-adjustments for these chemicals were also applied for the inhalation pathway as described in EPA (2015c). Mutagens were identified from the RSL table (EPA, 2015b). For water values, a separate equation was also used for mercury, which was considered volatile in water only (elemental form of mercury) based on EPA (2015e).

For non-carcinogens, Tier I SL calculations included only child subsistence user receptors because they yield lower SLs than do adult receptors. Exposure duration is not relevant for noncancer effects, so the lower body weight of children increases their exposure relative to adults.

Soil

Tier I soil SLs for the future subsistence user receptor were calculated using residential exposure equations from EPA guidance that were modified to incorporate subsistence user considerations. Residential soil SL equations (EPA, 2015c) were modified to include ingestion of caribou, which is relevant for the future subsistence user receptor.

Exposure assumptions for the subsistence user receptor from ADEC (2015) were used in combination with default values from EPA (2015c), and Site-specific values based on information compiled from the Alaska Department of Fish and Game (ADFG) (Table 6). The ADFG provides subsistence use data for communities throughout the State of Alaska in the *Community Profile Database* (ADFG, 2002). Caribou per capita annual ingestion rates for the two subsistence communities closest to the Prudhoe Bay facility (Nuiqsut and Kaktovik) were identified, and 206 pounds per year, the higher of the two, was used to calculate regional caribou ingestion rates for this receptor group, as described in Appendix A. The highest caribou ingestion rates were from Nuiqsut; these values are presented in Table 7 and further discussed in Appendix A.

Soil ingestion rates, dermal factors, and dietary ingestion rates were age-adjusted for carcinogen and mutagen SL calculations based on the equations provided in ADEC (2008a) and EPA (2015c). The dietary ingestion rate was multiplied by 0.45 for the child receptor, based on information presented in the EPA (2011b) *Exposure Factors Handbook* regarding the ratio of child-to-adult food consumption in subsistence communities.

Soil-to-plant uptake factors and beef transfer coefficients from the RAIS (ORNL, 2015), as well as an average food (lichen) consumption rate for caribou from Holleman et al. (1979) converted to a wet-weight basis, were used to estimate chemical uptake from soil to ingested meat (Table 4).

All soil SL equations for the future subsistence user are shown in Table B-3 of Appendix B, along with derivation details. Tier I soil SL values for the future subsistence user are summarized in Table 2.

Surface Water

The surface water SLs for the future subsistence user were calculated based on EPA (1991) *RAGS Part B*, EPA (2004) *RAGS Part E (Supplemental Guidance for Dermal Risk*

Assessment), and the EPA (2015c) *RSL User's Guide*. The EPA (1991, 2004, and 2015c) guidance documents provide SL equations for exposure of residential receptors to surface water or groundwater. EPA guidance was used because relevant SL equations were not available from ADEC. The EPA equations were modified to include relevant exposure routes for the future subsistence user receptor. Surface water ingestion, fish ingestion, and dermal contact with surface water and inhalation of volatiles (both while showering) were included in the equations. For volatile constituents, the volatilization factor of 0.5 liter per cubic meter (L/m^3) from EPA (1991 and 2015c) was used for water equations (Table 6).

Exposure assumptions for the subsistence user from ADEC (2015) were used in combination with default values from EPA (1991, 2004, and 2015c), and Site-specific values from ADFG (2002) (Table 6). Annual per capita fish ingestion rates for the Nuiqsut community from ADFG (2002) were used to calculate Site-specific SLs for this receptor group, because the estimate for this community was higher than that for Kaktovik (Table 7 and Appendix A). The Site-specific ingestion rate of 265 grams per day (g/day), calculated from the data for Nuiqsut presented in Table 7, is higher than any of the 99th percentile values used to develop AWQC (up to 153 g/day; EPA, 2014). Therefore, no upward adjustment to intake is needed to address the subsistence user. Fish tissue bioaccumulation factors were compiled from the ORNL (2015) RAIS (Table 4).

Water ingestion rates, dermal factors, and dietary ingestion rates were age-adjusted for carcinogen and mutagen SL calculations based on the equations provided in EPA (1991 and 2015c). The fish ingestion rate of 265 g/day (Table 6) was multiplied by 0.412 for the child receptor based on information from EPA (2011b) regarding the percentage of an adult's daily fish intake that is consumed by a child.

All water SL equations for the future subsistence user are shown in Table B-4 of Appendix B, along with derivation details. Tier I water SL values for the future subsistence user are summarized in Table 3. Tier I SL values for human and ecological receptors are summarized in Table 8.

6. TIER II SITE-SPECIFIC ACTION LEVELS

As discussed with EPA Region 10, Site-specific Tier II ALs were also developed for this Site. Tier II ALs were developed specifically to consider the "unique environmental characteristics of the North Slope" as described in the Order. Tier II ALs can be used in a variety of applications, including identification of chemicals of potential concern and chemicals of potential ecological concern for quantitative baseline risk assessment for specific SWMUs or groups of SWMUs, and as more relevant but still conservative screening levels to assist in decision-making at specific SWMUs or groups of SWMUs.

Tier II AL values for both human and ecological receptors are discussed in the following sections. Tier II AL calculation methods and results for ecological receptors are presented first (Section 6.1), followed by Tier II AL methods and results for human health (Section 6.2).

6.1 ECOLOGICAL ACTION LEVELS

For ecological receptors, Tier II ALs were developed based on indicator species currently relevant to the Site. Objective criteria, generally consistent with EPA ecological soil screening level (Eco-SSL) and AWQC methods and fully described in the following text, were used to identify the most relevant scientific toxicity studies on which to base the Tier II ALs. The most relevant studies are those that focus on endpoints that are close correlates of individual fitness such as reproduction, development, growth, and survival, because these endpoints will more accurately inform potential population-level effects. These points are discussed in greater detail throughout this section.

The local ecosystem consists of Arctic tundra with little topographic relief. The Site lies within the Arctic Slope ecoregion as defined by ADEC (1999a). Many small surface water features are present across the Site. Terrestrial plants are primarily grasses and sedges; mosses and lichens are also present in moist/dry upland areas.

For both mammals and birds, a variety of different taxa and feeding guilds are likely present at most SWMU and AOC locations. As previously discussed, the types of mammals range from small rodents to large ungulates, including carnivores (weasels), herbivores (lemmings and caribou), and omnivores (bears). Terrestrial (upland) bird species include songbirds, willow ptarmigan, and raptors. Aquatic birds include waterfowl (e.g., Canada goose), water birds (e.g., Arctic loon), and shorebirds. Approximately 30 species of birds are known to breed on the North Slope (Armstrong, 1980). Another study conducted in the nearby Arctic National Wildlife Refuge (ANWR) confirms approximately the same number of bird species as known breeding species in the region (USFWS, 2007). This number does not include species inhabiting the Brooks Range, approximately 100 miles south and east of the PBU, or those that do not breed in the area of the North Slope. The willow ptarmigan, raven, and snowy owl are the only potential year-round avian residents on the North Slope.

Aquatic communities include groups that inhabit the water column, such as algae (particularly phytoplankton), zooplankton (e.g., copepods), and aquatic plants. No fish populations are present across most water bodies due to their shallow depth and annual freezing. However, some large lakes and rivers may contain fish populations. As directed by EPA, fish were included as a receptor in the CSM for purposes of developing Tier II ALs to ensure that they are adequately addressed for locations where fish populations could be present. For PGs, SWMUs or AOCs proximal to lakes or rivers that could support fish populations and at locations where fish are observed, fish will be included as a receptor during the screening process.

6.1.1 ENDPOINTS

ERA guidance identifies assessment endpoints, which are the targets of protection, or values to be protected, at the site. Measures of effect are then selected that allow for determination of assessment endpoint success. This is also consistent with the ADEC (1999b) approach. For purposes of Tier II ALs, the following assessment endpoints have been identified:

- The potential for community-level effects on terrestrial plants, including overall species abundance and primary production;
- The potential for community-level effects on aquatic plants (including algae), including overall species abundance and primary production;
- The potential for community-level effects on zooplankton, including changes in species diversity and relative abundance;
- The potential for population-level effects on freshwater fish, including density and growth;
- The potential for population-level effects on mammals, including density and growth, and
- The potential for population-level effects on birds, including density and growth.

ADEC developed default assessment endpoints under their risk assessment program for use in different ecoregions (ADEC, 1999a). For the Arctic Slope ecoregion, ADEC divides the assessment endpoints by trophic level into:

- Producers (Trophic Level 0) – plants;
- Primary consumers (Trophic Levels 1 and 2) – herbivores and detritivores;
- Secondary consumers (Trophic Level 3) – invertivores, and
- Tertiary consumers (Trophic Level 4) – predators.

The assessment endpoints identified above for this study include all four trophic levels identified by ADEC. For wildlife, species within a trophic level are grouped by class (i.e., mammals, birds) and feeding guilds, and indicator species are selected for each feeding guild. The default assessment endpoints focus on “significant adverse effects” in a generic sense. The endpoints identified above for this Site incorporate ecological characteristics of the North Slope and will adequately protect the Arctic ecosystem.

Measures of effects are ways that the assessment endpoints will be evaluated in the first iteration of the ERA (i.e., Site-specific Tier II screening). As identified by ADEC (1999a), these measures of effect are primarily done through comparisons of media concentrations with benchmark concentrations, such as SLs or ALs. The assessment endpoints and measures of effect are consistent with those identified by ADEC (1999a) and follow the guidance and protocol laid out by the EPA (1997, 1998).

6.1.2 INDICATOR SPECIES

The identified indicator species were based primarily on feeding guilds, which in turn were developed using ADEC's list of primary indicator species for the Arctic Slope ecoregion. The Arctic Slope ecoregion described in the ADEC (1999b) guidance includes the Arctic Plain and portions of the Brooks Range. Because several of the ADEC indicator species are common in or near the Brooks Range, but are uncommon on the Arctic Plain near the coast, adjustments to indicator species for some guilds were made to more accurately reflect species common to the Prudhoe Bay region. Factors considered in selecting indicator species include their residency status, feeding habits, and whether they breed on the coastal plain area of the North Slope, where the Site is situated. The identified indicator species are shown in Table 9. Threatened and endangered species may visit or migrate through the Site, and a list of potentially present threatened and endangered species is provided in Table 10. Tier II ALs are not developed for threatened and endangered species. These will be separately evaluated as necessary to ensure protection of such species at the level of the individual rather than at the population level.

Plants, aquatic invertebrates, and fish are evaluated as taxonomic groups as a whole rather than through identification of individual indicator species.

ADEC has developed default primary indicator species for use in different ecoregions as part of their risk assessment program (ADEC, 1999b). For the Arctic Slope ecoregion, ADEC identifies terrestrial (upland) and freshwater species that could be used as representative species for quantitative evaluation.

As shown in italicized text in the list below, eight of the receptor groups with indicator species and four of the groups without specific indicator species were identified for Tier II AL development based on their key positions in the food web and abundance in the area. In some cases a species other than the ADEC default primary indicator species was selected to represent a receptor group (such as the snow goose for the semi-aquatic avian herbivore group). Default primary indicator species that were not selected to represent the applicable receptor group are shown in non-italicized font in the list provided below. Rationale for the inclusion of all receptor groups is summarized in Table 9. Further details on some of the species/guilds excluded as indicator species, and justification for use of species other than the primary indicator species defaults recommended by ADEC (1999a,b), are provided below the list.

- *Upland plants* (no specific species identified);
- *Aquatic plants* (macrophytes; no specific species identified);
- *All freshwater aquatic invertebrates* (no specific species identified);
- *All freshwater fish* (no specific species identified);
- *Semi-aquatic avian herbivores* (Northern pintail duck);
- *Terrestrial avian herbivores* (common redpoll);
- Semi-aquatic mammalian herbivore (moose);
- *Terrestrial mammalian herbivore (brown lemming);*
- Freshwater aquatic avian invertivore (ruddy turnstone);
- Freshwater semi-aquatic avian invertivore (common snipe);

- *Terrestrial avian invertivore (Lapland longspur)*;
- Freshwater amphibians (wood frog);
- *Terrestrial mammalian invertivore (tundra shrew);*
- *Freshwater avian piscivore (Arctic loon);*
- *Terrestrial mammalian carnivore (least weasel);*
- *Terrestrial avian carnivore* (Northern shrike), and
- Freshwater mammalian piscivore (river otter).

Three of the avian indicator species identified for the Site are different than those recommended by ADEC, including those representing semi-aquatic avian herbivores, terrestrial avian herbivores, and terrestrial avian carnivores. ADEC recommends the Northern pintail, common redpoll, and Northern shrike as indicator species for these three groups, respectively. However, review of survey information on the Site area compiled by Brown et al. (1980) indicates that the redpoll is not a common bird species. This species is more common further inland, and breeds more commonly south of the Brooks Range. The only common terrestrial avian herbivore that breeds on the North Slope and is a permanent resident at the Site is the willow ptarmigan, which was the basis for its selection as the indicator species for this feeding guild. Other herbivorous birds are present, but they are seasonal migrants on the North Slope. The ptarmigan will opportunistically feed on insects, but it is assumed to feed only on plants for purposes of Tier II AL development.

Another group for which the primary default indicator species was not selected is the semi-aquatic avian herbivores. ADEC recommends the Northern pintail duck as the default indicator species for semi-aquatic avian herbivores, but the snow goose was identified as the indicator species for this feeding guild at the Site. This was based on information provided by Armstrong (1980), which indicates that the snow goose forages in both moist and wet tundra, whereas the pintail duck forages mainly in moist tundra. Use of the snow goose allows for a single indicator species to represent this feeding guild at any site with a mixture of moist and wet tundra.

ADEC recommends the Northern shrike as the default indicator species for terrestrial avian carnivores. However, the snowy owl was used as an indicator species for this guild because the Northern shrike is uncommon near Prudhoe Bay (Hohenberger et al., 1994). The snowy owl is a common breeder in the area and sometimes overwinters there.

Several feeding guilds identified above are not represented in the list of primary indicator species identified for the Site; this includes two avian guilds, two mammalian guilds, and amphibians. Frogs and other amphibians have been observed near the Brooks Range, but not within the Site. Therefore, amphibians were not included in the ecological CSM. Similarly, semi-aquatic mammals such as moose, and aquatic mammals such as river otters, are not present in any abundance in this part of the Arctic coastal plain; they also typically occur closer to the Brooks Range. Members of these two mammalian feeding guilds were not selected as indicator species. The other guilds without selected indicator species are freshwater aquatic avian invertivores and freshwater semi-aquatic avian invertivores.

The Arctic loon was included as an avian piscivore. Although the Arctic loon also eats insects, particularly when young, Tier II ALs are developed for this indicator species based on the assumption that fish comprise 100 percent of the loon’s diet. This is a conservative assumption since chemicals are more likely to accumulate in fish relative to insects, resulting in greater potential exposure to higher trophic level organisms.

The ADEC-recommended aquatic avian invertivore is the ruddy turnstone. Four ADEC-identified alternative species to the ruddy turnstone that are common at the Site, are the oldsquaw, red phalarope, common eider, and king eider. With the exception of the red phalarope, these species also feed on fish, and are only present at the Site for about 90 days each year. Many of the shorebirds time their breeding activities to coincide with the emergence of crane flies from the tundra (MacLean, 1980). Although these birds may forage in aquatic and semi-aquatic habitats most of the year, they rely on upland habitats while on the North Slope. None of the recommended species meet the goal of evaluating specifically a freshwater, resident invertivore bird. Therefore, this guild is not specifically addressed in the AL evaluation. This does not exclude the potential for evaluating this guild at an individual SWMU or AOC in a baseline risk assessment, should a representative species be present.

The twelve indicator species discussed herein are considered to be relevant for Tier II AL development. If baseline risk assessments are warranted, it is possible that additional species may need to be included in the evaluation for some sites.

6.1.3 METHODOLOGY

Tier II ALs for wildlife (i.e., mammals and birds) were estimated consistent with the methodology used by EPA for developing Eco-SSLs (EPA, 2005). This involves identifying an appropriate toxicity-based dose referred to as a toxicity reference value (TRV). For aquatic receptors and terrestrial plants, targeted toxicity values were expressed as concentrations rather than doses. These concentrations were directly used as ALs. Tier II ALs for ecological receptors were developed using a three-part procedure, as follows:

- Literature search for relevant chemical-specific toxicity studies;
- Review of studies to identify relevant endpoints and toxicity values, and
- For wildlife, combine exposure and toxicity information to calculate Tier II ALs.

TRVs from the Eco-SSL documents were preferentially used, if available, as they were derived based on an extensive literature search and rigorous selection criteria. They have been approved by EPA and are considered the most comprehensive of the TRVs included in the selection process. In the absence of EcoSSL values, the Tier II ALs were based on the TRVs calculated herein, as discussed below. If insufficient data were available to develop a TRV, but a benchmark has been developed by Sample et al. (1996), then the benchmark from Sample et al. (1996) was used as the basis for the Tier II AL. Each of the three steps to developing a Site-specific ecological Tier II AL is discussed below.

6.1.3.1 Literature Search

Several sources were used to compile relevant toxicity information for development of Tier II ALs. These included documents in EPA’s toxicity databases: IRIS and AQUIRE (aquatic toxicology database), Eco-SSL documents for terrestrial species, and AWQC documents for aquatic species. Additionally, information from the open literature was used, as available, to augment these databases. Agency for Toxic Substances and Disease Registry (ATSDR) and ORNL sources, as well as sources cited by Sample et al. (1996), were also reviewed to augment the studies available for compiling Tier II ALs.

In order to be included in the evaluation, a study must provide data that enables a toxicity value to be determined (e.g., no-effect level or lethal dose), and must be for a relevant route of exposure. In some cases, a lack of ingestion studies required use of inhalation-based studies. In these situations, which were limited to a subset of VOCs, inhalation-based doses were converted to ingestion-based doses using dosimetric adjustments. Dosimetric adjustment calculations are shown in the relevant tables in Appendix C. Otherwise no route-to-route extrapolation was conducted on the doses reported in the studies. Also, a relevant form of the chemical needed to be used in the study; for example, chromium VI values were not used to develop Tier II ALs for chromium III. Studies needed to be either in peer-reviewed journals or published, sponsored, or cited by EPA in order to be initially included in the database for Tier II AL development. Other studies were used only in the absence of studies meeting these criteria. Finally, only toxicity studies were deemed relevant for this purpose; studies on bioaccumulation or uptake were not relevant to Tier II AL development and were excluded from this evaluation.

Based on the literature review, several chemicals had no relevant studies, and others had very few for a given receptor group (e.g., plants). Following the literature search, articles were compiled and reviewed as discussed below.

6.1.3.2 Study Review and Endpoint Selection

In light of the assessment endpoints identified in Section 6.1.1, the following types of primary studies, consistent with those in the Eco-SSL guidance, were most relevant for developing toxicity values (i.e., TRVs, Tier II aquatic ALs, Tier II plant ALs):

- Reproductive studies;
- Growth studies;
- Developmental studies, and
- Mortality studies.

These types of studies are most directly relevant as indicators of the population- and community-wide endpoints listed in Section 6.1.1.

Secondary studies included those considering general or systemic toxicity. In many cases, these studies provide the only available toxicity data for a given species or guild. Cancer studies were only used to identify non-neoplastic toxicity; cancer as an endpoint is not considered relevant to wildlife receptors.

Once relevant studies were identified, spreadsheets were compiled with key information, including:

- Study duration:
    - Chronic studies (considered at least 10 percent of a lifetime for most species) were preferable over subchronic studies (less than 10 percent of a lifetime);
    - Acute (short-term) studies were only used in the absence of longer-term studies, and
    - Most acute studies used for Tier II development were for aquatic receptors.
- Exposure medium:
    - Water, food, air (only if data from other exposure media were lacking).

- Endpoint:
  - Reproduction, development, growth, and mortality studies were preferable.
- Toxicity values (ordered below for each type of study from most relevant to least relevant):
  - Terrestrial studies
    - no observed adverse effect level [NOAEL],
    - no observed effect level [NOEL],
    - lowest observed adverse effect level [LOAEL],
    - lowest observed effect level [LOEL], and
    - lethal dose to 50 percent of a population [LD_{50}], and
  - Aquatic studies:
    - no observed effect concentration [NOEC],
    - lowest observed effect concentration [LOEC], and
    - effective concentration [EC], lethal concentration [LC].
- Ingestion rate of animals in the study, and
- Body weight of animals in the study.

To develop TRVs, information on ingestion rate and body weight of animals in the study was used to extrapolate the toxicity-based doses or concentrations (often reported, for example, in terms of mg/kg in diet) from the test species to the target species, as discussed below. A notes column was included to allow for comments on the study relevant to its use for developing toxicity values. Spreadsheets with toxicity information are provided alphabetically by chemical, organized by chemical group (VOCs, SVOCs, etc.), in Appendix C. Literature reviewed and considered for deriving toxicity values is listed in the Appendix C tables. A complete reference list of the toxicity studies included in development of toxicity values is provided in Appendix D.

Once this information was compiled for a given chemical and receptor group (e.g., birds), studies incorporating the most relevant endpoints, study durations, exposure routes, and toxicity values were identified and highlighted on the spreadsheet. In many cases, initial toxicity values for wildlife were reported as concentrations rather than doses. For these situations, the concentrations were converted to daily doses for wildlife (i.e., mg of chemical per kg of body weight per day).

For wildlife, information from a study was used to identify a daily ingestion rate and a body weight for the test animals. When these values were available, calculation of a daily dose was straightforward. In the absence of this information, either of two types of sources was used to make the calculation. In some cases, default values from the literature for a given species and age were used (e.g., water ingestion rate for a laboratory rat), while in other cases, values for the same species and age identified in another study were used. These two situations are identified on the individual tables in Appendix C, as encountered.

6.1.3.3 Calculation of Tier II Site-Specific Action Levels

The process for developing Tier II ALs was designed to be generally similar to methodologies used by EPA for developing Eco-SSLs (for birds and mammals) and AWQC (for aquatic receptors). This involves identifying an appropriate toxicity-based dose or concentration, and was done as discussed below for soil and water media. Certain assumptions regarding data quality in the literature were made herein and studies that may be different from those used in the EcoSSL process are included. Similarly, the AWQC process incorporates a larger number of studies and taxonomic groups than were available and/or applicable for development of aquatic Tier II ALs in this report. However, the overall approach to develop TRVs and Tier II ALs was largely based on the Eco-SSL and AWQC methodologies.

Terrestrial Receptors

For mammals and birds, data were reviewed to discern if at least three NOAEL or three LOAEL values were available for growth or reproduction for at least two species. If there were at least three NOAELs, then the toxicity value was equal to the geometric mean of the NOAELs in the reproduction and growth effect groups. An exception to this was if the geometric mean was greater than the lowest paired LOAEL (where “paired” indicates that both a NOAEL and a LOAEL were identified for the same endpoint in a particular study; such paired values are also referred to as “bound” NOAELs and LOAELs). In these situations, the toxicity value was equal to the highest bound NOAEL below the lowest bound LOAEL for the endpoints identified above. If there were at least three LOAELs for growth or reproduction, but fewer than three NOAELs, then the toxicity value was equal to the lowest LOAEL divided by a relevant uncertainty factor [UF] (discussed further below).

If there were fewer than three NOAELs, but at least one for the reproductive or growth endpoints, then the toxicity value was equal to the lowest NOAEL for either group. In cases where this NOAEL is higher than the lowest LOAEL for mortality, then the toxicity value was equal to the highest LOAEL for growth or reproduction below the lowest LOAEL for the mortality endpoint, or the lowest LOAEL, whichever was lower. If no studies were available on the three target endpoints, the applicable value for most relevant endpoint with available data was used.

UFs, as warranted and described in EPA (1997), were used to convert the toxicity value to a chronic no-effect level basis.

The TRVs for a given guild were then extrapolated to the indicator species by adjusting for body weight differences between the test and target species. As discussed with EPA, allometric equations are not considered accurate and appropriate for use in extrapolating across species, and instead EPA has recommended the simple body weight adjustment. Therefore, the same TRV was used to identify Tier II ALs for a variety of indicator species following species-specific body weight adjustments. For example, studies on mice and rats were typically used to extrapolate to the Arctic shrew, lemming, and least weasel. In some cases, mink studies were available; these were used to develop Tier II ALs for the least weasel as available. For birds, studies on poultry (e.g., chickens, turkeys) and quail were used as the basis for avian ALs relevant to the ptarmigan, while studies on mallards were used as the basis for avian ALs relevant to the snow goose where available. The lower of these values was used for the Lapland longspur and snowy owl, which are both in different Orders than poultry and mallards. As outlined in EPA (1997), an additional UF was incorporated to account for these taxonomic differences in species extrapolation. Specific UFs used are described further below.

Studies were not applied across classes of animals. In the absence of data for a given class (e.g., birds), no Tier II value was developed for that class, even if data from the other class (e.g., mammals) were available.

Tier II ALs were calculated assuming that wildlife indicator species are exposed to chemicals through their diet and through incidental soil ingestion. Incidental direct soil ingestion may occur during feeding and grooming. Tier II ALs were calculated by rearranging the basic deterministic risk equation. Instead of solving the equation for risk, one solves for the soil concentration associated with a given target ecological risk level (EPA, 2005). Assuming that indicator species forage on a single primary food type, the general equation for estimating a Tier II AL is as follows:

$$AL = \frac{TRV \times TR}{AUF \times SUF \times IRf \ \times (BAF + Ps)}$$

Where:

AL = Tier II Action Level (mg/kg)

TRV = Toxicity reference value (mg/kg-d)

TR = Target risk level (unitless)

AUF = Area use factor (unitless)

SUF = Seasonal use factor (unitless)

IRf = Ingestion rate of food (kg/kg-day)

BAF = Species-specific bioaccumulation factor (see below

Ps = Proportion of soil in diet (unitless)

Values for exposure factors used to calculate Tier II ALs for the various indicator species are presented in Table 11. Bioaccumulation factors are provided in Table 12. TRVs are provided in Tables 13 (mammals) and 14 (birds). Exposure factors and bioaccumulation factors are further discussed below.

Wildlife may range over large areas to meet resource needs. In many cases, wildlife forage over areas much larger than a contaminated site, and only a portion of the food or soil they ingest could possibly come from the contaminated site. The area use factor (AUF) can account for exposures that occur outside the contaminated site. The AUF is defined as the portion of the home range size of an animal that may be contaminated. For the purposes of developing Tier II ALs, the AUF was set to one. In other words, it was conservatively assumed that all indicator species forage only within a SWMU or AOC.

Most birds and many of the mammals that may be found near Prudhoe Bay are migrants that arrive in spring or early summer and depart in late summer or fall. As a result, only a portion of their annual food and soil ingestion could possibly include Site-related material. The seasonal use factor (SUF) can account for temporal changes in exposure conditions. SUF is defined as the proportion of the year that an animal may be present at the Site. With the exception of avian invertivores, it was conservatively assumed that all indicator species forage at a contaminated site for the entire year, and the SUF was conservatively set to one. Avian invertivores are seasonal migrants that do not overwinter in the Prudhoe Bay area, and the SUF for the Lapland longspur (avian invertivore indicator species) was set at 0.25 based on the one quarter of the year (i.e., summer) that this indicator species is present in the PBU. Note that the snow goose and arctic loon are also migratory, but based on EPA and ADEC preferences these two indicator species were assigned a SUF of 1 for screening purposes.

Chemical concentrations in the tissues of food consumed by wildlife were estimated using chemical-specific bioaccumulation factors. Tissue concentrations were estimated for three general types of organisms: plants that are consumed by herbivores, invertebrates (i.e., earthworms) that are consumed by invertivores, and small mammals that are consumed by predators. The models used by the EPA for deriving Eco-SSLs were used here to estimate tissue concentrations in invertebrates and small mammals (EPA, 2005). Earthworms are not present on the North Slope, but these values were used in the absence of values for more relevant soil invertebrates. Plant uptake of chemicals was estimated using models from the Eco-SSLs and the RAIS (ORNL, 2015). Chemical-specific models for estimating bioaccumulation by plants, invertebrates, and small mammals are presented in Table 12. In the absence of Eco-SSLs, bioaccumulation factors available from the following sources were used to estimate bioaccumulation into tissues:

- RAIS (ORNL, 2015);
- Bioaccumulation and Bioconcentration Screening Protocol (Department of Energy [DOE], 1999);
- Screening Level Ecological Risk Assessment Protocol, Appendix C (Media-to-Receptor Bioconcentration Factors [BCFs]) and Appendix D (BCFs for Wildlife Measurement Receptors) (EPA, 1999b);
- Bioaccumulation of Total Mercury and Monomethylmercury in the Earthworm (Burton et al., 2006), and
- Bioavailability of Phthalate Congeners to Earthworms (Hu et al., 2005).

All of the sources used to identify BAFs are documented in Table 12. In some cases, no BAF was available for a chemical. For example, EPA (2005) considers accumulation of PAHs into mammal tissues to be insignificant, and quantitative estimates of PAH uptake into mammal tissues are not included in Eco-SSL derivation. EPA (2005) has not developed Eco-SSLs for VOCs. Because most VOCs have relatively short half-lives in open systems, relatively low molecular weights, and low potential to accumulate in plant or animal tissues, quantitative estimates of uptake of VOCs from soil into invertebrate and mammal tissues were not modeled. Relative to direct soil ingestion, exposure to VOCs through the diet is expected to be minimal. However, invertebrate BAFs are available for some VOCs (i.e., acetone, carbon tetrachloride, chloroform, 1,4-dioxane, formaldehyde, methylene chloride, and vinyl chloride) and these are listed in Table 12 and were used in Tier II AL development.

Food ingestion rates (IR_f) are expressed as kilograms of food eaten per kilogram body weight per day (kg/kg-d). Food ingestion rates were compiled from literature sources; the rates and sources for individual ecological receptors are shown in Tables 15 through 22. Food ingestion rates for each receptor are summarized in Table 11. Many of the food ingestion rates taken from the literature were expressed on a wet weight basis. However, because the EPA (2005) BAFs relate dry weight soil concentrations to dry weight tissue concentrations, the food ingestion rates from the literature used to estimate dietary exposure were converted to dry weight estimates as follows (see EPA, 2005):

$$IR_{f(dry\ wt)} = IR_{f(wet\ wt)} \times (1 - WC)$$

Where:

$IR_{f(dry\ wt)}$	=	Dry weight food ingestion rate (kg/kg-d)
$IR_{f(wet\ wt)}$	=	Wet weight food ingestion rate (kg/kg-d)
WC	=	Water content of diet (unitless)

EPA (2005) estimates of water content were used for the following food items:

Plants = 85%

Invertebrates (earthworms) = 84%

Small mammals = 68%

For plants, Tier II ALs were directly compiled from toxicity studies focusing on the same three target endpoints, applying UFs for endpoints as outlined below (e.g., extrapolating from an EC_{50} to an EC_{10} or LOEC). Since the majority of plant matter across the Site consists of grasses and sedges, studies on monocots were used exclusively where available rather than information on dicots.

Aquatic Receptors

For the loon, the same process used to calculate dose-based TRVs for soil indicator species was used to calculate TRVs for this aquatic avian indicator species. The same basic equations were also used to calculate Tier II ALs for the loon, except that a wet weight-based food ingestion rate was used since fish BCFs are provided on a wet weight basis. Also, water ingestion was included separately rather than as a proportion of dietary ingestion. Uptake of chemicals to fish was estimated using models from the RAIS (ORNL, 2015).

For aquatic organisms (i.e., algae, zooplankton, and fish), based on EPA (2011a) comments, the 10th percentile toxicity value was targeted as the toxicity value, focusing preferentially on reproduction and growth endpoints. This was done only if at least ten values were available for the same endpoint (e.g., EC_{50}). If this 10th percentile value was based on a lethal endpoint (e.g., LC_{50}), the value was divided by a UF of five, as requested by EPA (2011a). When available, measured studies were preferred over studies where the chemical concentration was only measured at the start of the experiment (i.e., “nominal” studies). In the absence of sufficient information to compile a 10th percentile, the lower of the LC_{50}, EC_{50}, LOEC, and NOEC concentrations were used for each taxonomic group, and were divided by UFs, as discussed further below. Because the targeted toxicity values are concentrations for aquatic organisms rather than doses, the toxicity values were directly used as ALs.

6.1.3.4 Uncertainty Factors

Use of UFs is a regulatory necessity to account for the majority of studies that are not of chronic duration and/or do not identify no-effect levels. A variety of UF schemes have been developed, including factors of 10 for individual extrapolations (e.g., subchronic to chronic), factors of the square root of 10 (e.g., 3), and simple numerical values that increase as the deviation from a chronic NOEL endpoint increases.

For development of Tier II ALs, the UFs presented in EPA (1997) were used. The following UF multipliers were applied to the toxicity-based values to generate TRVs. One value is selected from the first group, and up to two values are selected from the second group, as applicable.

Toxicity-study based UFs:

Extrapolation of acute or subchronic LOAEL to chronic NOAEL	UF = 10
Extrapolation of chronic LOAEL to chronic NOAEL	UF = 5
Extrapolation of LD_{50} to chronic NOAEL	UF = 50
Lethality-based 10th Percentile used (aquatic only)	UF = 5

Taxonomic-based UFs:

Test and target species in different Family, same Order	UF = 2
Test and target species in different Order, same Class	UF = 4

Therefore, a UF up to 200 could be applied to toxicity-based values. The high end of this range would be, for example, extrapolating from an LD_{50} study for a rat (Order Rodentia) to a chronic NOAEL for the least weasel (Order Carnivora). The highest UF that can result from using a chronic NOAEL-based toxicity study under this scheme is 4. The situation where a subchronic NOAEL is used as the key value is not addressed in the EPA (1997) scheme. For this situation, a UF of 5 is used, similar to the value used for extrapolation of a chronic LOAEL to a chronic NOAEL.

This scheme was developed primarily for terrestrial receptors (e.g., mammals, birds) rather than aquatic organisms. The assessment endpoints and goals of the ERA focus for aquatic organisms are on the population level. Therefore, targeting a LOEC for aquatic organisms is considered equivalent to a 10th percentile toxicity value. In situations where 10th percentile values were used, an additional toxicity-study-based UF was not incorporated into the AL unless the 10th percentile value was based on lethality. Similarly, the LD_{50} to chronic NOAEL UF was adjusted from 50 (used for birds and mammals) to 10 for aquatic organisms to reflect extrapolation of an LC_{50} to a LOEC, rather than to a NOEC. Results of the Tier II AL development for ecological receptors are discussed below.

6.1.4 RESULTS

Over 600 articles were compiled from the literature search, which represented approximately half of the articles identified through the database searches (the other articles were not selected as they did not meet minimum criteria). For developing ALs, a total of over 200 different articles were used, as documented in Appendices C and D. Appendix D also includes a complete list of references cited in the individual spreadsheets.

The results of Tier II AL development for ecological receptors are discussed separately in Appendix C. Tier II ecological ALs and calculations are provided for the mammalian indicator species (brown lemming, tundra shrew, and least weasel) in Tables 15 through 17, respectively, and for the avian indicator species (willow ptarmigan, snow goose, Lapland longspur, snowy owl, and Arctic loon) in Tables 18 through 22, respectively. These values are summarized in Tables 23 and 24 for soil and water, respectively. For taxonomic groups where individual species are not addressed (e.g., zooplankton), the Tier II ALs are compiled in chemical-specific tables in Appendix C and summarized in Table 24.

6.1.4.1 Soil

In soil, mammalian-based Tier II ALs were developed for 50 (76 percent) of the RO-COPCs with Tier I SLs (Table 23). In contrast, avian- or plant-based Tier II soil ALs were developed for only 21 (32 percent) of the RO-COPCs with Tier I SLs.

No relevant studies were available to use in developing Tier II ALs for two VOCs, just under one-half of the SVOCs, and for total chromium. For the latter, valence-specific data were used to develop Tier II ALs for chromium III and chromium VI in place of total chromium values. Tier II ALs were not developed for aluminum and manganese because these two constituents are only regulated under the AWQS. The other chemicals for which Tier II ALs were not developed are discussed in Section 7.

The chemical-specific soil Tier II AL for a given site will depend on the relevant land use and indicator species for each site. In general, it is anticipated that the lowest Tier II value will be used initially, and other more appropriate values will be used on a site-by-site basis.

6.1.4.2 Water

In water, sufficient toxicity data were available to estimate Tier II ALs for the majority of RO-COPCs (Table 24). Of the various aquatic ecological receptor groups (i.e., algae, zooplankton, fish, and the loon), relevant aquatic toxicity data were most plentiful for zooplankton (e.g., *Daphnia*). Aquatic ALs for fish were developed for more than half (57 percent) of the RO-COPCs. No aquatic Tier II ALs could be developed for 15 of the chemicals with Tier I aquatic SLs (21 percent). Tier II ALs were also not developed for aluminum and manganese, because these two RO-COPCs are only regulated under the AWQS. Chemicals for which Tier II ALs could not be developed are discussed further in Section 7.

The nature of the surface water bodies adjacent to a particular SWMU, AOC, or PG will be relevant in identifying the most appropriate aquatic AL to use for the specific evaluation. For example, if fish are not present at a site based on the criteria previously described, then the ALs for the 12 chemicals for which the lowest ALs are based on fish are not relevant to use at that site. Instead, the next lowest Tier II value would be used, assuming that the receptor that is the basis for that AL is present at the location. This process is further described in SLR (2014).

6.2 HUMAN HEALTH-BASED ACTION LEVELS

Tier II ALs were developed for industrial and subsistence user receptors (Table 25). Tier I SLs are shown for both of these receptors (Tables 2 and 3), but more Site-specific environmental factors and use patterns that influence potential exposures are incorporated into the Tier II AL calculations. Current subsistence users are also evaluated in addition to future subsistence users in Tier II. As previously discussed, residential land use is currently an incomplete exposure scenario across of the Site. Tier II ALs were therefore not developed for residential receptors. In the few instances where residential land use may be possible near-term (i.e., in the event that zoning on native allotment tracts were to be changed to residential), Tier II residential ALs can be calculated consistent with methods discussed herein. To account for cumulative risk, a target risk of $1x10^{-6}$ was used to calculate Tier II ALs for all carcinogenic chemicals, and a target hazard quotient of 0.1 was used for noncancer effects.

With the exception of arsenic, Tier II ALs were calculated assuming that the relative bioavailability of metals in soil was 100 percent (i.e., bioavailability of the metal in soil is identical to that of the metal in key toxicity studies). For arsenic in soil, the EPA default relative bioavailability of 60 percent was used to calculate Tier II ALs for the soil ingestion pathway (EPA, 2012b).

Details of the Tier II AL development are discussed below for each receptor. The equations used to calculate industrial worker and subsistence user ALs are provided in Appendix B, along with further details documenting the input parameters.

Tier II ALs for human receptors are summarized in Table 25 for both soil and water media.

6.2.1 INDUSTRIAL WORKER TIER II ALS

The Tier II ALs for the industrial worker take into consideration the data compiled over 20 or more years regarding typical exposure conditions for Prudhoe Bay workers (e.g., exposure frequency). Soil action levels were calculated for the industrial worker receptor using equations provided in ADEC (2008b), exposure assumptions from EPA (1991, 2004, and 2015c), and Site-specific data. Site-specific exposure assumptions for this receptor include exposure frequency and exposure time. Specifically, an exposure frequency of 185 days/year and an exposure time of 12 hours/day were used to calculate ALs for the inhalation pathway based on information regarding length and frequency of work shifts at the Prudhoe Bay facility. For direct soil contact pathways (i.e., ingestion and dermal contact), an exposure frequency of 100 days/year was used to reflect the annual number of days that the ground is not covered with snow or frozen (Wendler et al., 2010). Tier II soil ALs for industrial workers include the soil ingestion, dermal soil contact, and inhalation exposure pathways and represent the lower of cancer and noncancer based multi-pathway values.

To develop Tier II water ALs for the industrial worker receptor, the exposure frequency of 200 days/year presented in Table 5 that was used to develop Tier I SLs (for the dermal pathway) for this receptor was reduced to 100 days/year to reflect the annual number of days that the ground is not covered with snow or frozen (Wendler et al., 2010). For the rest of the year, it is assumed that surface water is frozen and no exposure pathways are complete.

Input values and sources for development of industrial worker Tier II values are defined in Table B-5. Values are developed in Tables B-8 (soil) and B-9 (water) of Appendix B.

6.2.2 SUBSISTENCE USER TIER II ALs

As discussed in Section 4.7.2.3, little subsistence use is anticipated within the PBU while the field is active. Subsistence users do not currently frequent the PBU for sources of food, and the only anticipated use is the recent opportunistic hunting of caribou and waterfowl along the narrow strip of coastline contiguous with the PBU during whaling trips. Tier II ALs were developed for current subsistence users to reflect this scenario. However, because subsistence use may need to be considered under future land use scenarios, a future subsistence user scenario was also included in the development of Tier II ALs for human health.

To calculate Tier II ALs for subsistence user receptors, the ADFG's subsistence use database (ADFG, 2002) and discussions with native Alaskan North Slope residents, as discussed in Section 4.7.2.3 and Appendix A, were used to estimate the amount of fish and game consumption. These estimated amounts of fish and game consumed (100% freshwater fish consumption assumed for calculation of Tier II water ALs and 100% caribou consumption assumed for calculation of Tier II soil ALs) were used, whether or not the daily diet would include both freshwater fish and caribou or the diet was supplemented from other sources. As discussed in Appendix A, a substantial portion (possibly as much as 40 percent) of the subsistence diet is composed of items purchased at grocery stores. The discounting of other dietary sources adds to the conservatism in the Tier II ALs for the subsistence user receptors since no downward adjustments to the proportion of fish and game in the diet were made for either current or future subsistence user Tier II AL calculations.

6.2.2.1 Future Resident Subsistence User

To develop Tier II ALs for the future subsistence user receptor, the following Site-specific modifications were made to the parameters in Table 6 that were used to develop Tier I SLs:

- An area use factor (AUF) of 0.25 (25 percent) was used instead of a value of 1.0 (100 percent) for soil-based dietary ingestion values. It is unlikely, given the wide variability in migration routes, that caribou will be chronically exposed to Site chemicals; it is also unlikely that subsistence users would successfully hunt only those caribou that frequent the Site. However, it is recognized that caribou can move through the Site and be harvested well away from the Site. Therefore, an AUF of 0.25 is considered a conservative estimate of the relative fraction of food ingested by caribou that may be considered impacted by Site chemicals.
- Because fishing is done almost exclusively in rivers, a fraction of 10 percent (0.1) was assumed to reflect the potential fraction of fish ingested by subsistence users that could come from Site lakes, rather than the unrealistic assumption in Tier I that all harvested fish come from lakes.
- The exposure frequency for soil ingestion and dermal contact with soil was reduced from 200 days/year to 100 days/year (Wendler et al., 2010) to reflect the annual number of days the ground is not covered with snow or frozen.

This future resident subsistence use scenario is also protective of residential exposures, because it includes the additional exposure pathways of consumption of fish and game derived from local hunting and fishing. Input values and sources for development of future subsistence user Tier II values are defined in Table B-6. Values are developed in Tables B-10 (soil) and B-11 (water) of Appendix B.

6.2.2.2 Current Nonresident Subsistence User

Only a very narrow strip of land along the coastline is used for current subsistence harvesting within the Site (caribou and geese are collected along this strip), representing less than 5 percent of the Site by area (Appendix A). Because this small portion of the Site is currently utilized for opportunistic hunting, Tier II ALs were developed for current subsistence users.

Although no areas within the Site are currently used for subsistence fishing, Tier II ALs were developed for both soil and water (conservatively including ingestion of freshwater fish) for this receptor.

Since subsistence users do not currently live at the Site, a full-time subsistence resident scenario is not applicable for current subsistence users. Therefore, only exposure pathways that could occur during opportunistic hunting or fishing excursions were incorporated into the Tier II ALs for current subsistence users. Soil ALs for this receptor include the soil ingestion, dermal contact with soil, and inhalation of dust/vapors in outdoor air exposure pathways in addition to caribou ingestion. Exposure pathways included in the surface water ALs include dermal contact with surface water and fish ingestion. An exposure frequency of 30 days/year was used to reflect the duration of hunting activities adjacent to the Site (i.e., duration of whaling trips). Since consumption of fish and game harvested during this 30 day period could occur year-round, the exposure frequency of 365 days/year was retained for dietary ingestion pathways only.

Exposures to children were not included in the calculations for exposure pathways other than dietary ingestion because children under the age of 6 are not typically present on these whaling trips. It was conservatively assumed that both children and adults could consume caribou and fish collected from the Site year-round. While dietary AL values for carcinogens combine the child and adult life stages, noncarcinogen values are derived separately for children and adults. Therefore, for the dietary ingestion pathway, separate noncancer values were calculated for child and adult subsistence user receptors. For adults, dietary ingestion values were combined with values for the other exposure pathways included under the opportunistic hunting or fishing scenarios. The lower of the multi-pathway adult ALs and child ALs for the dietary ingestion pathway were then selected as the noncancer ALs for the current subsistence user. Consistent with other SL and AL calculations, the lower of the cancer and noncancer based values were then selected as the Tier II ALs.

Input values and sources for development of current subsistence user Tier II values are defined in Table B-7. Values are developed in Tables B-12 (soil) and B-13 (water) of Appendix B.

6.2.3 RESULTS

Tier II soil and water ALs were developed for human receptors for RO-COPCs, except for acenaphthylene, benzo(g,h,i)perylene, phenanthrene, aluminum, total chromium, lead, and manganese. Tier II ALs were not developed for aluminum and manganese because these two constituents are only regulated under the AWQS. Valence-specific data were used to develop Tier II ALs for chromium III and chromium VI in place of total chromium values. Chemicals without calculated Tier II AL values are discussed further in Section 7.

Tier II values for human and ecological receptors are summarized in Table 26.

7. APPLICATION OF RESULTS

The Tier I SL and Tier II AL values described in Sections 5 and 6 of this document have numerous potential applications. The application of SL and AL values, and incorporation of background concentrations, will be site-specific and will initially be described in individual RFI work plans. Treatment of COIs without SL and AL values, and potential future updates to SL and AL values, are discussed in the following sections.

7.1 CONSTITUENTS WITHOUT SCREENING OR ACTION LEVELS

Constituents that are detected but for which no screening levels are available will be evaluated on a case-by-case basis to determine whether screening levels should be developed or a surrogate chemical should be used to assess potential risk. For some chemicals, no relevant toxicity data were available to calculate a Tier II AL (e.g., acenaphthylene, benzo[g,h,i]perylene). For such chemicals, values for a structurally similar chemical may be used if available. For example, Tier II values for acenaphthene could be used as surrogates for acenaphthylene. If an appropriate surrogate chemical cannot be identified, the Tier I SL can be used as the “action level”.

7.2 FUTURE UPDATES

Because toxicity values, regulatory-based screening values, and other parameters change periodically, the Tier I SLs and Tier II ALs may need to be updated on a periodic basis to maintain consistency with the cited sources. Updates will be provided in the Annual Reports required by the Order (Section IX). Detections of additional COIs at a SWMU, AOC, or PG, may result in the development of Tier I SLs, and if necessary, Tier II ALs. If additional Tier I SLs or Tier II ALs are developed, the same procedures described in this report will be used. Any new or revised SLs or ALs will be submitted to ADEC for review and EPA for review and approval.

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LIMITATIONS

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

Opinions and recommendations contained in this work product are based on conditions that existed at the time the services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. The data reported and the findings, observations, and conclusions expressed are limited by the scope of work. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this work product.

The purpose of an environmental assessment is to reasonably evaluate the potential for, or actual impact of, past practices on a given site area. In performing an environmental assessment, it is understood that a balance must be struck between a reasonable inquiry into the environmental issues and an appropriate level of analysis for each conceivable issue of potential concern. The following paragraphs discuss the assumptions and parameters under which such an opinion is rendered.

No investigation can be thorough enough to exclude the presence of hazardous materials at a given site. If hazardous conditions have not been identified during the assessment, such a finding should not therefore be construed as a guarantee of the absence of such materials on the site, but rather as the result of the services performed within the scope, practical limitations, and cost of the work performed.

Environmental conditions that are not apparent may exist at the site. Our professional opinions are based in part on interpretation of data from a limited number of discrete sampling locations and therefore may not be representative of the actual overall Site environmental conditions.

The passage of time, manifestation of latent conditions, or occurrence of future events may require further study at the Site, analysis of the data, and/or reevaluation of the findings, observations, and conclusions in the work product.

This work product presents professional opinions and findings of a scientific and technical nature. The work product shall not be construed to offer legal opinion or representations as to the requirements of, nor the compliance with, environmental laws rules, regulations, or policies of federal, state or local governmental agencies.

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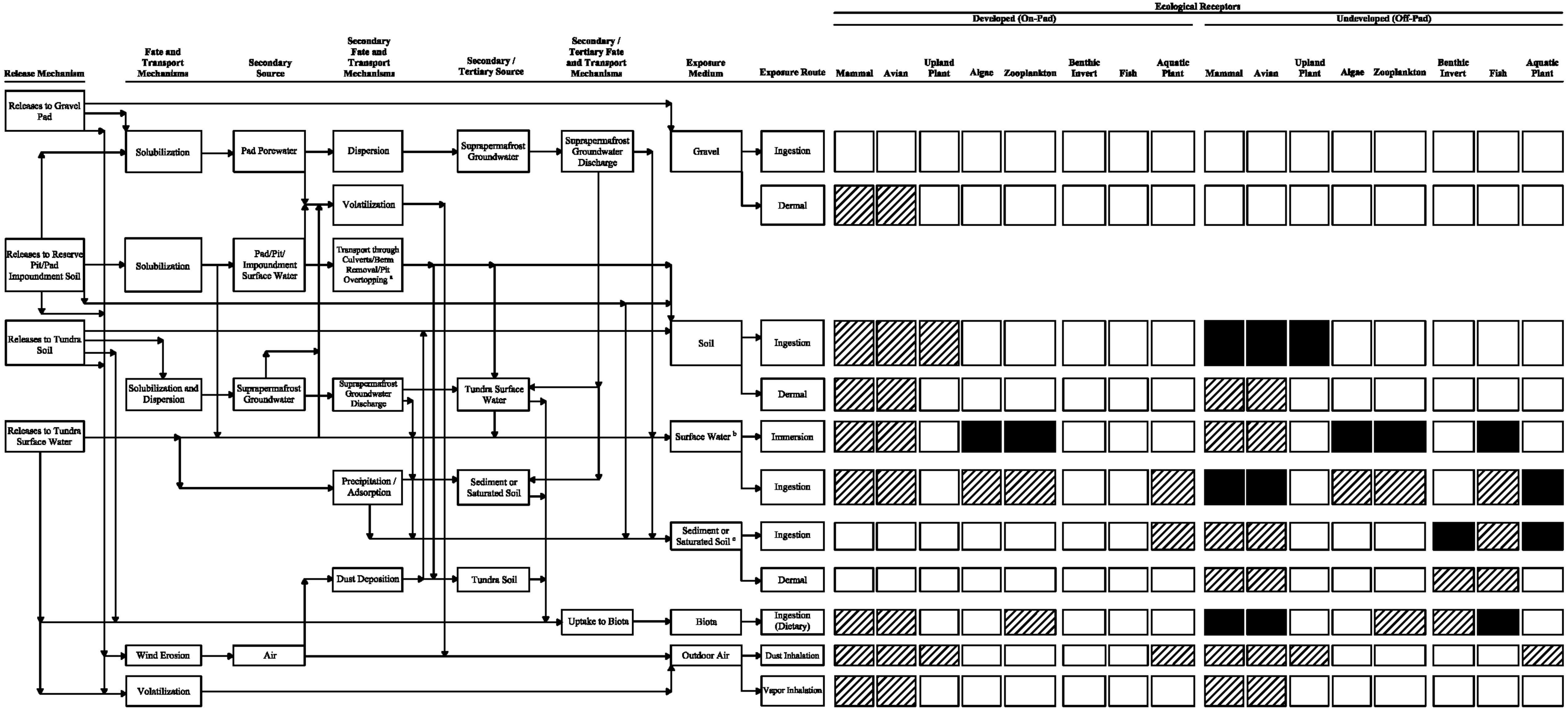
FIGURES

Figure 1
Site-Wide Ecological Conceptual Site Model Diagram
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska
BP Exploration (Alaska) Inc.



		Ecological Receptors															
		Developed (On-Pad)								Undeveloped (Off-Pad)							
Exposure Medium	Exposure Route	Mammal	Avian	Upland Plant	Algae	Zooplankton	Benthic Invert	Fish	Aquatic Plant	Mammal	Avian	Upland Plant	Algae	Zooplankton	Benthic Invert	Fish	Aquatic Plant
Gravel	Ingestion	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
	Dermal	▨	▨	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Soil	Ingestion	▨	▨	▨	□	□	□	□	□	■	■	■	□	□	□	□	□
	Dermal	▨	▨	□	□	□	□	□	□	▨	▨	□	□	□	□	□	□
Surface Water b	Immersion	▨	▨	□	■	■	□	□	□	▨	▨	□	■	■	□	■	□
	Ingestion	▨	▨	□	▨	▨	□	□	▨	■	■	□	▨	▨	□	▨	■
Sediment or Saturated Soil c	Ingestion	□	□	□	□	□	□	□	▨	▨	▨	□	□	□	■	▨	■
	Dermal	□	□	□	□	□	□	□	□	▨	▨	□	□	□	▨	▨	□
Biota	Ingestion (Dietary)	▨	▨	□	□	▨	□	□	□	■	■	□	□	▨	▨	■	□
Outdoor Air	Dust Inhalation	▨	▨	▨	□	□	□	□	▨	▨	▨	▨	□	□	□	□	▨
	Vapor Inhalation	▨	▨	□	□	□	□	□	□	▨	▨	□	□	□	□	□	□

■	Receptor likely to be exposed via this route so pathway considered potentially complete and significant.
▨	Receptor may be exposed via this route, but exposure pathway is expected to be insignificant on the basis of Site-specific characteristics. Pathway may be considered potentially complete and significant for some locations.
□	This is not a complete exposure pathway.

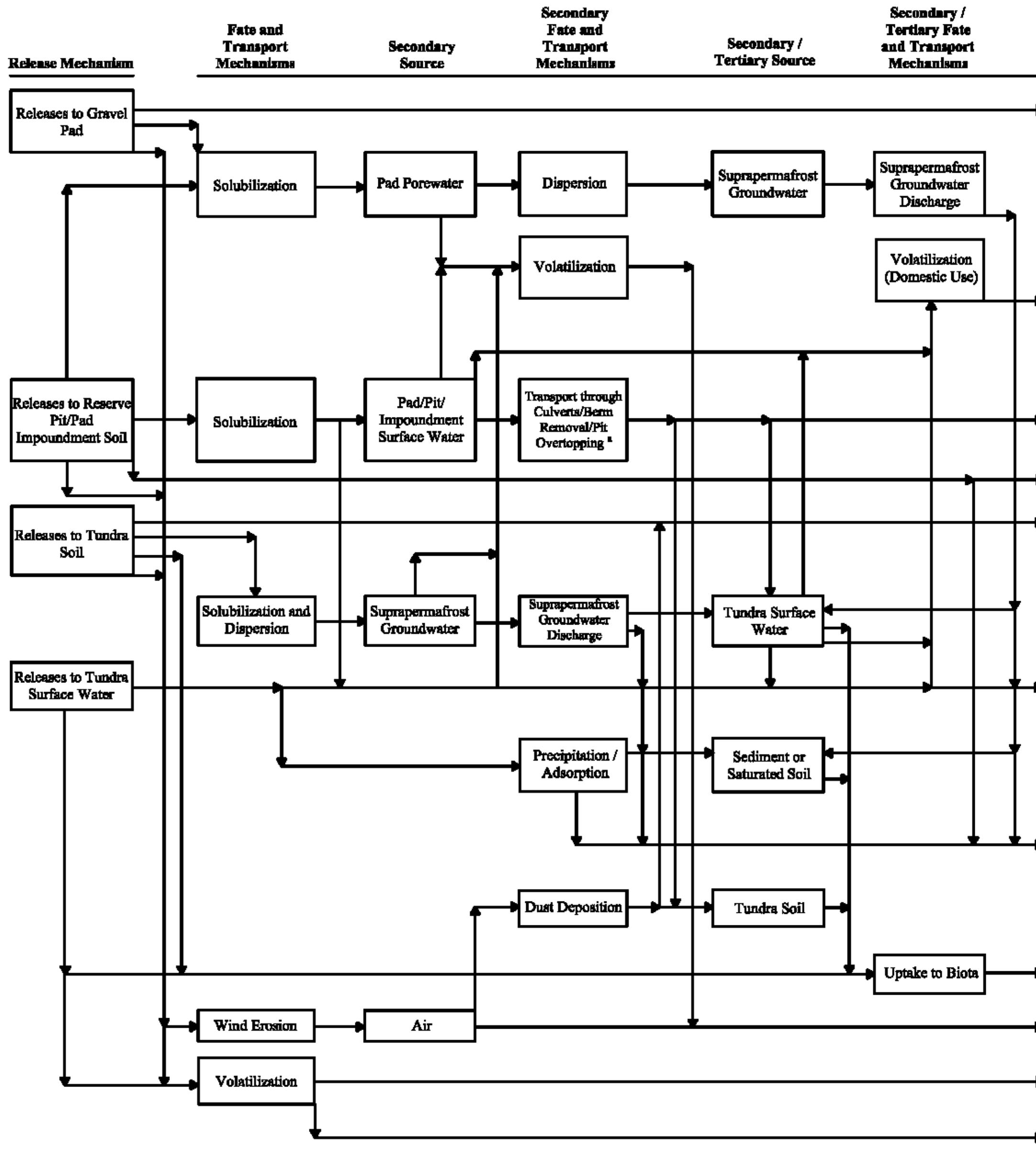
Footnotes:

[a] Pit overtopping is considered an incomplete transport mechanism.

[b] Fish are relevant only for some ponds and rivers, and not for other surface water features such as pad impoundments.

[c] Sediment and benthic invertebrates are relevant only for some ponds and rivers, and not for other surface water features such as pad impoundments. Saturated soil may be present in a pad impoundment and/or some tundra surface water features.

Figure 2
Site-Wide Human Health Conceptual Site Model Diagram
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska
BP Exploration (Alaska) Inc.



Exposure Medium	Exposure Route	Human Receptors							
		Developed (On-Pad)				Undeveloped (Off-Pad)			
		Industrial Worker	Future Resident	Future Subsistence User	Current Subsistence User	Industrial Worker	Future Resident	Future Subsistence User	Current Subsistence User
Gravel	Ingestion	■	■	■	□	□	□	□	□
	Dermal	■	■	■	□	□	□	□	□
Indoor Air	Inhalation	□	■	■	□	□	■	■	□
Soil	Ingestion	■	■	■	□	▨	■	■	■
	Dermal	■	■	■	□	▨	■	■	■
Surface Water	Ingestion	□	■	■	□	□	■	■	▨
	Dermal	■	■	■	□	□	■	■	■
Sediment or Saturated Soil [b]	Ingestion	■	■	■	□	▨	■	■	▨
	Dermal	■	■	■	□	▨	■	■	▨
Biota [c]	Ingestion (Dietary)	□	□	▨	▨	□	□	■	■
Outdoor Air	Dust Inhalation	■	■	■	▨	▨	■	■	■
	Vapor Inhalation	■	■	■	▨	▨	■	■	■
Indoor Air	Vapor Inhalation	▨	□	□	□	□	□	□	□

■ Receptor likely to be exposed via this route so pathway considered potentially complete and significant.

▨ Receptor may be exposed via this route, but exposure pathway is expected to be insignificant on the basis of Site-specific characteristics. Pathway may be considered potentially complete and significant for some locations.

□ This is not a complete exposure pathway.

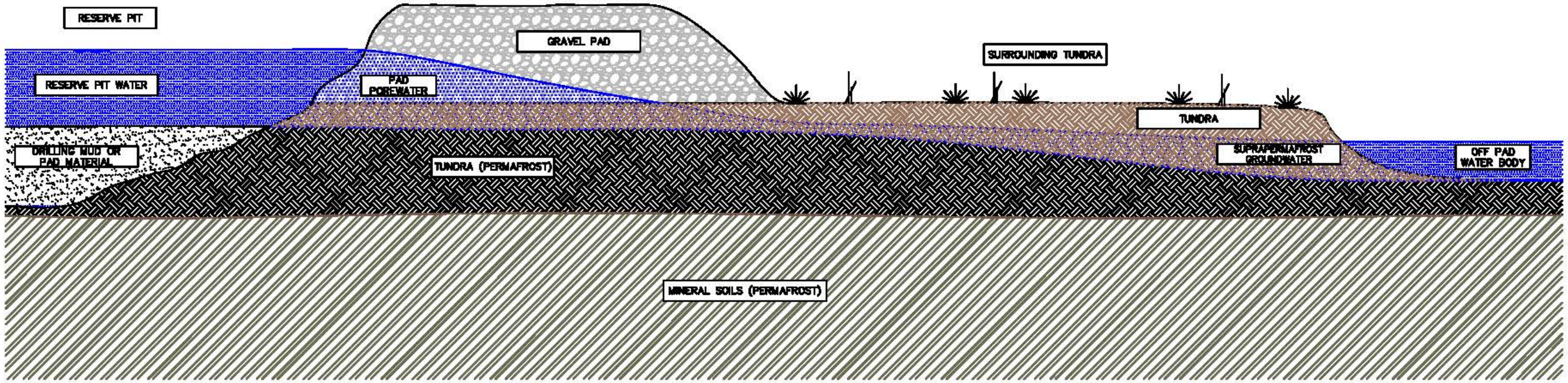
Footnotes:

[a] Pit overtopping is considered an incomplete transport mechanism.

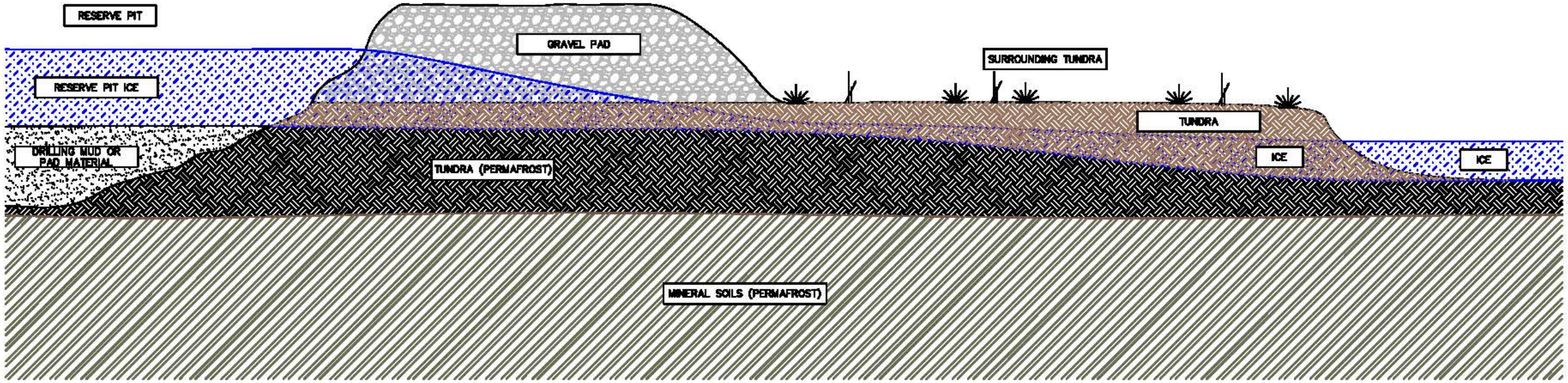
[b] Sediment is relevant only for some ponds and rivers, and not for other surface water features such as pad impoundments. Saturated soil may be present in a pad impoundment and/or some tundra surface water features.

[c] Aquatic biota ingestion is potentially complete only in undeveloped (off-pad) areas; fishing is relevant only for some ponds and rivers that can support fish populations.

THAW



FREEZE



LEGEND

▨	DRILLING MUD OR PAD MATERIAL
▨	GRAVEL PAD
▨	MINERAL SOILS (PERMAFROST)
▨	TUNDRA
▨	TUNDRA (PERMAFROST)
▨	WATER
▨	ICE

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

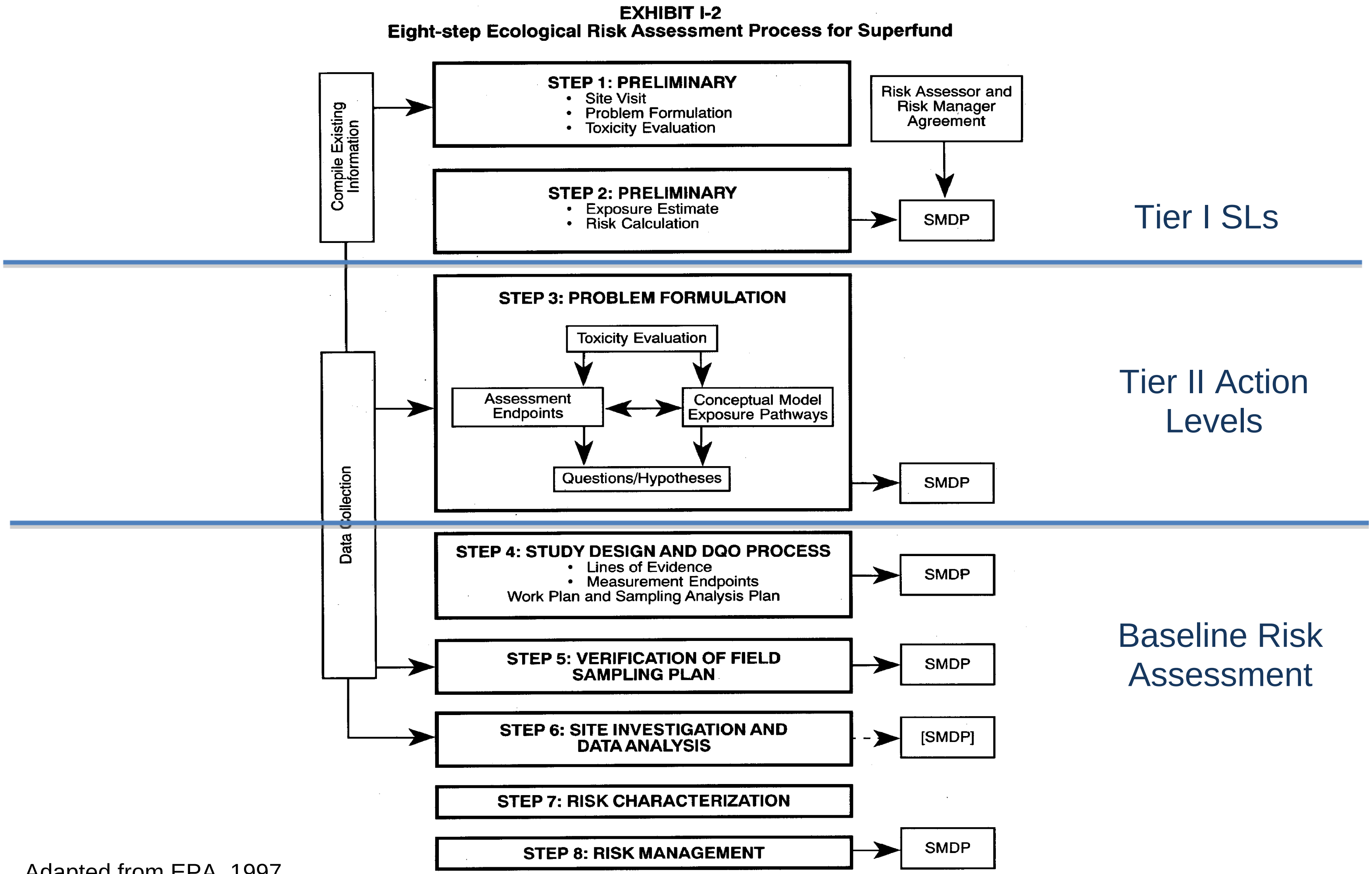
BP Exploration (Alaska) Inc.
P.O. Box 196612
900 East Benson Boulevard
Anchorage, Alaska 99519-6612

Report Site-Wide Project Work Plan -- Part III Revised Site-Wide Conceptual Site Model and Screening Levels

Drawing Cross-Section Schematic of Common Elements at the Site

Date August 18, 2010	Scale Not to Scale	Fig. No. 3
File Name CSM F3	Project No. 105.00008.10002	

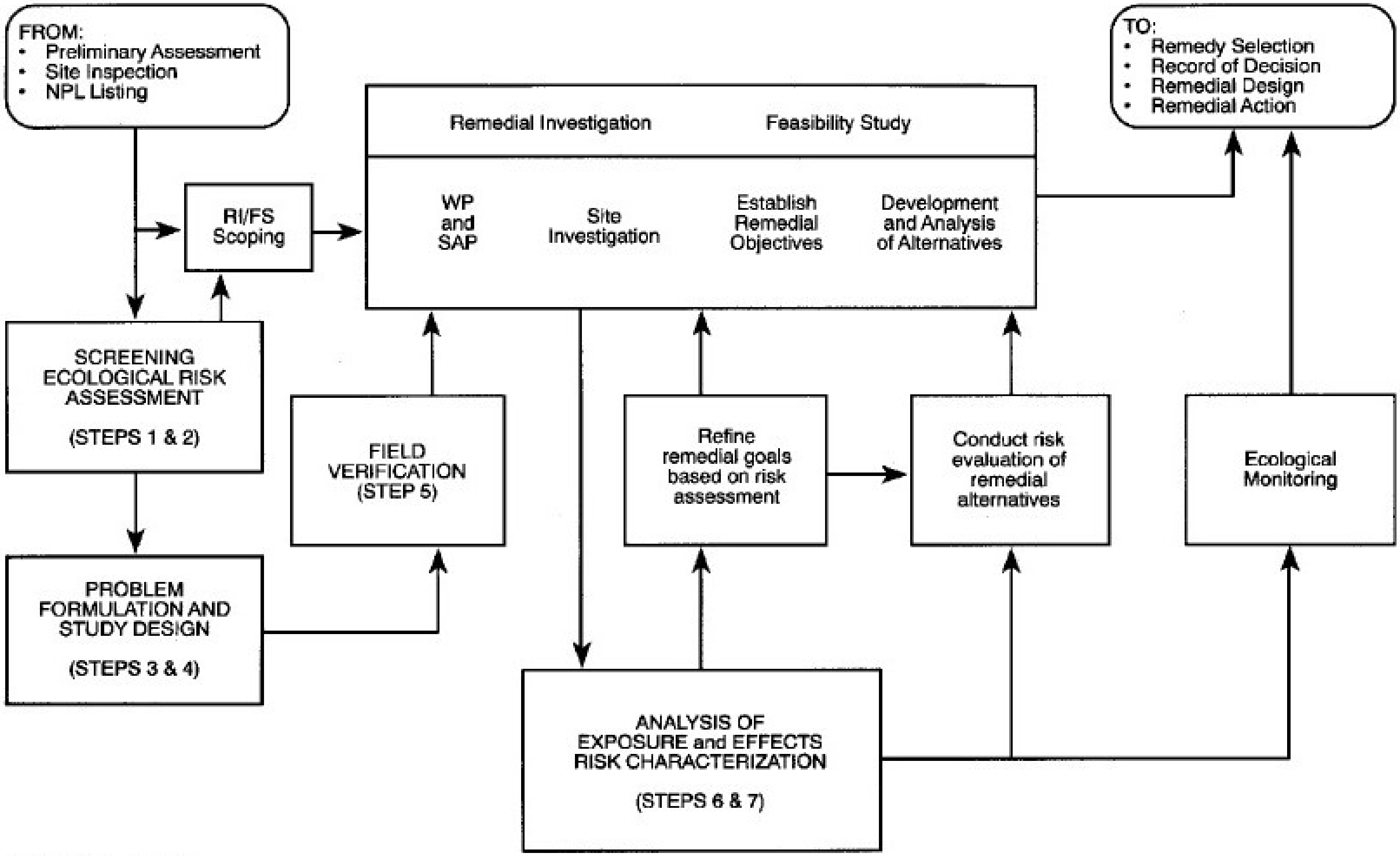
Figure 4 Ecological Risk Assessment Eight-Step Process Diagram



Adapted from EPA, 1997.

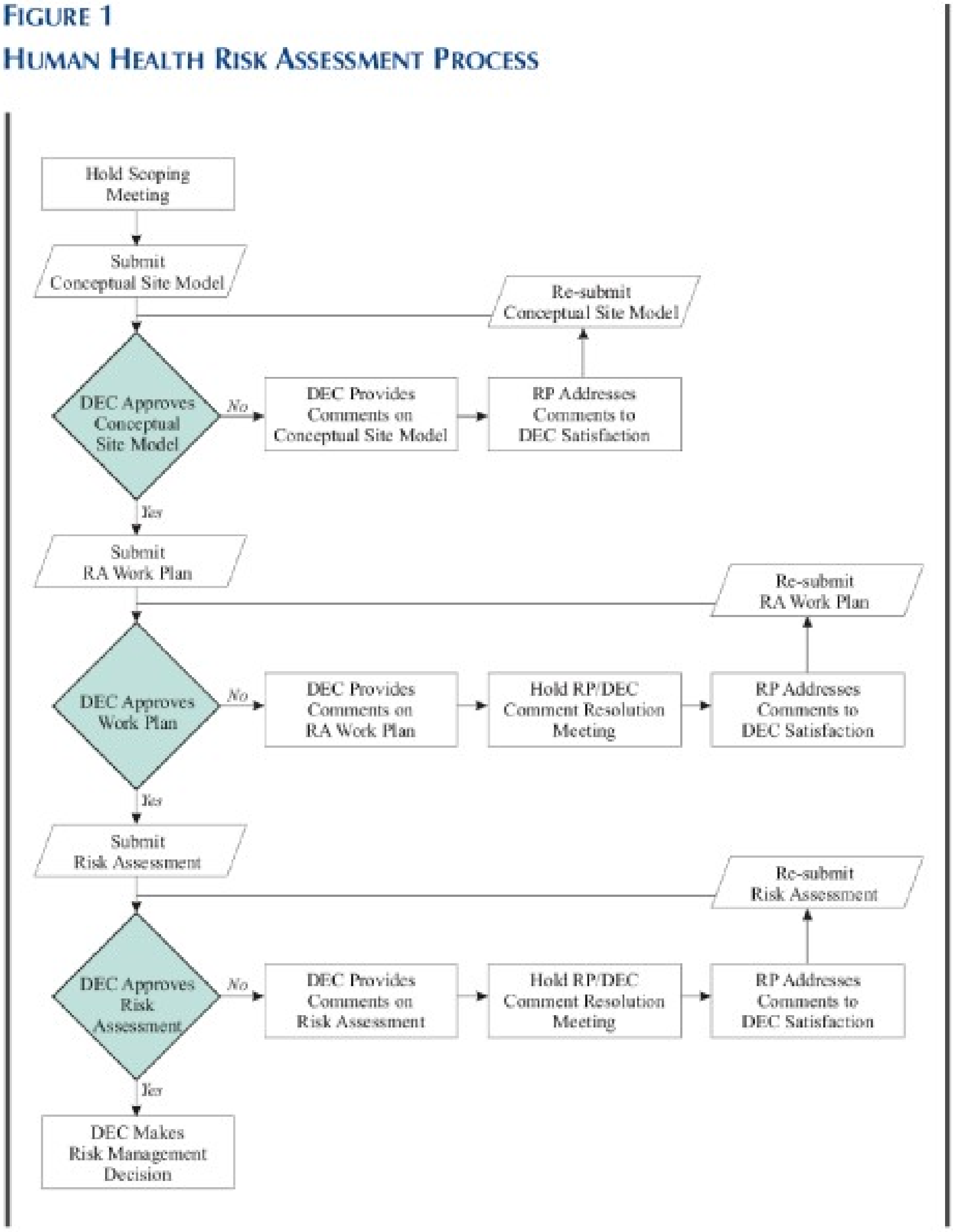
Figure 5 Risk Assessment in the RI/FS Process

EXHIBIT I-3
Ecological Risk Assessment in the RI/FS Process



Adapted from EPA, 1997.

Figure 6 Human Health Risk Assessment Process under ADEC



Adapted from ADEC, 2015.

TABLES

Table 1a
Tier I Ecological Soil Screening Level Development
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Tier I SL[a] (mg/kg)	Receptors, Sources, and Soil Values (mg/kg)											
			Plants			Invertebrates			Birds			Mammals		
CAS #	Chemical Name		Eco-SSL[b]	ORNL[c]	EPA Region 4[d]	Eco-SSL[b]	ORNL[c]	EPA Region 4[d]	Eco-SSL[b]	EPA Region 4[d]	ODEQ[e]	Eco-SSL[b]	EPA Region 4[d]	ODEQ[e]
Volatiles														
67-64-1	Acetone	4.0E-02	NA	NA	NA	NA	NA	**4.0E-02**	NA	1.4E+01	NA	NA	1.2E+00	1.3E+03
107-02-8	Acrolein	1.0E-04	NA	NA	NA	NA	NA	**1.0E-04**	NA	NA	NA	NA	NA	NA
71-43-2	Benzene	1.2E-01	NA	NA	NA	NA	NA	**1.2E-01**	NA	NA	NA	NA	2.4E+01	3.3E+03
78-93-3	2-Butanone	1.0E+00	NA	NA	NA	NA	NA	**1.0E+00**	NA	NA	NA	NA	3.6E+02	2.0E+05
56-23-5	Carbon tetrachloride	5.0E-02	NA	NA	NA	NA	NA	**5.0E-02**	NA	NA	NA	NA	NA	2.0E+03
108-90-7	Chlorobenzene	2.4E+00	NA	NA	NA	NA	4.0E+01	**2.4E+00**	NA	NA	NA	NA	4.3E+01	NA
75-00-3	Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
67-66-3	Chloroform	5.0E-02	NA	NA	NA	NA	NA	**5.0E-02**	NA	NA	NA	NA	8.0E+00	1.9E+03
106-93-4	1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
95-50-1	1,2-Dichlorobenzene	9.0E-02	NA	NA	NA	NA	NA	**9.0E-02**	NA	NA	NA	NA	9.2E-01	NA
75-34-3	1,1-Dichloroethane	1.4E-01	NA	NA	NA	NA	NA	**1.4E-01**	NA	NA	NA	NA	2.1E+02	NA
107-06-2	1,2-Dichloroethane	4.0E-01	NA	NA	NA	NA	NA	**4.0E-01**	NA	1.4E+00	7.0E+01	NA	2.7E+01	2.8E+03
75-35-4	1,1-Dichloroethene	4.0E-02	NA	NA	NA	NA	NA	**4.0E-02**	NA	NA	NA	NA	1.1E+01	3.8E+03
156-59-2	cis-1,2-Dichloroethene	4.0E-02	NA	NA	NA	NA	NA	**4.0E-02**	NA	NA	NA	NA	NA	2.5E+03
156-60-5	trans-1,2-Dichloroethene	4.0E-02	NA	NA	NA	NA	NA	**4.0E-02**	NA	NA	NA	NA	NA	2.5E+03
60-29-7	Diethyl ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
123-91-1	1,4-Dioxane	6.3E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**6.3E+01**
100-41-4	Ethylbenzene	2.7E-01	NA	NA	NA	NA	NA	**2.7E-01**	NA	NA	NA	NA	NA	NA
50-00-0	Formaldehyde	3.9E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**3.9E+03**
67-56-1	Methanol	6.3E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**6.3E+03**
75-09-2	Methylene chloride	2.1E-01	NA	NA	1.6E+03	NA	NA	**2.1E-01**	NA	NA	NA	NA	2.6E+00	7.3E+02
108-10-1	4-Methyl-2-pentanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
103-65-1	n-Propylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
127-18-4	Tetrachloroethene	6.0E-02	NA	NA	1.0E+01	NA	NA	**6.0E-02**	NA	NA	NA	NA	1.8E-01	8.0E+01
108-88-3	Toluene	1.5E-01	NA	2.0E+02	2.0E+02	NA	NA	**1.5E-01**	NA	NA	NA	NA	2.3E+01	1.4E+03
71-55-6	1,1,1-Trichloroethane	4.0E-02	NA	NA	NA	NA	NA	**4.0E-02**	NA	NA	NA	NA	2.6E+02	5.6E+04
79-01-6	Trichloroethene	6.0E-02	NA	NA	NA	NA	NA	**6.0E-02**	NA	NA	NA	NA	4.2E+01	4.0E+01
95-63-6	1,2,4-Trimethylbenzene	9.0E-02	NA	NA	NA	NA	NA	**9.0E-02**	NA	NA	NA	NA	NA	NA
108-67-8	1,3,5-Trimethylbenzene	1.6E-01	NA	NA	NA	NA	NA	**1.6E-01**	NA	NA	NA	NA	NA	NA
75-01-4	Vinyl chloride	3.0E-02	NA	NA	NA	NA	NA	**3.0E-02**	NA	NA	NA	NA	1.2E-01	2.0E+01
1330-20-7	Xylenes	1.0E-01	NA	NA	1.0E+02	NA	NA	**1.0E-01**	NA	4.1E+01	NA	NA	1.4E+00	1.2E+02
Semi-Volatiles														
83-32-9	Acenaphthene	2.5E-01	NA	2.0E+01	**2.5E-01**	NA	NA	NA	NA	NA	NA	NA	1.2E+02	NA
208-96-8	Acenaphthylene	1.2E+02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**1.2E+02**	NA
120-12-7	Anthracene	6.8E+00	NA	NA	**6.8E+00**	NA	NA	NA	NA	NA	NA	NA	2.1E+02	NA
56-55-3	Benzo(a)anthracene	1.0E+00	NA	NA	1.8E+01	NA	NA	NA	NA	**1.0E+00**	NA	NA	3.0E+00	NA
50-32-8	Benzo(a)pyrene	5.3E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**5.3E+01**	1.3E+02
205-99-2	Benzo(b)fluoranthene	1.8E+01	NA	NA	**1.8E+01**	NA	NA	NA	NA	NA	NA	NA	3.8E+01	NA
191-24-2	Benzo(g,h,i)perylene	2.4E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**2.4E+01**	NA
207-08-9	Benzo(k)fluoranthene	6.2E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**6.2E+01**	NA
218-01-9	Chrysene	2.4E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**2.4E+00**	NA
53-70-3	Dibenz(a,h)anthracene	1.2E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**1.2E+01**	NA
105-67-9	2,4-Dimethylphenol	4.0E-02	NA	NA	NA	NA	NA	**4.0E-02**	NA	NA	NA	NA	NA	NA
84-74-2	Di-n-butylphthalate	1.1E-02	NA	2.0E+02	1.6E+02	NA	NA	2.2E-01	NA	**1.1E-02**	4.5E-01	NA	1.8E+02	3.0E+04
206-44-0	Fluoranthene	1.0E+01	NA	NA	NA	NA	NA	**1.0E+01**	NA	NA	NA	NA	2.2E+01	NA
86-73-7	Fluorene	3.7E+00	NA	NA	NA	NA	3.0E+01	**3.7E+00**	NA	NA	NA	NA	2.5E+02	NA
193-39-5	Indeno(1,2,3-cd)pyrene	6.2E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**6.2E+01**	NA
90-12-0	1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
91-57-6	2-Methylnaphthalene	1.6E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**1.6E+01**	NA
95-48-7	2-Methylphenol	1.0E-01	NA	NA	6.7E-01	NA	NA	**1.0E-01**	NA	NA	NA	NA	5.9E+02	1.6E+04
108-39-4	3-Methylphenol	9.0E-02	NA	NA	6.9E-01	NA	NA	**9.0E-02**	NA	NA	NA	NA	NA	NA
106-44-5	4-Methylphenol	8.0E-02	NA	NA	NA	NA	NA	**8.0E-02**	NA	NA	NA	NA	NA	NA
34mp	3&4-Methylphenol[f]	8.0E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
91-20-3	Naphthalene	1.0E+00	NA	NA	**1.0E+00**	NA	NA	NA	NA	5.7E+00	NA	NA	9.7E+00	3.9E+03
85-01-8	Phenanthrene	5.5E+00	NA	NA	NA	NA	NA	**5.5E+00**	NA	NA	NA	NA	1.0E+01	NA
108-95-2	Phenol	7.9E-01	NA	7.0E+01	**7.9E-01**	NA	3.0E+01	1.8E+00	NA	NA	NA	NA	3.8E+01	NA
129-00-0	Pyrene	1.0E+01	NA	NA	NA	NA	NA	**1.0E+01**	NA	3.4E+01	NA	NA	2.2E+01	NA
Metals														
7429-90-5	Aluminum[g]	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	2.7E-01	NA	5.0E+00	1.1E+01	7.8E+01	NA	7.8E+01	NA	NA	NA	**2.7E-01**	**2.7E-01**	1.5E+01
7440-38-2	Arsenic[h]	1.0E+01	1.8E+01	**1.0E+01**	1.8E+01	NA	6.0E+01	6.0E+01	4.3E+01	4.3E+01	**1.0E+01**	4.6E+01	4.6E+01	2.9E+01
7440-39-3	Barium	8.5E+01	NA	5.0E+02	1.1E+02	3.3E+02	NA	3.3E+02	NA	1.0E+03	**8.5E+01**	2.0E+03	2.0E+03	6.4E+02
7440-43-9	Cadmium	3.6E-01	3.2E+01	4.0E+00	3.2E+01	1.4E+02	2.0E+01	1.4E+02	7.7E-01	7.7E-01	6.0E+00	**3.6E-01**	**3.6E-01**	1.3E+02
7440-47-3	Chromium	4.0E-01	NA	1.0E+00	NA	NA	**4.0E-01**	NA	NA	2.8E+01	NA	NA	4.5E+01	NA
16065-83-1	Chromium (III)	4.0E+00	NA	NA	NA	NA	NA	1.8E+01	2.6E+01	2.6E+01	**4.0E+00**	3.4E+01	3.4E+01	3.4E+05
18540-29-9	Chromium (VI)	3.5E-01	NA	1.0E+00	**3.5E-01**	NA	4.0E-01	7.8E+00	NA	1.9E+02	NA	1.3E+02	8.1E+01	4.1E+02
7440-50-8	Copper	2.8E+01	7.0E+01	1.0E+02	7.0E+01	8.0E+01	5.0E+01	8.0E+01	**2.8E+01**	**2.8E+01**	1.9E+02	4.9E+01	4.9E+01	3.9E+02
7439-92-1	Lead	1.1E+01	1.2E+02	5.0E+01	1.2E+02	1.7E+03	5.0E+02	1.7E+03	**1.1E+01**	**1.1E+01**	1.6E+01	5.6E+01	5.6E+01	4.0E+03
7439-96-5	Manganese[g]	--	--	--	--	--	--	--	--	--	--	--	--	--
7439-97-6	Mercury[i]	1.3E-02	NA	3.0E-01	3.0E-01	NA	1.0E-01	1.0E-01	NA	**1.3E-02**	1.5E+00	NA	1.7E+00	7.3E+01
7440-02-0	Nickel	3.0E+01	3.8E+01	**3.0E+01**	3.8E+01	2.8E+02	2.0E+02	2.8E+02	2.1E+02	2.1E+02	3.2E+02	1.3E+02	1.3E+02	6.3E+02
7782-49-2	Selenium	5.2E-01	**5.2E-01**	1.0E+00	**5.2E-01**	4.1E+00	7.0E+01	4.1E+00	1.2E+00	1.2E+00	2.0E+00	6.3E-01	6.3E-01	2.5E+01
7440-22-4	Silver	2.0E+00	5.6E+02	**2.0E+00**	5.6E+02	NA	NA	NA	4.2E+00	4.2E+00	NA	1.4E+01	1.4E+01	NA
7440-62-2	Vanadium	2.0E+00	NA	**2.0E+00**	6.0E+01	NA	NA	NA	7.8E+00	7.8E+00	4.7E+01	2.8E+02	2.8E+02	2.5E+01
7440-66-6	Zinc	4.6E+01	1.6E+02	5.0E+01	1.6E+02	1.2E+02	1.0E+02	NA	**4.6E+01**	**4.6E+01**	6.0E+01	7.9E+01	7.9E+01	2.0E+04
Petroleum Hydrocarbons														
57-12-5	Cyanide	1.0E-01	NA	NA	NA	NA	NA	9.0E-01	NA	**1.0E-01**	NA	NA	NA	NA

Bold values represent Tier I screening values.

Abbreviations:
CAS #: Chemical Abstract Service registry number
mg/kg: milligrams per kilogram
Eco-SSL: ecological soil screening level
ORNL: Oak Ridge National Laboratory
EPA: United States Environmental Protection Agency
ODEQ: Oregon Department of Environmental Quality
NA: not available
--: not applicable

Footnotes:

[a] Lowest of available values from sources shown.

[b] Ecological soil screening levels from EPA (2005).

[c] Ecological toxicity benchmarks from Efroymson et al. (1997a; plants or 1997b; invertebrates).

[d] EPA Region 4 Soil Screening Values for Hazardous Waste Sites from EPA (2015d).

[e] Level II screening level values from ODEQ (1998).

[f] Screening levels for the more toxic of the coeluting compounds used to represent this mixture.

[g] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil. For water, only Alaska Water Quality Criteria

[h] Arsenic values from ODEQ (1998) are for arsenic III.

[i] Where value sources differentiated between mercuric chloride/other inorganic salts and elemental mercury, values for mercuric chloride/other inorganic salts were used preferentially. Values for mercuric chloride/other inorganic salts were not available from ODEQ (1998), so soil values from this source are for elemental mercury.

References:

Efroymson, RA, ME Will, GW Suter II, and AC Wooten. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. November. ES/ER/TM-85/R3.

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Oregon Department of Environmental Quality (ODEQ). 1998. Guidance for Ecological Risk Assessment: Levels I, II, III, IV. Final. Waste Management and Cleanup Division, Portland. April. Level II values last updated December 2001.

U.S. Environmental Protection Agency (EPA). 2015d. Region 4 Ecological Risk Assessment Supplemental Guidance. Interim Draft. August.

EPA. 2005. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response.

Table 1b
Tier I Ecological Water Screening Level Development
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Tier I SL [a] (µg/L)	Receptors, Value Types, and Water Values (µg/L)													
			General Aquatic Biota Values					Taxon-Specific Lowest Chronic Values (LCVs) [g]				Taxon-Specific EC20 Values [g]			Wildlife Values [h]	
CAS #	Chemical Name		AWQC [b]	AK WQC [c]	Tier II SCV [d]	EPA Region 4 [e]	EPA Region 3 BTAG [f]	Aquatic Plants	Daphnids	Non-Daphnid Invertebrates	Fish	Daphnids	Fish	Sensitive Species	Birds	Mammals
Volatiles																
67-64-1	Acetone	1.5E+03	NA	NA	**1.5E+03**	1.7E+03	**1.5E+03**	NA	1.6E+03	NA	5.1E+05	NA	1.6E+05	NA	NA	7.6E+04
107-02-8	Acrolein	3.0E+00	**3.0E+00**	NA	NA	**3.0E+00**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
71-43-2	Benzene	2.1E+01	NA	NA	1.3E+02	1.6E+02	3.7E+02	5.3E+05	9.8E+04	NA	NA	NA	**2.1E+01**	NA	NA	2.0E+05
78-93-3	2-Butanone	1.4E+04	NA	NA	**1.4E+04**	2.2E+04	**1.4E+04**	NA	1.4E+06	NA	2.8E+05	NA	9.9E+04	NA	NA	NA
56-23-5	Carbon tetrachloride	9.8E+00	NA	NA	**9.8E+00**	7.7E+01	1.3E+01	NA	5.6E+03	NA	2.0E+03	NA	6.5E+01	NA	NA	1.2E+05
108-90-7	Chlorobenzene	1.3E+00	NA	NA	6.4E+01	2.5E+01	**1.3E+00**	2.2E+05	1.5E+04	NA	1.2E+03	NA	1.0E+03	NA	NA	NA
75-00-3	Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
67-66-3	Chloroform	1.8E+00	NA	NA	2.8E+01	1.4E+02	**1.8E+00**	NA	4.5E+03	NA	1.2E+03	NA	8.4E+03	NA	NA	1.2E+05
106-93-4	1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
95-50-1	1,2-Dichlorobenzene	7.0E-01	NA	NA	1.4E+01	2.3E+01	**7.0E-01**	NA	NA	NA	NA	NA	NA	NA	NA	NA
75-34-3	1,1-Dichloroethane	4.7E+01	NA	NA	**4.7E+01**	4.1E+02	**4.7E+01**	NA	NA	NA	1.5E+04	NA	8.2E+03	NA	NA	NA
107-06-2	1,2-Dichloroethane	1.0E+02	NA	NA	9.1E+02	2.0E+03	**1.0E+02**	NA	1.5E+04	NA	4.1E+04	1.1E+04	2.9E+04	NA	1.3E+05	2.0E+05
75-35-4	1,1-Dichloroethene	2.5E+01	NA	NA	**2.5E+01**	1.3E+02	**2.5E+01**	8.0E+05	4.7E+03	NA	2.8E+03	NA	NA	NA	NA	2.3E+05
156-59-2	cis-1,2-Dichloroethene	6.2E+02	NA	NA	NA	**6.2E+02**	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.8E+05
156-60-5	trans-1,2-Dichloroethene	5.6E+02	NA	NA	NA	**5.6E+02**	9.7E+02	NA	NA	NA	NA	NA	NA	NA	NA	1.8E+05
60-29-7	Diethyl ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
123-91-1	1,4-Dioxane	4.0E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**4.0E+03**
100-41-4	Ethylbenzene	7.3E+00	NA	NA	**7.3E+00**	6.1E+01	9.0E+01	4.4E+05	1.3E+04	NA	4.4E+02	NA	NA	NA	NA	NA
50-00-0	Formaldehyde	7.4E+01	NA	NA	NA	**7.4E+01**	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.8E+05
67-56-1	Methanol	3.3E+02	NA	NA	NA	**3.3E+02**	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.8E+05
75-09-2	Methylene chloride	9.8E+01	NA	NA	2.2E+03	1.5E+03	**9.8E+01**	NA	4.3E+04	NA	1.1E+05	NA	4.1E+02	NA	NA	4.5E+04
108-10-1	4-Methyl-2-pentanone	1.7E+02	NA	NA	**1.7E+02**	**1.7E+02**	**1.7E+02**	NA	NA	NA	7.7E+04	NA	NA	NA	NA	NA
103-65-1	n-Propylbenzene	1.3E+02	NA	NA	NA	NA	**1.3E+02**	NA	NA	NA	NA	NA	NA	NA	NA	NA
127-18-4	Tetrachloroethene	5.3E+01	NA	NA	9.8E+01	**5.3E+01**	1.1E+02	8.2E+05	7.5E+02	NA	8.4E+02	5.1E+02	5.0E+02	NA	NA	6.0E+03
108-88-3	Toluene	2.0E+00	NA	NA	9.8E+00	6.2E+01	**2.0E+00**	2.5E+05	2.5E+04	NA	1.3E+03	NA	2.6E+01	NA	NA	1.0E+05
71-55-6	1,1,1-Trichloroethane	1.1E+01	NA	NA	**1.1E+01**	7.6E+01	**1.1E+01**	6.7E+05	NA	NA	3.5E+03	1.3E+03	2.5E+03	NA	NA	4.0E+06
79-01-6	Trichloroethene	2.1E+01	NA	NA	4.7E+01	2.0E+02	**2.1E+01**	NA	7.3E+03	NA	1.1E+04	NA	5.8E+03	NA	NA	3.0E+03
95-63-6	1,2,4-Trimethylbenzene	1.5E+01	NA	NA	NA	**1.5E+01**	3.3E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA
108-67-8	1,3,5-Trimethylbenzene	2.6E+01	NA	NA	NA	**2.6E+01**	7.1E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA
75-01-4	Vinyl chloride	9.3E+02	NA	NA	NA	**9.3E+02**	**9.3E+02**	NA	NA	NA	NA	NA	NA	NA	NA	1.3E+03
1330-20-7	Xylenes	1.3E+01	NA	NA	**1.3E+01**	2.7E+01	**1.3E+01**	NA	NA	NA	6.2E+04	NA	2.7E+03	NA	NA	8.0E+03
Semi-Volatiles																
83-32-9	Acenaphthene	5.8E+00	NA	NA	NA	1.5E+01	**5.8E+00**	5.2E+02	6.7E+03	2.3E+02	7.4E+01	NA	2.0E+02	NA	NA	NA
208-96-8	Acenaphthylene	1.3E+01	NA	NA	NA	**1.3E+01**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
120-12-7	Anthracene	1.2E-02	NA	NA	7.3E-01	2.0E-02	**1.2E-02**	NA	2.1E+00	NA	9.0E-02	8.2E+00	3.5E-01	NA	NA	NA
56-55-3	Benzo(a)anthracene	1.8E-02	NA	NA	2.7E-02	4.7E+00	**1.8E-02**	NA	6.5E-01	NA	NA	NA	NA	NA	NA	NA
50-32-8	Benzo(a)pyrene	1.4E-02	NA	NA	**1.4E-02**	6.0E-02	1.5E-02	NA	3.0E-01	NA	NA	NA	3.0E+00	NA	NA	8.0E+03
205-99-2	Benzo(b)fluoranthene	2.6E+00	NA	NA	NA	**2.6E+00**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
191-24-2	Benzo(g,h,i)perylene	4.4E-01	NA	NA	NA	**4.4E-01**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	6.4E-01	NA	NA	NA	**6.4E-01**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
218-01-9	Chrysene	4.7E+00	NA	NA	NA	**4.7E+00**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
53-70-3	Dibenz(a,h)anthracene	2.8E-01	NA	NA	NA	**2.8E-01**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
105-67-9	2,4-Dimethylphenol	1.5E+01	NA	NA	NA	**1.5E+01**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
84-74-2	Di-n-butylphthalate	1.9E+01	NA	NA	3.5E+01	**1.9E+01**	**1.9E+01**	NA	7.0E+02	NA	7.2E+02	5.0E+02	2.7E+02	NA	8.0E+02	2.2E+06
206-44-0	Fluoranthene	4.0E-02	NA	NA	NA	8.0E-01	**4.0E-02**	5.4E+04	1.5E+01	NA	3.0E+01	NA	NA	NA	NA	NA
86-73-7	Fluorene	3.0E+00	NA	NA	3.9E+00	1.9E+01	**3.0E+00**	NA	NA	NA	NA	NA	NA	NA	NA	NA
193-39-5	Indeno(1,2,3-cd)pyrene	2.8E-01	NA	NA	NA	**2.8E-01**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
90-12-0	1-Methylnaphthalene	2.1E+00	NA	NA	**2.1E+00**	**2.1E+00**	**2.1E+00**	NA	NA	NA	5.3E+02	NA	5.0E+02	NA	NA	NA
91-57-6	2-Methylnaphthalene	4.7E+00	NA	NA	NA	**4.7E+00**	**4.7E+00**	NA	NA	NA	NA	NA	NA	NA	NA	NA
95-48-7	2-Methylphenol	1.3E+01	NA	NA	**1.3E+01**	6.7E+01	**1.3E+01**	NA	1.3E+03	NA	4.9E+02	NA	4.7E+02	NA	NA	2.2E+06
108-39-4	3-Methylphenol	6.2E+01	NA	NA	NA	**6.2E+01**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
106-44-5	4-Methylphenol	5.3E+01	NA	NA	NA	**5.3E+01**	5.4E+02	NA	NA	NA	NA	NA	NA	NA	NA	NA
34mp	3&4-Methylphenol [i]	5.3E+01	NA	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--
91-20-3	Naphthalene	1.1E+00	NA	NA	1.2E+01	2.1E+01	**1.1E+00**	3.3E+04	1.2E+03	NA	6.2E+02	6.0E+02	4.5E+02	NA	NA	2.8E+05
85-01-8	Phenanthrene	4.0E-01	NA	NA	NA	2.3E+00	**4.0E-01**	NA	2.0E+02	NA	NA	1.1E+02	NA	NA	NA	NA
108-95-2	Phenol	4.0E+00	NA	NA	NA	1.6E+02	**4.0E+00**	2.0E+04	2.0E+03	NA	2.0E+02	NA	2.3E+02	NA	NA	NA
129-00-0	Pyrene	2.5E-02	NA	NA	NA	4.6E+00	**2.5E-02**	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals																
7429-90-5	Aluminum [j]	7.5E+01	8.7E+01	8.7E+01	NA	8.7E+01	8.7E+01	4.6E+02	1.9E+03	NA	3.3E+03	5.4E+02	4.7E+03	**7.5E+01**	--	--
7440-36-0	Antimony	3.0E+01	NA	NA	**3.0E+01**	1.9E+02	**3.0E+01**	6.1E+02	5.4E+03	NA	1.6E+03	1.9E+03	2.3E+03	NA	NA	1.0E+03
7440-38-2	Arsenic [k]	5.0E+00	1.5E+02	1.5E+02	NA	1.5E+02	**5.0E+00**	2.3E+03	9.1E+02	NA	3.0E+03	6.3E+02	2.1E+03	5.5E+01	1.8E+04	6.0E+03
7440-39-3	Barium	4.0E+00	NA	NA	**4.0E+00**	2.2E+02	**4.0E+00**	NA	NA	NA	NA	NA	NA	NA	1.5E+05	3.9E+04
7440-43-9	Cadmium	1.3E-02	2.5E-01	2.8E-01	NA	2.5E-01	2.5E-01	2.0E+00	1.5E-01	NA	1.7E+00	7.5E-01	1.8E+00	**1.3E-02**	1.0E+04	8.0E+03
7440-47-3	Chromium	8.5E+01	NA	NA	NA	NA	**8.5E+01**	NA	NA	NA	NA	NA	NA	NA	NA	NA
16065-83-1	Chromium (III)	9.0E+01	7.4E+01	**9.0E+01**	NA	7.4E+01	7.4E+01	4.0E+02	4.4E+01	NA	6.9E+01	NA	8.9E+01	8.4E+00	7.2E+03	2.1E+07
18540-29-9	Chromium (VI)	1.1E+01	1.1E+01	**1.1E+01**	NA	1.1E+01	1.1E+01	2.0E+00	6.1E+00	NA	7.3E+01	5.0E-01	5.1E+01	2.7E-01	NA	2.5E+04
7440-50-8	Copper	2.1E-01	1.5E+00	9.7E+00	NA	9.0E+00	9.0E+00	1.0E+00	2.3E-01	6.1E+00	3.8E+00	**2.1E-01**	5.0E+00	2.6E-01	3.4E+05	5.3E+04
7439-92-1	Lead	3.5E-01	2.5E+00	3.4E+00	NA	2.5E+00	2.5E+00	5.0E+02	1.2E+01	2.6E+01	1.9E+01	NA	2.2E+01	**3.5E-01**	2.8E+04	3.2E+05
7439-96-5	Manganese [j]	9.3E+01	NA	NA	1.2E+02	**9.3E+01**	1.2E+02	NA	1.1E+03	NA	1.8E+03	1.1E+03	1.3E+03	NA	--	--
7439-97-6	Mercury [l]	2.6E-02	7.7E-01	9.1E-01	1.3E+00	7.7E-01	**2.6E-02**	5.0E+00	9.6E-01	NA	2.3E-01	8.7E-01	8.7E-01	1.8E-01	3.3E+03	1.0E+04
7440-02-0	Nickel	5.0E+00	5.2E+01	5.4E+01	NA	5.2E+01	5.2E+01	**5.0E+00**	**5.0E+00**	1.3E+02	3.5E+01	4.5E+01	6.2E+01	1.1E+01	5.6E+05	3.8E+04
7782-49-2	Selenium	1.0E+00	5.0E+00	5.0E+00	NA	5.0E+00	**1.0E+00**	1.0E+02	9.2E+01	NA	8.8E+01	2.5E+01	4.0E+01	2.6E+00	3.6E+03	1.5E+03
7440-22-4	Silver	6.0E-02	NA	NA	3.6E-01	**6.0E-02**	3.2E+00	3.0E+01	2.6E+00	NA	1.2E-01	5.6E-01	2.0E-01	1.4E-01	NA	NA
7440-62-2	Vanadium	2.0E+01	NA	NA	**2.0E+01**	2.7E+01	**2.0E+01**	NA	1.9E+03	NA	8.0E+01	4.3E+02	4.1E+01	NA	8.2E+04	1.6E+03
7440-66-6	Zinc	2.1E+01	1.2E+02	1.2E+02	NA	1.2E+02	1.2E+02	3.0E+01	4.7E+01	5.2E+03	3.6E+01	NA	4.7E+01	**2.1E+01**	1.1E+05	1.2E+06
Inorganics																
57-12-5	Cyanide	1.2E+00	5.2E+00	5.2E+00	NA	5.2E+00	5.0E+00	3.0E+01	NA	1.8E+01	7.8E+00	NA	5.3E+00	**1.2E+00**	NA	NA

Bold values represent Tier I screening values.

Abbreviations:
CAS #: Chemical Abstract Service registry number
µg/L: micrograms per liter
AWQC: National ambient water quality criteria
AK WQC: Alaska water quality criteria
SCV: secondary chronic value
EPA: United States Environmental Protection Agency
BTAG: Biological Technical Assistance Group
EC20: effect concentration 20 percent
NA: not available
--: not applicable

Footnotes:

[a] Lowest of available values from sources shown for chemicals regulated by EPA. For chemicals regulated by ADEC but not by EPA (n-propylbenzene, 1,2,4- and 1,3,5-trimethylbenzene, 1-methylnaphthalene, chromium [III], and chromium [VI]), the Alaska water quality criterion (AK WQC) was selected as the Tier I screening level. If no AK WQC value was available, the lowest available water value from the sources shown was selected.

[b] Ambient water quality criteria, chronic freshwater criteria, as reported by EPA (2015a).

[c] Alaska water quality criteria, aquatic life for freshwater, chronic values from ADEC (2008c). Hardness-dependant (cadmium, chromium III, copper, lead, nickel, and zinc) values were calculated using the median alkalinity (as CaCO3) value for PBU background lakes of 105 milligrams per liter (OASIS, 2005), and are for total metals. Values for chromium VI and mercury were converted to the total recoverable metal values using the total-dissolved conversion factors from ADEC (2008c).

[d] Tier II SCV values from Suter and Tsao (1996).

[e] EPA Region 4 Surface Water Screening Values for Hazardous Waste Sites from EPA (2015d).

[f] EPA Region III BTAG Freshwater Screening Benchmarks from EPA (2006).

[g] LCVs and EC20 values from Suter and Tsao (1996).

[h] Level II screening level values from ODEQ (1998); surface water ingestion values for birds and mammals.

[i] Screening levels for the more toxic of the coeluting compounds used to represent this mixture.

[j] Aluminum and manganese are only regulated as water quality constituents by ADEC and therefore, only Alaska Water Quality Criteria are relevant for these two target analytes.

[k] LCVs, EC20s, and wildlife values are for arsenic III.

[l] Water values for elemental mercury were used where available.

References:

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Suter, GW II and CL Tsao. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. June. ES/ER/TM-96/R2.
U.S. Environmental Protection Agency (EPA). 2015a. Current National Recommended Water Quality Criteria. June. http://www2.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table
EPA. 2015d. Region 4 Ecological Risk Assessment Supplemental Guidance. Interim Draft. August.
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Table 2
Tier I Human Health Screening Level Development for Soil
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Soil										
			Residential Values						Other Values			
CAS #	Chemical Name	Lowest Soil Value [a] (mg/kg)	Residential Value (mg/kg)	June 2015 RSL [b] (mg/kg)		Adjusted Multi-Pathway ADEC CLs [c] (mg/kg)	Multi-Pathway ADEC CLs [c] (mg/kg)		Industrial Soil RSL [d] (mg/kg)		Future Resident Subsistence User Value [e] (mg/kg)	Csat Values [f] (mg/kg)
Volatiles												
67-64-1	Acetone	5.6E+03	5.6E+03	6.1E+03	n	**5.6E+03**	5.6E+04	n	6.7E+04	n	1.1E+04	1.1E+05
107-02-8	Acrolein	1.4E-02	1.4E-02	**1.4E-02**	n	NA	NA		6.0E-02	n	3.9E-02	2.3E+04
71-43-2	Benzene	1.2E+00	1.2E+00	**1.2E+00**	c**	1.6E+00	1.6E+01	c	5.1E+00	c**	1.7E+00	1.8E+03
78-93-3	2-Butanone	2.7E+03	2.7E+03	**2.7E+03**	n	5.5E+03	5.5E+04	ni	1.9E+04	n	5.4E+03	2.8E+04
56-23-5	Carbon tetrachloride	4.3E-01	4.3E-01	6.5E-01	c*	**4.3E-01**	4.3E+00	c	2.9E+00	c*	1.4E+00	4.6E+02
108-90-7	Chlorobenzene	2.8E+01	2.8E+01	**2.8E+01**	n	4.0E+01	4.0E+02	ni	1.3E+02	n	3.8E+01	7.6E+02
75-00-3	Chloroethane	3.4E+00	3.4E+00	1.4E+03	n	**3.4E+00**	3.4E+01	c	5.7E+03	ns	3.0E+03	2.1E+03
67-66-3	Chloroform	3.2E-01	3.2E-01	**3.2E-01**	c*	4.7E-01	4.7E+00	c	1.4E+00	c*	6.2E-01	2.5E+03
106-93-4	1,2-Dibromoethane	3.6E-02	3.6E-02	**3.6E-02**	c	7.7E-02	7.7E-01	c	1.6E-01	c	6.5E-02	1.3E+03
95-50-1	1,2-Dichlorobenzene	1.8E+02	1.8E+02	**1.8E+02**	n	2.3E+02	2.3E+03	ni	9.3E+02	ns	2.4E+02	3.8E+02
75-34-3	1,1-Dichloroethane	3.6E+00	3.6E+00	**3.6E+00**	c	2.1E+02	2.1E+03	ci	1.6E+01	c	7.1E+00	1.7E+03
107-06-2	1,2-Dichloroethane	4.6E-01	4.6E-01	**4.6E-01**	c**	6.7E-01	6.7E+00	c	2.0E+00	c**	8.4E-01	3.0E+03
75-35-4	1,1-Dichloroethene	1.2E-01	1.2E-01	2.3E+01	n	**1.2E-01**	1.2E+00	c	1.0E+02	n	5.1E+01	1.2E+03
156-59-2	cis-1,2-Dichloroethene	1.6E+01	1.6E+01	**1.6E+01**	n	1.7E+01	1.7E+02	n	2.3E+02	n	2.7E+01	2.4E+03
156-60-5	trans-1,2-Dichloroethene	2.2E+01	2.2E+01	1.6E+02	n	**2.2E+01**	2.2E+02	n	2.3E+03	ns	2.7E+02	1.9E+03
60-29-7	Diethyl ether	1.6E+03	1.6E+03	**1.6E+03**	n	NA	NA		2.3E+04	ns	2.7E+03	1.0E+04
123-91-1	1,4-Dioxane	5.3E+00	5.3E+00	**5.3E+00**	c*	7.0E+01	7.0E+02	c	2.4E+01	c*	8.1E+00	1.2E+05
100-41-4	Ethylbenzene	5.8E+00	5.8E+00	**5.8E+00**	c*	4.9E+02	4.9E+03	ci	2.5E+01	c*	7.5E+00	4.8E+02
50-00-0	Formaldehyde	1.7E+01	1.7E+01	**1.7E+01**	c**	NA	NA		7.3E+01	c**	4.5E+01	4.2E+04
67-56-1	Methanol	1.2E+04	1.2E+04	**1.2E+04**	n	NA	NA		1.2E+05	nms	1.9E+04	1.1E+05
75-09-2	Methylene chloride	2.1E+01	2.1E+01	3.5E+01	n	**2.1E+01**	2.1E+02	c	3.2E+02	n	6.3E+01	3.3E+03
108-10-1	4-Methyl-2-pentanone	5.3E+02	5.3E+02	**5.3E+02**	n	9.5E+02	9.5E+03	ni	5.6E+03	ns	9.4E+02	3.4E+03
103-65-1	n-Propylbenzene [a]	3.3E+01	3.3E+01	3.8E+02	ns	**3.3E+01**	3.3E+02	ni	2.4E+03	ns	5.1E+02	2.6E+02
127-18-4	Tetrachloroethene	8.8E-01	8.8E-01	8.1E+00	n	**8.8E-01**	8.8E+00	c	3.9E+01	n	1.4E+01	1.7E+02
108-88-3	Toluene	4.9E+02	4.9E+02	**4.9E+02**	n	8.1E+02	8.1E+03	ni	4.7E+03	ns	7.8E+02	8.2E+02
71-55-6	1,1,1-Trichloroethane	5.7E+02	5.7E+02	8.1E+02	ns	**5.7E+02**	5.7E+03	ni	3.6E+03	ns	1.7E+03	6.4E+02
79-01-6	Trichloroethene	8.2E-02	8.2E-02	4.1E-01	n	**8.2E-02**	8.2E-01	c	1.9E+00	n	7.5E-01	6.9E+02
95-63-6	1,2,4-Trimethylbenzene [a]	7.3E+00	5.8E+00	5.8E+00	n	**7.3E+00**	7.3E+01	ni	2.4E+01	n	7.0E+00	2.2E+02
108-67-8	1,3,5-Trimethylbenzene [a]	6.3E+00	6.3E+00	7.8E+01	n	**6.3E+00**	6.3E+01	ni	1.2E+03	ns	5.0E+00	1.8E+02
75-01-4	Vinyl chloride	5.9E-02	5.9E-02	**5.9E-02**	c	3.5E-01	3.5E+00	c	1.7E+00	c*	7.0E-02	3.9E+03
1330-20-7	Xylenes	6.5E+01	6.5E+01	**6.5E+01**	n	7.8E+01	7.8E+02	ni	2.8E+02	ns	8.4E+01	2.6E+02
Semi-Volatiles												
83-32-9	Acenaphthene	3.6E+02	3.6E+02	**3.6E+02**	n	3.8E+02	3.8E+03	n	4.5E+03	n	5.5E+02	NA
208-96-8	Acenaphthylene	3.8E+02	3.8E+02	NA		**3.8E+02**	3.8E+03	n	NA		NA	NA
120-12-7	Anthracene	1.8E+03	1.8E+03	**1.8E+03**	n	2.8E+03	2.8E+04	n	2.3E+04	n	2.6E+03	NA
56-55-3	Benzo(a)anthracene	1.3E-01	1.6E-01	1.6E-01	c	6.6E-01	6.6E+00	c	2.9E+00	c	**1.3E-01**	NA
50-32-8	Benzo(a)pyrene	1.1E-02	1.6E-02	1.6E-02	c	6.6E-02	6.6E-01	c	2.9E-01	c	**1.1E-02**	NA
205-99-2	Benzo(b)fluoranthene	1.3E-01	1.6E-01	1.6E-01	c	6.6E-01	6.6E+00	c	2.9E+00	c	**1.3E-01**	NA
191-24-2	Benzo(g,h,i)perylene	1.9E+02	1.9E+02	NA		**1.9E+02**	1.9E+03	n	NA		NA	NA
207-08-9	Benzo(k)fluoranthene	1.1E+00	1.6E+00	1.6E+00	c	6.6E+00	6.6E+01	c	2.9E+01	c	**1.1E+00**	NA
218-01-9	Chrysene	1.3E+01	1.6E+01	1.6E+01	c	6.6E+01	6.6E+02	c	2.9E+02	c	**1.3E+01**	NA
53-70-3	Dibenz(a,h)anthracene	7.3E-03	1.6E-02	1.6E-02	c	6.6E-02	6.6E-01	c	2.9E-01	c	**7.3E-03**	NA
105-67-9	2,4-Dimethylphenol	1.3E+02	1.3E+02	**1.3E+02**	n	1.8E+02	1.8E+03	n	1.6E+03	n	2.1E+02	NA
84-74-2	Di-n-butylphthalate	6.3E+02	6.3E+02	**6.3E+02**	n	1.1E+03	1.1E+04	n	8.2E+03	n	8.9E+02	NA
206-44-0	Fluoranthene	2.4E+02	2.4E+02	**2.4E+02**	n	2.5E+02	2.5E+03	n	3.0E+03	n	2.9E+02	NA
86-73-7	Fluorene	2.4E+02	2.4E+02	**2.4E+02**	n	3.2E+02	3.2E+03	n	3.0E+03	n	3.6E+02	NA
193-39-5	Indeno(1,2,3-cd)pyrene	7.6E-02	1.6E-01	1.6E-01	c	6.6E-01	6.6E+00	c	2.9E+00	c	**7.6E-02**	NA
90-12-0	1-Methylnaphthalene [a]	2.8E+01	1.8E+01	1.8E+01	c*	**2.8E+01**	2.8E+02	n	7.3E+01	c*	2.5E+01	NA
91-57-6	2-Methylnaphthalene	2.4E+01	2.4E+01	**2.4E+01**	n	2.8E+01	2.8E+02	n	3.0E+02	n	3.7E+01	NA
95-48-7	2-Methylphenol	3.2E+02	3.2E+02	**3.2E+02**	n	4.4E+02	4.4E+03	c	4.1E+03	n	5.4E+02	NA
108-39-4	3-Methylphenol	3.2E+02	3.2E+02	**3.2E+02**	n	4.4E+02	4.4E+03	c	4.1E+03	n	5.4E+02	NA
106-44-5	4-Methylphenol	4.8E+01	4.8E+01	6.3E+02	n	**4.8E+01**	4.8E+02	c	8.2E+03	n	1.1E+03	NA
34mp	3&4-Methylphenol [g]	4.8E+01	**4.8E+01**	--		--	--		4.1E+03		5.4E+02	--
91-20-3	Naphthalene	3.8E+00	3.8E+00	**3.8E+00**	c**	4.1E+00	4.1E+01	n	1.7E+01	c**	4.4E+00	NA
85-01-8	Phenanthrene	2.8E+03	2.8E+03	NA		**2.8E+03**	2.8E+04	n	NA		NA	NA
108-95-2	Phenol	1.9E+03	1.9E+03	**1.9E+03**	n	3.1E+03	3.1E+04	n	2.5E+04	n	3.3E+03	NA
129-00-0	Pyrene	1.8E+02	1.8E+02	**1.8E+02**	n	1.9E+02	1.9E+03	n	2.3E+03	n	2.3E+02	NA
Metals												
7429-90-5	Aluminum [h]	--	--	**--**		**--**	--		**--**		**--**	**--**
7440-36-0	Antimony	2.7E+00	3.1E+00	3.1E+00	n	5.5E+00	5.5E+01	n	4.7E+01	n	**2.7E+00**	NA
7440-38-2	Arsenic	4.4E-01	6.1E-01	6.8E-01	c**R	6.1E-01	6.1E+00	c	3.0E+00	c*R	**4.4E-01**	NA
7440-39-3	Barium	1.5E+03	1.5E+03	**1.5E+03**	n	2.7E+03	2.7E+04	n	2.2E+04	n	2.4E+03	NA
7440-43-9	Cadmium	5.5E+00	7.1E+00	7.1E+00	n	1.1E+01	1.1E+02	c	9.8E+01	n	**5.5E+00**	NA
7440-47-3	Chromium	4.1E+01	4.1E+01	NA		**4.1E+01**	4.1E+02	n	NA		NA	NA
16065-83-1	Chromium (III) [a]	2.1E+04	1.2E+04	1.2E+04	n	**2.1E+04**	2.1E+05	n	1.8E+05	nm	1.7E+04	NA
18540-29-9	Chromium (VI) [a]	4.1E+01	3.0E-01	3.0E-01	c*	**4.1E+01**	4.1E+02	n	6.3E+00	c*	4.1E-01	NA
7440-50-8	Copper	2.5E+01	3.1E+02	3.1E+02	n	5.5E+02	5.5E+03	n	4.7E+03	n	**2.5E+01**	NA
7439-92-1	Lead [i]	4.0E+02	4.0E+02	**4.0E+02**	L	**4.0E+02**	4.0E+02	c	8.0E+02	L	NA	NA
7439-96-5	Manganese [h]	--	--	**--**		**--**	--		**--**		**--**	**--**
7439-97-6	Mercury [j]	3.6E-03	1.6E+00	2.3E+00	n	1.6E+00	1.6E+01	n	3.5E+01	n	**3.6E-03**	NA
7440-02-0	Nickel	9.6E+01	1.5E+02	1.5E+02	n	2.7E+02	2.7E+03	n	2.2E+03	n	**9.6E+01**	NA
7782-49-2	Selenium	2.3E+01	3.9E+01	3.9E+01	n	6.8E+01	6.8E+02	n	5.8E+02	n	**2.3E+01**	NA
7440-22-4	Silver	9.6E+00	3.9E+01	3.9E+01	n	6.8E+01	6.8E+02	n	5.8E+02	n	**9.6E+00**	NA
7440-62-2	Vanadium	3.9E+01	3.9E+01	**3.9E+01**	n	9.6E+01	9.6E+02	n	5.8E+02	n	6.4E+01	NA
7440-66-6	Zinc	7.6E+00	2.3E+03	2.3E+03	n	4.1E+03	4.1E+04	n	3.5E+04	n	**7.6E+00**	NA
Inorganics												
57-12-5	Cyanide	2.7E-01	2.7E-01	**2.7E-01**	n	2.7E+02	2.7E+03	n	1.2E+00	n	8.2E+00	9.7E+05

Bold values represent Tier I screening values.

Abbreviations:

CAS #: Chemical Abstract Service registry number
mg/kg: milligrams per kilogram
RSL: regional screening level
ADEC: Alaska Department of Environmental Conservation
CL: cleanup level
Csat: soil saturation level
NA: not available
--: not applicable
n: noncancer
c: cancer
s: concentration exceeds Csat
m: concentration exceeds ceiling limit
L: see RSL User Guide (EPA, 2014b) for lead information
R: RSL calculated with relative bioavailability factor of 0.6
*: where: n RSL < 100X c RSL
**: where: n RSL < 10X c RSL
i: Csat based inhalation value replaced with risk-based value

References:

Alaska Department of Environmental Conservation (ADEC). 2008a. Cumulative Risk Guidance. Division of Spill Prevention and Response, Contaminated Sites Program. June 9.

ADEC. 2012. Oil and Other Hazardous Substances Pollution Control. 18 AAC 75. Article Three Only. Revised as of April 8, 2012.

U.S. Environmental Protection Agency (EPA). 2015b. Regional Screening Level Tables. June. http://www2.epa.gov/risk/risk-based-screening-table-generic-tables

EPA. 2015c. Regional Screening Level User's Guide. June. http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Footnotes:

[a] For chemicals regulated by ADEC but not by EPA (n-propylbenzene, 1,2,4- and 1,3,5-trimethybenzene, 1-methylnaphthalene, chromium [III], and chromium [VI]), the adjusted ADEC CL value was selected as the Tier I screening level. If no ADEC value was available, the lowest soil value was selected.

[b] Residential human health soil RSLs from EPA (2015b). Noncancer-based values are based on a hazard quotient of 0.1, and cancer-based values are based on a target risk of 10^{6}.
For target analytes that include the inhalation exposure route and have overall soil RSLs that exceed the saturation limit (Csat), the RSLs may be overly protective (see EPA, 2015c).
If detected chemical concentrations exceed the Csat concentration, more sophisticated modeling may be necessary on a SWMU/AOC-specific basis.
At chemical concentrations at and above the ceiling limit of 1 x 10^{5} mg/kg, or 10% by weight of the soil sample, the assumptions for soil contact may be violated due to the presence of the foreign substance itself (EPA, 2015c). Target analytes with detected concentrations above the ceiling limit should be evaluated further on a SWMU/AOC-specific basis.

[c] ADEC Method 2 Soil Cleanup Levels for the Arctic Zone from 18AAC75 (ADEC, 2012); direct contact and inhalation values combined into a single multi-pathway value using the equation:
ADEC CL = 1/((1/Direct Contact CL) + (1/Inhalation CL)). For target analytes with Method 2 inhalation values based on Csat concentrations, risk-based inhalation values from ADEC (2008a) were used in place of the Csat-based value. Values were adjusted to a cancer risk of 10-6 and a hazard quotient of 0.1 (by dividing by 10).

[d] Industrial human health soil RSLs from EPA (2015b). Noncancer-based values are based on a hazard quotient of 0.1, and cancer-based values are based on a target risk of 10^{6}.
For target analytes that include the inhalation exposure route and have overall soil RSLs that exceed the saturation limit (Csat), the RSLs may be overly protective (see EPA, 2015c).
If detected chemical concentrations exceed the Csat concentration, more sophisticated modeling may be necessary on a SWMU/AOC-specific basis.
At chemical concentrations at and above the ceiling limit of 1 x 10^{5} mg/kg, or 10% by weight of the soil sample, the assumptions for soil contact may be violated due to the presence of the foreign substance itself (EPA, 2015c). Target analytes with detected concentrations above the ceiling limit should be evaluated further on a SWMU/AOC-specific basis.

[e] Subsistence user soil screening levels were developed using a target hazard quotient of 0.1 and a target cancer risk of 10^{6}. Equations and SL calculations are provided in Table B-3 of Appendix B. Exposure assumptions are provided in Table 6; toxicity values and chemical-specific parameters are provided in Table 4.

[f] Csat values are from EPA (2015b).

[g] Screening levels for the more toxic of the coeluting compounds used to represent this mixture.

[h] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

[i] Lead value from ADEC (2012) was not divided by 10 because this value is based on blood-lead modeling rather than risk-based equations. See EPA (2015c) for details.
Toxicity values for lead are not available from EPA (2015b); lead is typically evaluated through blood-lead modeling. Therefore, no screening levels were developed for lead for the subsistence user receptor.

[j] Where value sources differentiated between mercuric chloride/other inorganic salts and elemental mercury, values for mercuric chloride/other inorganic salts were used.

Table 3
Tier I Human Health Screening Level Development for Surface Water
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Surface Water and Suprapermafrost Groundwater										
			Residential Values								Other Values	
CAS #	Chemical Name	Lowest Water Value [a] (µg/L)	Residential Value (µg/L)	AWQC [b] (µg/L)	MCL [c] (µg/L)	Adjusted ADEC Table C [d] (µg/L)	ADEC Table C [d] (µg/L)	ADEC Water Quality Criteria [e] (µg/L)	June 2015 RSL [f] (µg/L)		Industrial Worker Value [g] (µg/L)	Future Resident Subsistence User Value [h] (µg/L)
Volatiles												
67-64-1	Acetone	1.0E+03	1.4E+03	NA	NA	3.3E+03	3.3E+04	NA	1.4E+03	n	NA	**1.0E+03**
107-02-8	Acrolein	4.1E-03	4.2E-03	3.0E+00	NA	NA	NA	3.2E+02	4.2E-03	n	1.9E+03	**4.1E-03**
71-43-2	Benzene	3.9E-01	4.5E-01	2.1E+00	5.0E+00	5.0E-01	5.0E+00	5.0E+00	4.5E-01	c**	9.1E+01	**3.9E-01**
78-93-3	2-Butanone	4.6E+02	5.6E+02	NA	NA	2.2E+03	2.2E+04	NA	5.6E+02	n	1.7E+06	**4.6E+02**
56-23-5	Carbon tetrachloride	3.3E-01	4.0E-01	4.0E-01	5.0E+00	5.0E-01	5.0E+00	5.0E+00	4.5E-01	c*	4.2E+01	**3.3E-01**
108-90-7	Chlorobenzene	5.2E+00	7.8E+00	1.0E+02	1.0E+02	1.0E+01	1.0E+02	6.8E+02	7.8E+00	n	1.6E+03	**5.2E+00**
75-00-3	Chloroethane	2.9E+01	2.9E+01	NA	NA	**2.9E+01**	2.9E+02	NA	2.1E+03	n	NA	2.1E+03
67-66-3	Chloroform	1.9E-01	2.2E-01	6.0E+01	7.0E+01	1.4E+01	1.4E+02	NA	2.2E-01	c*	2.8E+02	**1.9E-01**
106-93-4	1,2-Dibromoethane	5.0E-03	5.0E-03	NA	5.0E-02	**5.0E-03**	5.0E-02	5.0E-02	7.5E-03	c	6.9E+00	5.5E-03
95-50-1	1,2-Dichlorobenzene	4.0E+00	3.0E+01	1.0E+03	6.0E+02	6.0E+01	6.0E+02	6.0E+02	3.0E+01	n	3.6E+03	**4.0E+00**
75-34-3	1,1-Dichloroethane	2.3E+00	2.7E+00	NA	NA	7.3E+02	7.3E+03	NA	2.7E+00	c	1.7E+03	**2.3E+00**
107-06-2	1,2-Dichloroethane	1.5E-01	1.7E-01	9.9E+00	5.0E+00	5.0E-01	5.0E+00	5.0E+00	1.7E-01	c**	1.7E+02	**1.5E-01**
75-35-4	1,1-Dichloroethene	7.0E-01	7.0E-01	3.0E+02	7.0E+00	**7.0E-01**	7.0E+00	7.0E+00	2.8E+01	n	1.0E+04	1.9E+01
156-59-2	cis-1,2-Dichloroethene	1.5E+00	3.6E+00	NA	7.0E+01	7.0E+00	7.0E+01	7.0E+01	3.6E+00	n	NA	**1.5E+00**
156-60-5	trans-1,2-Dichloroethene	1.0E+01	1.0E+01	1.0E+02	1.0E+02	**1.0E+01**	1.0E+02	1.0E+02	3.6E+01	n	4.4E+03	1.5E+01
60-29-7	Diethyl ether	2.2E+02	3.9E+02	NA	NA	NA	NA	NA	3.9E+02	n	2.3E+05	**2.2E+02**
123-91-1	1,4-Dioxane	4.4E-01	4.6E-01	NA	NA	7.7E+00	7.7E+01	NA	4.6E-01	c*	2.1E+03	**4.4E-01**
100-41-4	Ethylbenzene	6.1E-01	1.5E+00	6.8E+01	7.0E+02	7.0E+01	7.0E+02	7.0E+02	1.5E+00	c*	1.2E+02	**6.1E-01**
50-00-0	Formaldehyde	4.3E-01	4.3E-01	NA	NA	NA	NA	NA	**4.3E-01**	c**	3.5E+05	4.3E-01
67-56-1	Methanol	1.7E+03	2.0E+03	NA	NA	NA	NA	NA	2.0E+03	n	2.0E+07	**1.7E+03**
75-09-2	Methylene chloride	5.0E-01	5.0E-01	2.0E+01	5.0E+00	**5.0E-01**	5.0E+00	5.0E+00	1.1E+01	n	4.3E+03	2.7E+00
108-10-1	4-Methyl-2-pentanone	9.0E+01	1.2E+02	NA	NA	2.9E+02	2.9E+03	NA	1.2E+02	n	5.9E+04	**9.0E+01**
103-65-1	n-Propylbenzene [a]	3.7E+01	3.7E+01	NA	NA	**3.7E+01**	3.7E+02	NA	6.6E+01	n	NA	9.9E+00
127-18-4	Tetrachloroethene	5.0E-01	5.0E-01	1.0E+01	5.0E+00	**5.0E-01**	5.0E+00	5.0E+00	4.1E+00	n	2.8E+02	1.1E+00
108-88-3	Toluene	5.7E+01	5.7E+01	**5.7E+01**	1.0E+03	1.0E+02	1.0E+03	1.0E+03	1.1E+02	n	6.4E+03	6.0E+01
71-55-6	1,1,1-Trichloroethane	2.0E+01	2.0E+01	1.0E+04	2.0E+02	**2.0E+01**	2.0E+02	2.0E+02	8.0E+02	n	3.1E+05	7.0E+02
79-01-6	Trichloroethene	1.7E-01	2.8E-01	6.0E-01	5.0E+00	5.0E-01	5.0E+00	5.0E+00	2.8E-01	n	8.5E+01	**1.7E-01**
95-63-6	1,2,4-Trimethylbenzene [a]	1.8E+02	1.5E+00	NA	NA	**1.8E+02**	1.8E+03	NA	1.5E+00	n	NA	1.1E+00
108-67-8	1,3,5-Trimethylbenzene [a]	1.8E+02	1.2E+01	NA	NA	**1.8E+02**	1.8E+03	NA	1.2E+01	n	NA	4.5E-01
75-01-4	Vinyl chloride	1.1E-02	1.9E-02	2.2E-02	2.0E+00	2.0E-01	2.0E+00	2.0E+00	1.9E-02	c	1.3E+01	**1.1E-02**
1330-20-7	Xylenes	1.7E+01	1.9E+01	NA	1.0E+04	1.0E+03	1.0E+04	1.0E+04	1.9E+01	n	9.1E+03	**1.7E+01**
Semi-Volatiles												
83-32-9	Acenaphthene	1.1E+00	5.3E+01	7.0E+01	NA	2.2E+02	2.2E+03	1.2E+03	5.3E+01	n	NA	**1.1E+00**
208-96-8	Acenaphthylene	2.2E+02	2.2E+02	NA	NA	**2.2E+02**	2.2E+03	NA	NA		NA	NA
120-12-7	Anthracene	2.3E+00	1.8E+02	3.0E+02	NA	1.1E+03	1.1E+04	9.6E+03	1.8E+02	n	NA	**2.3E+00**
56-55-3	Benzo(a)anthracene	9.3E-04	1.2E-03	1.2E-03	NA	1.2E-01	1.2E+00	NA	1.2E-02	c	NA	**9.3E-04**
50-32-8	Benzo(a)pyrene	5.1E-06	1.2E-04	1.2E-04	2.0E-01	2.0E-02	2.0E-01	2.0E-01	3.4E-03	c	NA	**5.1E-06**
205-99-2	Benzo(b)fluoranthene	8.7E-05	1.2E-03	1.2E-03	NA	1.2E-01	1.2E+00	NA	3.4E-02	c	NA	**8.7E-05**
191-24-2	Benzo(g,h,i)perylene	1.1E+02	1.1E+02	NA	NA	**1.1E+02**	1.1E+03	NA	NA		NA	NA
207-08-9	Benzo(k)fluoranthene	5.3E-04	1.2E-02	1.2E-02	NA	1.2E+00	1.2E+01	NA	3.4E-01	c	NA	**5.3E-04**
218-01-9	Chrysene	8.3E-03	1.2E-01	1.2E-01	NA	1.2E+01	1.2E+02	NA	3.4E+00	c	NA	**8.3E-03**
53-70-3	Dibenz(a,h)anthracene	2.7E-06	1.2E-04	1.2E-04	NA	1.2E-02	1.2E-01	NA	3.4E-03	c	NA	**2.7E-06**
105-67-9	2,4-Dimethylphenol	1.2E+01	3.6E+01	1.0E+02	NA	7.3E+01	7.3E+02	5.4E+02	3.6E+01	n	3.9E+03	**1.2E+01**
84-74-2	Di-n-butylphthalate	7.5E+00	2.0E+01	2.0E+01	NA	3.7E+02	3.7E+03	2.7E+03	9.0E+01	n	2.0E+03	**7.5E+00**
206-44-0	Fluoranthene	1.5E-01	2.0E+01	2.0E+01	NA	1.5E+02	1.5E+03	3.0E+02	8.0E+01	n	NA	**1.5E-01**
86-73-7	Fluorene	1.0E+00	2.9E+01	5.0E+01	NA	1.5E+02	1.5E+03	1.3E+03	2.9E+01	n	NA	**1.0E+00**
193-39-5	Indeno(1,2,3-cd)pyrene	2.1E-05	1.2E-03	1.2E-03	NA	1.2E-01	1.2E+00	NA	3.4E-02	c	NA	**2.1E-05**
90-12-0	1-Methylnaphthalene [a]	1.5E+01	1.1E+00	NA	NA	**1.5E+01**	1.5E+02	NA	1.1E+00	c*	NA	3.6E-01
91-57-6	2-Methylnaphthalene	6.7E-01	3.6E+00	NA	NA	1.5E+01	1.5E+02	NA	3.6E+00	n	NA	**6.7E-01**
95-48-7	2-Methylphenol	3.8E+01	9.3E+01	NA	NA	1.8E+02	1.8E+03	NA	9.3E+01	n	1.5E+04	**3.8E+01**
108-39-4	3-Methylphenol	4.2E+01	9.3E+01	NA	NA	1.8E+02	1.8E+03	NA	9.3E+01	n	1.5E+04	**4.2E+01**
106-44-5	4-Methylphenol	1.8E+01	1.8E+01	NA	NA	**1.8E+01**	1.8E+02	NA	1.9E+02	n	3.1E+04	8.4E+01
34mp	3&4-Methylphenol [i]	1.8E+01	**1.8E+01**	--	--	--	--	--	--		1.5E+04	4.2E+01
91-20-3	Naphthalene	1.7E-01	1.7E-01	NA	NA	7.3E+01	7.3E+02	NA	1.7E-01	c**	8.7E+02	**1.7E-01**
85-01-8	Phenanthrene	1.1E+03	1.1E+03	NA	NA	**1.1E+03**	1.1E+04	NA	NA		NA	NA
108-95-2	Phenol	1.7E+02	5.8E+02	4.0E+03	NA	1.1E+03	1.1E+04	2.1E+04	5.8E+02	n	1.7E+05	**1.7E+02**
129-00-0	Pyrene	2.7E-01	1.2E+01	2.0E+01	NA	1.1E+02	1.1E+03	9.6E+02	1.2E+01	n	NA	**2.7E-01**
Metals												
7429-90-5	Aluminum [j]	5.0E+03	5.0E+03	--	--	--	--	**5.0E+03**	--		--	--
7440-36-0	Antimony	5.1E-02	6.0E-01	5.6E+00	6.0E+00	6.0E-01	6.0E+00	6.0E+00	7.8E-01	n	2.5E+02	**5.1E-02**
7440-38-2	Arsenic	1.4E-03	1.8E-02	1.8E-02	1.0E+01	1.0E+00	1.0E+01	1.0E+01	5.2E-02	c*	7.7E+01	**1.4E-03**
7440-39-3	Barium	2.0E+02	2.0E+02	1.0E+03	2.0E+03	**2.0E+02**	2.0E+03	2.0E+03	3.8E+02	n	5.8E+04	2.4E+02
7440-43-9	Cadmium	6.4E-02	5.0E-01	NA	5.0E+00	5.0E-01	5.0E+00	5.0E+00	9.2E-01	n	1.0E+02	**6.4E-02**
7440-47-3	Chromium	1.0E+01	1.0E+01	NA	1.0E+02	**1.0E+01**	1.0E+02	1.0E+02	NA		NA	NA
16065-83-1	Chromium (III) [a]	5.5E+03	2.2E+03	NA	NA	**5.5E+03**	5.5E+04	NA	2.2E+03	n	8.1E+04	2.2E+03
18540-29-9	Chromium (VI) [a]	1.0E+01	3.5E-02	NA	NA	**1.0E+01**	1.0E+02	5.0E+01	3.5E-02	c	2.9E+00	1.8E-03
7440-50-8	Copper	2.7E+00	8.0E+01	1.3E+03	1.3E+03	1.0E+02	1.0E+03	2.0E+02	8.0E+01	n	1.7E+05	**2.7E+00**
7439-92-1	Lead [k]	1.5E+01	1.5E+01	NA	**1.5E+01**	**1.5E+01**	1.5E+01	5.0E+01	**1.5E+01**	L	NA	NA
7439-96-5	Manganese [j]	5.0E+01	5.0E+01	--	--	--	--	**5.0E+01**	--		--	--
7439-97-6	Mercury [l]	3.8E-03	5.0E-02	NA	2.0E+00	2.0E-01	2.0E+00	5.0E-02	6.3E-02	n	8.7E+01	**3.8E-03**
7440-02-0	Nickel	2.6E+00	1.0E+01	6.1E+02	NA	1.0E+01	1.0E+02	2.0E+02	3.9E+01	n	1.7E+04	**2.6E+00**
7782-49-2	Selenium	3.3E-01	5.0E+00	1.7E+02	5.0E+01	5.0E+00	5.0E+01	1.0E+01	1.0E+01	n	2.1E+04	**3.3E-01**
7440-22-4	Silver	5.6E+00	9.4E+00	NA	1.0E+02	1.0E+01	1.0E+02	NA	9.4E+00	n	1.4E+03	**5.6E+00**
7440-62-2	Vanadium	8.6E+00	8.6E+00	NA	NA	2.6E+01	2.6E+02	1.0E+02	8.6E+00	n	5.4E+02	**8.6E+00**
7440-66-6	Zinc	4.1E+00	5.0E+02	7.4E+03	5.0E+03	5.0E+02	5.0E+03	2.0E+03	6.0E+02	n	2.1E+06	**4.1E+00**
Inorganics												
57-12-5	Cyanide	1.5E-01	1.5E-01	4.0E+00	2.0E+02	2.0E+01	2.0E+02	2.0E+02	1.5E-01	n	2.5E+03	**1.5E-01**

Bold values represent Tier I screening values.

Abbreviations:

CAS #: Chemical Abstract Service registry number
AWQC: ambient water quality criteria
MCL: maximum contaminant level
ADEC: Alaska Department of Environmental Conservation
RSL: regional screening level
µg/L: micrograms per liter
NA: not available
--: not applicable
n: noncancer
c: cancer
*: where: n RSL < 100X c RSL
**: where: n RSL < 10X c RSL
L: see RSL User Guide (EPA, 2014b) for lead information

References:

Alaska Department of Environmental Conservation (ADEC). 2008c. Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances. As amended through December 12, 2008.

ADEC. 2012. Oil and Other Hazardous Substances Pollution Control. 18 AAC 75. Article Three Only. Revised as of April 8, 2012.

U.S. Environmental Protection Agency (EPA). 2009b. National Primary Drinking Water Regulations. EPA 816-F-09-004. May. http://water.epa.gov/drink/contaminants/#List

EPA. 2015a. Current National Recommended Water Quality Criteria. June. http://www2.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table

EPA. 2015b. Regional Screening Level Tables. June. http://www2.epa.gov/risk/risk-based-screening-table-generic-tables

EPA. 2015c. Regional Screening Level User's Guide. June. http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Footnotes:

[a] For chemicals regulated by ADEC but not by EPA (n-propylbenzene, 1,2,4- and 1,3,5-trimethybenzene, 1-methylnaphthalene, chromium [III], and chromium [VI]), the lower of the adjusted ADEC Table C value and the ADEC water quality criterion was selected as the Tier I screening level. If no ADEC value was available, the lowest water value was selected.

[b] AWQC for human health, consumption of water + organism, from EPA (2015a).

[c] Maximum Contaminant Levels (MCLs) from EPA (2009b). Values for silver and zinc are secondary MCLs.

[d] Table C Cleanup Levels as listed in 18AAC75 (ADEC, 2012), adjusted to a cancer risk of 10^{-6} and a hazard quotient of 0.1 (by dividing by 10).

[e] Alaska Water Quality Criteria for human health, lowest available water value (ADEC, 2008c).

[f] Residential human health tap water RSLs from EPA (2015b). Noncancer-based values are based on a hazard quotient of 0.1, and cancer-based values are based on a target risk of 10^{6}.

[g] Industrial worker values were developed using a target hazard quotient of 0.1 and a target cancer risk of 10^{-6}. Equations and SL calculations are provided in Table B-2 of Appendix B. Exposure assumptions are provided in Table 5; toxicity values and chemical-specific parameters are provided in Table 4.

[h] Subsistence user surface water screening levels were developed using a target hazard quotient of 0.1 and a target cancer risk of 10^{6}. Equations and SL calculations are provided in Table B-4 of Appendix B. Exposure assumptions are provided in Table 6; toxicity values and chemical-specific parameters are provided in Table 4.

[i] Screening levels for the more toxic of the coeluting compounds used to represent this mixture.

[j] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes.

[k] Lead value from ADEC (2012) was not divided by 10 because this value is based on blood-lead modeling rather than risk-based equations. See EPA (2015c) for details. Toxicity values for lead are not available from EPA (2015b); lead is typically evaluated through blood-lead modeling. Therefore, no screening levels were developed for lead for the subsistence user or industrial worker receptors.

[l] Where value sources differentiated between mercuric chloride/other inorganic salts and elemental mercury, values for elemental mercury were used.

Table 4
Human Health Screening and Action Level Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [b]							Chemical Properties											Biota Uptake Factors [e]		
CAS #	Chemical Name		Oral		Dermal			Inhalation		Inhalation Pathway Components [c]					Dermal Pathway Components [d]						Caribou		Fish
			SFo	RfDo	ABS$_{GI}$	SFd	RfDd	RfCi	URFi	Koc	Di	Dw	H'	VF / PEF	ABSd	Kp	Outside of	τ	FA	B	BV	BTF	BCF
		Mutagen? [a]	(mg/kg-d)$^{-1}$	(mg/kg-d)	(unitless)	(mg/kg-d)$^{-1}$	(mg/kg-d)	(mg/m^3)	(mg/m^3)$^{-1}$	(L/kg)	(cm^2/s)	(cm^2/s)	(Unitless)	(m^3/kg)	(Unitless)	(cm/hr)	EPD?	(hr/event)	(Unitless)	(Unitless)	(Unitless)	(d/kg)	(L/kg)
Volatiles																							
67-64-1	Acetone	No	NA	9.0E-01	1.0E+00	NA	9.0E-01	3.1E+01	NA	2.4E+00	1.1E-01	1.2E-05	1.4E-03	2.0E+04	0.0E+00	5.1E-04	NA	2.2E-01	NA	1.5E-03	1.1E+01	1.4E-08	3.2E+00
107-02-8	Acrolein	No	NA	5.0E-04	1.0E+00	NA	5.0E-04	2.0E-05	NA	1.0E+00	1.1E-01	1.2E-05	5.0E-03	1.1E+04	0.0E+00	7.5E-04	No	2.2E-01	1.0E+00	2.2E-03	7.8E+00	2.4E-08	3.2E+00
71-43-2	Benzene	No	5.5E-02	4.0E-03	1.0E+00	5.5E-02	4.0E-03	3.0E-02	7.8E-03	1.5E+02	9.0E-02	1.0E-05	2.3E-01	3.0E+03	0.0E+00	1.5E-02	No	2.9E-01	1.0E+00	5.1E-02	4.5E-01	3.4E-06	4.3E+00
78-93-3	2-Butanone	No	NA	6.0E-01	1.0E+00	NA	6.0E-01	5.0E+00	NA	4.5E+00	9.1E-02	1.0E-05	2.3E-03	1.7E+04	0.0E+00	9.6E-04	No	2.7E-01	1.0E+00	3.1E-03	5.2E+00	4.9E-08	3.2E+00
56-23-5	Carbon tetrachloride	No	7.0E-02	4.0E-03	1.0E+00	7.0E-02	4.0E-03	1.0E-01	6.0E-03	4.4E+01	5.7E-02	9.8E-06	1.1E+00	1.9E+03	0.0E+00	1.6E-02	No	7.6E-01	1.0E+00	7.8E-02	1.8E-01	1.7E-05	7.4E+00
108-90-7	Chlorobenzene	No	NA	2.0E-02	1.0E+00	NA	2.0E-02	5.0E-02	NA	2.3E+02	7.2E-02	9.5E-06	1.3E-01	4.9E+03	0.0E+00	2.8E-02	No	4.5E-01	1.0E+00	1.2E-01	1.7E-01	1.7E-05	1.8E+01
75-00-3	Chloroethane	No	NA	NA	1.0E+00	NA	NA	1.0E+01	NA	2.2E+01	1.0E-01	1.2E-05	4.5E-01	1.7E+03	0.0E+00	6.1E-03	No	2.4E-01	1.0E+00	1.9E-02	1.1E+00	6.7E-07	4.1E+00
67-66-3	Chloroform	No	3.1E-02	1.0E-02	1.0E+00	3.1E-02	1.0E-02	9.8E-02	2.3E-02	3.2E+01	7.7E-02	1.1E-05	1.5E-01	2.9E+03	0.0E+00	6.8E-03	No	4.9E-01	1.0E+00	2.9E-02	5.5E-01	2.3E-06	1.3E+01
106-93-4	1,2-Dibromoethane	No	2.0E+00	9.0E-03	1.0E+00	2.0E+00	9.0E-03	9.0E-03	6.0E-01	4.0E+01	4.3E-02	1.0E-05	2.7E-02	8.9E+03	0.0E+00	2.8E-03	No	1.2E+00	1.0E+00	1.5E-02	5.6E-01	2.3E-06	1.5E+01
95-50-1	1,2-Dichlorobenzene	No	NA	9.0E-02	1.0E+00	NA	9.0E-02	2.0E-01	NA	3.8E+02	5.6E-02	8.9E-06	7.8E-02	8.4E+03	0.0E+00	4.5E-02	No	7.0E-01	1.0E+00	2.1E-01	7.9E-02	6.7E-05	2.7E+02
75-34-3	1,1-Dichloroethane	No	5.7E-03	2.0E-01	1.0E+00	5.7E-03	2.0E-01	NA	1.6E-03	3.2E+01	8.4E-02	1.1E-05	2.3E-01	2.4E+03	0.0E+00	6.8E-03	No	3.8E-01	1.0E+00	2.6E-02	7.1E-01	1.5E-06	7.1E+00
107-06-2	1,2-Dichloroethane	No	9.1E-02	6.0E-03	1.0E+00	9.1E-02	6.0E-03	7.0E-03	2.6E-02	4.0E+01	8.6E-02	1.1E-05	4.8E-02	4.7E+03	0.0E+00	4.2E-03	No	3.8E-01	1.0E+00	1.6E-02	1.1E+00	7.6E-07	4.4E+00
75-35-4	1,1-Dichloroethene	No	NA	5.0E-02	1.0E+00	NA	5.0E-02	2.0E-01	NA	3.2E+01	8.6E-02	1.1E-05	1.1E+00	1.5E+03	0.0E+00	1.2E-02	No	3.7E-01	1.0E+00	4.4E-02	4.5E-01	3.4E-06	1.3E+01
156-59-2	cis-1,2-Dichloroethene	No	NA	2.0E-03	1.0E+00	NA	2.0E-03	NA	NA	4.0E+01	8.8E-02	1.1E-05	1.7E-01	2.7E+03	0.0E+00	1.1E-02	NA	3.7E-01	NA	4.2E-02	6.4E-01	1.8E-06	1.1E+01
156-60-5	trans-1,2-Dichloroethene	No	NA	2.0E-02	1.0E+00	NA	2.0E-02	NA	NA	4.0E+01	8.8E-02	1.1E-05	3.9E-01	2.0E+03	0.0E+00	1.1E-02	No	3.7E-01	1.0E+00	4.2E-02	4.7E-01	3.1E-06	1.1E+01
60-29-7	Diethyl ether	No	NA	2.0E-01	1.0E+00	NA	2.0E-01	NA	NA	9.7E+00	8.5E-02	9.4E-06	5.0E-02	4.2E+03	0.0E+00	2.4E-03	No	2.7E-01	1.0E+00	7.8E-03	2.4E+00	1.9E-07	5.4E+00
123-91-1	1,4-Dioxane	No	1.0E-01	3.0E-02	1.0E+00	1.0E-01	3.0E-02	3.0E-02	5.0E-03	2.6E+00	8.7E-02	1.1E-05	2.0E-04	5.9E+04	1.0E-01	3.3E-04	No	3.3E-01	1.0E+00	1.2E-03	1.1E+01	1.3E-08	5.0E-01
100-41-4	Ethylbenzene	No	1.1E-02	1.0E-01	1.0E+00	1.1E-02	1.0E-01	1.0E+00	2.5E-03	4.5E+02	6.8E-02	8.5E-06	3.2E-01	4.1E+03	0.0E+00	4.9E-02	No	4.1E-01	1.0E+00	2.0E-01	1.2E-01	3.5E-05	5.6E+01
50-00-0	Formaldehyde	No	NA	2.0E-01	1.0E+00	NA	2.0E-01	9.8E-03	1.3E-02	1.0E+00	1.7E-01	1.7E-05	1.4E-05	1.2E+05	1.0E-01	1.8E-03	No	1.5E-01	1.0E+00	3.8E-03	4.8E+00	5.6E-08	3.2E+00
67-56-1	Methanol	No	NA	2.0E+00	1.0E+00	NA	2.0E+00	2.0E+01	NA	1.0E+00	1.6E-01	1.7E-05	1.9E-04	4.5E+04	1.0E-01	3.2E-04	No	1.6E-01	1.0E+00	6.9E-04	2.2E+01	4.3E-09	3.2E+00
75-09-2	Methylene chloride	Yes	2.0E-03	6.0E-03	1.0E+00	2.0E-03	6.0E-03	6.0E-01	1.0E-05	2.2E+01	1.0E-01	1.3E-05	1.3E-01	2.6E+03	0.0E+00	3.5E-03	No	3.1E-01	1.0E+00	1.3E-02	1.5E+00	4.5E-07	2.3E+01
108-10-1	4-Methyl-2-pentanone	No	NA	8.0E-02	1.0E+00	NA	8.0E-02	3.0E+00	NA	1.3E+01	7.0E-02	8.3E-06	5.6E-03	1.3E+04	0.0E+00	3.2E-03	No	3.8E-01	1.0E+00	1.2E-02	1.3E+00	5.1E-07	3.4E+00
103-65-1	n-Propylbenzene	No	NA	1.0E-01	1.0E+00	NA	1.0E-01	1.0E+00	NA	8.1E+02	6.0E-02	7.8E-06	4.3E-01	4.9E+03	0.0E+00	9.4E-02	NA	5.0E-01	NA	4.0E-01	5.6E-02	1.2E-04	1.3E+02
127-18-4	Tetrachloroethene	No	2.1E-03	6.0E-03	1.0E+00	2.1E-03	6.0E-03	4.0E-02	2.6E-04	9.5E+01	5.0E-02	9.5E-06	7.2E-01	2.4E+03	0.0E+00	3.3E-02	No	8.9E-01	1.0E+00	1.7E-01	8.2E-02	6.3E-05	5.2E+01
108-88-3	Toluene	No	NA	8.0E-02	1.0E+00	NA	8.0E-02	5.0E+00	NA	2.3E+02	7.8E-02	9.2E-06	2.7E-01	3.4E+03	0.0E+00	3.1E-02	No	3.5E-01	1.0E+00	1.1E-01	2.0E-01	1.3E-05	8.3E+00
71-55-6	1,1,1-Trichloroethane	No	NA	2.0E+00	1.0E+00	NA	2.0E+00	5.0E+00	NA	4.4E+01	6.5E-02	9.6E-06	7.0E-01	1.9E+03	0.0E+00	1.3E-02	No	5.9E-01	1.0E+00	5.6E-02	2.8E-01	7.7E-06	5.0E+00
79-01-6	Trichloroethene	Yes	4.6E-02	5.0E-04	1.0E+00	4.6E-02	5.0E-04	2.0E-03	4.1E-03	6.1E+01	6.9E-02	1.0E-05	4.0E-01	2.3E+03	0.0E+00	1.2E-02	No	5.7E-01	1.0E+00	5.1E-02	3.0E-01	6.6E-06	1.6E+01
95-63-6	1,2,4-Trimethylbenzene	No	NA	5.0E-02	1.0E+00	NA	5.0E-02	7.0E-03	NA	6.1E+02	6.1E-02	7.9E-06	2.5E-01	5.6E+03	0.0E+00	8.6E-02	NA	5.0E-01	NA	3.6E-01	6.0E-02	1.1E-04	1.2E+02
108-67-8	1,3,5-Trimethylbenzene	No	NA	1.0E-02	1.0E+00	NA	1.0E-02	6.0E-03	NA	6.0E+02	6.0E-02	7.8E-06	3.6E-01	4.7E+03	0.0E+00	6.2E-02	NA	5.0E-01	NA	2.6E-01	8.0E-02	6.6E-05	1.9E+02
75-01-4	Vinyl chloride	Yes	7.2E-01	3.0E-03	1.0E+00	7.2E-01	3.0E-03	1.0E-01	4.4E-03	2.2E+01	1.1E-01	1.2E-05	1.1E+00	1.3E+03	0.0E+00	8.4E-03	No	2.4E-01	1.0E+00	2.5E-02	8.9E-01	1.0E-06	5.5E+00
1330-20-7	Xylenes [f]	No	NA	2.0E-01	1.0E+00	NA	2.0E-01	1.0E-01	NA	3.8E+02	6.9E-02	8.5E-06	2.1E-01	4.7E+03	0.0E+00	5.0E-02	No	4.1E-01	1.0E+00	2.0E-01	1.1E-01	3.6E-05	1.5E+01
Semi-Volatiles																							
83-32-9	Acenaphthene	No	NA	6.0E-02	1.0E+00	NA	6.0E-02	NA	NA	5.0E+03	5.1E-02	8.3E-06	7.5E-03	9.2E+04	1.3E-01	8.6E-02	NA	7.7E-01	NA	4.1E-01	4.1E-02	2.1E-04	7.6E+02
208-96-8	Acenaphthylene	No	NA	NA	1.0E+00	NA	NA	NA	NA	5.0E+03	4.5E-02	7.0E-06	4.7E-03	1.2E+05	1.3E-01	9.1E-02	NA	NA	NA	NA	4.0E-02	2.2E-04	2.7E+02
120-12-7	Anthracene	No	NA	3.0E-01	1.0E+00	NA	3.0E-01	NA	NA	1.6E+04	3.9E-02	7.9E-06	2.3E-03	3.4E+05	1.3E-01	1.4E-01	NA	1.0E+00	NA	7.3E-01	2.0E-02	7.1E-04	1.8E+03
56-55-3	Benzo(a)anthracene	Yes	7.3E-01	NA	1.0E+00	7.3E-01	NA	NA	1.1E-01	1.8E+05	2.6E-02	6.7E-06	4.9E-04	2.8E+06	1.3E-01	--	Yes	2.0E+00	1.0E+00	3.2E+00	3.5E-03	1.4E-02	2.6E+02
50-32-8	Benzo(a)pyrene	Yes	7.3E+00	NA	1.0E+00	7.3E+00	NA	NA	1.1E+00	5.9E+05	4.8E-02	5.6E-06	1.9E-05	4.6E+09	1.3E-01	--	Yes	2.7E+00	1.0E+00	4.4E+00	2.1E-03	3.4E-02	5.2E+03
205-99-2	Benzo(b)fluoranthene	Yes	7.3E-01	NA	1.0E+00	7.3E-01	NA	NA	1.1E-01	6.0E+05	4.8E-02	5.6E-06	2.7E-05	4.6E+09	1.3E-01	--	Yes	2.7E+00	1.0E+00	2.5E+00	3.4E-03	1.5E-02	3.0E+03
191-24-2	Benzo(g,h,i)perylene	No	NA	NA	1.0E+00	NA	NA	NA	NA	2.0E+06	4.5E-02	5.2E-06	1.4E-05	4.6E+09	1.3E-01	1.1E+00	NA	NA	NA	NA	1.1E-03	1.1E-01	1.1E+04
207-08-9	Benzo(k)fluoranthene	Yes	7.3E-02	NA	1.0E+00	7.3E-02	NA	NA	1.1E-01	5.9E+05	4.8E-02	5.6E-06	2.4E-05	4.6E+09	1.3E-01	--	Yes	2.7E+00	NA	4.2E+00	2.2E-03	3.2E-02	5.0E+03
218-01-9	Chrysene	Yes	7.3E-03	NA	1.0E+00	7.3E-03	NA	NA	1.1E-02	1.8E+05	2.6E-02	6.7E-06	2.1E-04	4.6E+09	1.3E-01	--	Yes	2.0E+00	1.0E+00	3.5E+00	3.3E-03	1.6E-02	3.2E+03
53-70-3	Dibenz(a,h)anthracene	Yes	7.3E+00	NA	1.0E+00	7.3E+00	NA	NA	1.2E+00	1.9E+06	4.5E-02	5.2E-06	5.8E-06	4.6E+09	1.3E-01	--	Yes	3.8E+00	6.0E-01	6.1E+00	9.4E-04	1.4E-01	9.6E+03
105-67-9	2,4-Dimethylphenol	No	NA	2.0E-02	1.0E+00	NA	2.0E-02	NA	NA	4.9E+02	6.2E-02	8.3E-06	3.9E-05	4.6E+09	1.0E-01	1.1E-02	No	5.1E-01	1.0E+00	4.6E-02	3.6E-01	5.0E-06	1.5E+01
84-74-2	Di-n-butylphthalate	No	NA	1.0E-01	1.0E+00	NA	1.0E-01	NA	NA	1.2E+03	2.1E-02	5.3E-06	7.4E-05	4.6E+09	1.0E-01	4.2E-02	No	3.8E+00	9.0E-01	2.7E-01	1.9E-02	7.9E-04	1.7E+02
206-44-0	Fluoranthene	No	NA	4.0E-02	1.0E+00	NA	4.0E-02	NA	NA	5.5E+04	2.8E-02	7.2E-06	3.6E-04	4.6E+09	1.3E-01	--	Yes	1.4E+00	1.0E+00	1.7E+00	7.8E-03	3.6E-03	3.6E+03
86-73-7	Fluorene	No	NA	4.0E-02	1.0E+00	NA	4.0E-02	NA	NA	9.2E+03	4.4E-02	7.9E-06	3.9E-03	1.8E+05	1.3E-01	1.1E-01	NA	9.0E-01	NA	5.5E-01	2.9E-02	3.8E-04	5.3E+02
193-39-5	Indeno(1,2,3-cd)pyrene	Yes	7.3E-01	NA	1.0E+00	7.3E-01	NA	NA	1.1E-01	2.0E+06	4.5E-02	5.2E-06	1.4E-05	4.6E+09	1.3E-01	--	Yes	3.7E+00	6.0E-01	7.9E+00	1.0E-03	1.3E-01	1.2E+04
90-12-0	1-Methylnaphthalene	No	2.9E-02	7.0E-02	1.0E+00	2.9E-02	7.0E-02	NA	NA	2.5E+03	5.3E-02	7.8E-06	2.1E-02	3.8E+04	1.3E-01	9.3E-02	NA	6.6E-01	NA	4.3E-01	4.4E-02	1.9E-04	5.3E+01
91-57-6	2-Methylnaphthalene	No	NA	4.0E-03	1.0E+00	NA	4.0E-03	NA	NA	2.5E+03	5.2E-02	7.8E-06	2.1E-02	3.8E+04	1.3E-01	9.2E-02	NA	6.6E-01	NA	4.2E-01	4.4E-02	1.8E-04	7.5E+01
95-48-7	2-Methylphenol	No	NA	5.0E-02	1.0E+00	NA	5.0E-02	6.0E-01	NA	3.1E+02	7.3E-02	9.3E-06	4.9E-05	4.6E+09	1.0E-01	7.7E-03	No	4.2E-01	1.0E+00	3.1E-02	5.7E-01	2.2E-06	1.1E+01
108-39-4	3-Methylphenol	No	NA	5.0E-02	1.0E+00	NA	5.0E-02	6.0E-01	NA	3.0E+02	7.3E-02	9.3E-06	3.5E-05	4.6E+09	1.0E-01	7.8E-03	No	4.2E-01	1.0E+00	3.1E-02	5.6E-01	2.3E-06	9.1E+00
106-44-5	4-Methylphenol	No	NA	1.0E-01	1.0E+00	NA	1.0E-01	6.0E-01	NA	3.0E+02	7.2E-02	9.2E-06	4.1E-05	4.6E+09	1.0E-01	7.5E-03	No	4.2E-01	1.0E+00	3.0E-02	5.8E-01	2.2E-06	8.9E+00
34mp	3&4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
91-20-3	Naphthalene	No	NA	2.0E-02	1.0E+00	NA	2.0E-02	3.0E-03	3.4E-02	1.5E+03	6.0E-02	8.4E-06	1.8E-02	3.1E+04	1.3E-01	4.7E-02	No	5.5E-01	1.0E+00	2.0E-01	9.4E-02	5.0E-05	8.5E+01
85-01-8	Phenanthrene	No	NA	NA	1.0E+00	NA	NA	NA	NA	1.7E+04	3.5E-02	6.7E-06	1.7E-03	4.2E+05	1.3E-01	--	Yes	1.1E+00	1.0E+00	7.0E-01	2.0E-02	7.2E-04	2.5E+03
108-95-2	Phenol	No	NA	3.0E-01	1.0E+00	NA	3.0E-01	2.0E-01	NA	1.9E+02	8.3E-02	1.0E-05	1.4E-05	4.6E+09	1.0E-01	4.3E-03	No	3.5E-01	1.0E+00	1.6E-02	1.1E+00	7.2E-07	1.7E+01
129-00-0	Pyrene	No	NA	3.0E-02	1.0E+00	NA	3.0E-02	NA	NA	5.4E+04	2.8E-02	7.2E-06	4.9E-04	1.5E+06	1.3E-01	2.0E-01	NA	1.4E+00	NA	1.1E+00	1.1E-02	1.9E-03	1.5E+03
Metals																							
7429-90-5	Aluminum [g]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.0E-03	--	--	--
7440-36-0	Antimony	No	NA	4.0E-04	1.5E-01	NA	6.0E-05	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-03	No	5.1E-01	--	4.2E-03	5.0E-02	1.0E-03	1.0E+02
7440-38-2	Arsenic	No	1.5E+00	3.0E-04	1.0E+00	1.5E+00	3.0E-04	1.5E-05	4.3E+00	NA	NA	NA	NA	4.6E+09	3.0E-02	1.0E-03	No	2.8E-01	--	3.3E-03	1.0E-02	2.0E-03	3.0E+02
7440-39-3	Barium	No	NA	2.0E-01	7.0E-02	NA	1.4E-02	5.0E-04	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-03	No	6.2E-01	--	4.5E-03	3.8E-02	1.5E-04	4.0E+00
7440-43-9	Cadmium (food)	No	NA	1.0E-03	2.5E-02	NA	2.5E-05	1.0E-05	1.8E+00	NA	NA	NA	NA	4.6E+09	1.0E-03	1.0E-03	No	4.5E-01	--	4.1E-03	1.3E-01	5.5E-04	2.0E+02
7440-43-9	Cadmium (water)	No	NA	5.0E-04	5.0E-02	NA	2.5E-05	1.0E-05	1.8E+00	--	--	--	--	--	1.0E-03	1.0E-03	No	4.5E-01	--	4.1E-03	1.4E-01	5.5E-04	2.0E+02
7440-47-3	Chromium	No	NA	NA	1.3E-02	NA	NA	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-03	No	2.1E-01	--	2.8E-03	1.9E-03	5.5E-03	2.0E+02
16065-83-1	Chromium (III)	No	NA	1.5E+00	1.3E-02	NA	2.0E-02	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-03	No	2.1E-01	--	2.8E-03	1.9E-03	5.5E-03	NA
18540-29-9	Chromium (VI)	Yes	5.0E-01	3.0E-03	2.5E-02	2.0E+01	7.5E-05	1.0E-04	8.4E+01	NA	NA	NA	NA	4.6E+09	0.0E+00	2.0E-03	No	2.1E-01	--	5.5E-03	1.9E-03	5.5E-03	2.0E+02
7440-50-8	Copper	No	NA	4.0E-02	1.0E+00	NA	4.0E-02	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-03	No	2.4E-01	--	3.1E-03	1.0E-01	1.0E-02	2.0E+02
7439-92-1	Lead	No	NA	NA	1.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-04	NA	1.5E+00	--	5.5E-04	1.1E-02	4.0E-04	3.0E+02
7439-96-5	Manganese [g]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0E-03	--	2.1E-01	--	2.9E-03	--	--	--
7487-94-7	Mercury (inorganic salts)	No	NA	3.0E-04	7.0E-02	NA	2.1E-05	3.0E-04	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-03	No	3.5E+00	--	6.3E-03	2.3E-01	2.5E-01	1.0E+03
7439-97-6	Mercury (elemental)	No	NA	NA	1.0E+00	NA	NA	3.0E-04	NA	NA	3.1E-02	6.3E-06	4.7E-01	--	0.0E+00	1.0E-03	No	1.4E+00	--	5.4E-03	2.3E-01	2.5E-01	NA
7440-02-0	Nickel [h]	No	NA	2.0E-02	4.0E-02	NA	8.0E-04	9.0E-05	2.6E-01	NA	NA	NA	NA	4.6E+09	0.0E+00	2.0E-04	No	2.2E-01	--	5.9E-04	1.5E-02	6.0E-03	1.0E+02
7782-49-2	Selenium	No	NA	5.0E-03	1.0E+00	NA	5.0E-03	2.0E-02	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-03	No	2.9E-01	--	3.4E-03	6.3E-03	1.5E-02	2.0E+02
7440-22-4	Silver	No	NA	5.0E-03	4.0E-02	NA	2.0E-04	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	6.0E-04	No	4.2E-01	--	2.4E-03	1.0E-01	3.0E-03	5.0E+00
7440-62-2	Vanadium	No	NA	5.0E-03	2.6E-02	NA	1.3E-04	1.0E-04	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.0E-03	No	2.0E-01	--	2.7E-03	1.4E-03	2.5E-03	NA
7440-66-6	Zinc	No	NA	3.0E-01	1.0E+00	NA	3.0E-01	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	6.0E-04	No	2.4E-01	--	1.9E-03	2.6E-01	1.0E-01	1.0E+03

Table 4
Human Health Screening and Action Level Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [b]							Chemical Properties											Biota Uptake Factors [e]		
CAS #	Chemical Name		Oral		Dermal			Inhalation		Inhalation Pathway Components [c]					Dermal Pathway Components [d]						Caribou		Fish
		Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	ABS_{GI} (unitless)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	Koc (L/kg)	Di (cm^2/s)	Dw (cm^2/s)	H' (Unitless)	VF / PEF (m^3/kg)	ABSd (Unitless)	Kp (cm/hr)	Outside of EPD?	τ (hr/event)	FA (Unitless)	B (Unitless)	BV (Unitless)	BTF (d/kg)	BCF (L/kg)
Inorganics																							
57-12-5	Cyanide	No	NA	6.0E-04	1.0E+00	NA	6.0E-04	8.0E-04	NA	NA	2.1E-01	2.5E-05	9.9E-01	--	0.0E+00	1.0E-03	No	1.5E-01	NA	2.0E-03	1.1E+01	1.4E-08	NA

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFo: oral slope factor
RfDo: oral reference dose
ABS_{GI}: gastrointestinal absoption factor
SFd: dermal slope factor
RfDd: dermal reference dose
RfCi: inhalation reference concentration
URFi: inhalation unit risk factor
Koc: organic carbon partition coefficient
Di: diffusivity in air
Dw: diffusivity in water
H': Henry's law constant (dimensionless)
VF: volatilization factor
PEF: particulate emission factor
ABSd: dermal absorption factor
Kp: dermal permeability coefficient of compound in water
EPD: effective prediction domain for dermal permeability
τ: lag time per event
FA: fraction absorbed water
B: ratio of the permeability coefficient of a compound through the stratum
corneum relative to its permeability coefficient across the viable epidermis
BV: soil-to-wet-plant uptake factor
BTF: beef transfer coefficient
BCF: fish bioaccumulation factor
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
L/kg: liters per kilogram
cm^2/s: square centimeters per second
m^3/kg: cubic meters per kilogram
cm/hr: centimeters per hour
hr/event: hours per event
d/kg: days per kilogram
NA: not available
--: not applicable

References:

Oak Ridge National Laboratories (ORNL). 2015. Risk Assessment Information System. Online database. http://rais.ornl.gov/

U.S. Environmental Protection Agency (EPA). 1999a. Risk Assessment Issue Paper For: Derivation of a Provisional RfD for 1,2,4-Trimethylbenzene (CASRN 95-63-6) and 1,3,5-Trimethylbenzene (CASRN 108-67-8). Superfund Health Risk Technical Support Center, for internal use only. June 30.

EPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005. July.

EPA. 2007. Recommendations for Human Health Risk-based Chemical Screening and Related Issues at EPA Region 10 CERCLA and RCRA Sites. Memorandum from Michael Cox, Manager, Risk Evaluation Unit, Office of Environmental Assessment. April 17.

EPA. 2015b. Regional Screening Level Tables. June. http://www2.epa.gov/risk/risk-based-screening-table-generic-tables

Footnotes:

[a] Carcinogens with a mutagenic mode of action were identified based on EPA (2015b).

[b] Toxicity values are from EPA (2015b). Gastrointestinal absorption fractions are from EPA (2015b) and ORNL (2015). For dermal toxicity values, SFd = SFo/ABS_{GI}; RfDd = RfDo x ABS_{GI}. Adjustments are based on EPA (2004).
The RfDo value for 1,2,4-trimethylbenzene and the RfCi value for 1,3,5-trimethylbenzene are the recommended values from EPA (1999a), as requested by ADEC.
The URFi for naphthalene is the recommended value from EPA (2007) and is consistent with EPA (2015b).

[c] Chemical properties for the inhalation pathway are from EPA (2015b). Values for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene are not available from EPA (2015b) and are from ORNL (2015). VF/PEF calculated in Table B-1 of Appendix B.

[d] Dermal absorption factors and FA values are from EPA (2004). Dermal permeability coefficients, τ, and B values are from EPA (2015b). Values for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene are not available from EPA (2015b) and are from ORNL (2015) or EPA (2004). Chemicals outside of the effective prediction domain for dermal permeability were identified based on EPA (2004), Exhibits A-1, A-2, and B-2, and were not evaluated for dermal water contact. Kp values are therefore not provided for these chemicals (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, indeno[1,2,3-cd]pyrene, and phenanthrene).

[e] Uptake factors for plants, beef, and fish are from ORNL (2015).

[f] FA value is for m-xylene (only available value for xylenes from EPA, 2004). Fish BCF is for m- and p- xylenes (higher of values for three isomers). Other values are for xylenes.

[g] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes and no additional Tier I SL or Tier II AL values were developed.

[h] Nickel values are for soluble salts.

Table 5
Industrial Worker Screening Level Calculation Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Abbreviation	Definition	Units	Value	Source
TR	Target Lifetime Excess Cancer Risk	--	1.0E-06	EPA, 2015c
THQ	Target Hazard Quotient	--	0.1	EPA, 2015c
BW	Body Weight	kg	80	EPA, 2015c
ATc	Averaging Time, Carcinogen	years	70	EPA, 2015c
ATnc	Averaging Time, Non-carcinogen	years	25	EPA, 2015c
--	Days in One Year	days	365	--
SFd	Slope Factor, Dermal	$(mg/kg\text{-}day)^{-1}$	Chemical-specific	See Table 4
RfDd	Reference Dose, Dermal	mg/kg-day	Chemical-specific	See Table 4
ED	Exposure Duration	years	25	EPA, 2015c
EF	Exposure Frequency	days/year	200	ADEC, 2015
CF	Conversion Factor	kg/mg	0.000001	--
CF_2	Conversion Factor	L/cm^3	0.001	--
CF_3	Conversion Factor	µg/mg	1,000	--
EV	Event Frequency	events/day	1	EPA, 2004
SAw	Skin Surface Area, Water Contact	cm^2	3,527	EPA, 2015c
FA	Fraction Absorbed Water	--	Chemical-specific	See Table 4
Kp	Dermal Permeability Coefficient of Compound in Water	cm/hour	Chemical-specific	See Table 4
τ	Lag Time per Event	hours/event	Chemical-specific	See Table 4
t_{event}	Event Duration	hours/event	1	Best professional judgement
B	Ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis	--	Chemical-specific	See Table 4

Units Abbreviations:
mg: milligram
kg: kilogram
µg: microgram
L: liter
cm: centimeter
cm^2: square centimeter
cm^3: cubic centimeter
--: not applicable

References:

Alaska Department of Environmental Conservation (ADEC). 2015. Risk Assessment Procedures Manual. Division of Spill Prevention and Response, Contaminated Sites Program. October 1.

U.S. Environmental Protection Agency (EPA). 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005. July.

EPA. 2015c. Regional Screening Level User's Guide. June. http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Table 6
Future Resident Subsistence User Screening Level Calculation Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Abbreviation	Definition	Units	Value	Source
General				
TR	Target Lifetime Excess Cancer Risk	--	1.0E-06	EPA, 2015c
THQ	Target Hazard Quotient	--	0.1	EPA, 2015c
BWa	Body Weight, Adult	kg	80	EPA, 2015c
BWc	Body Weight, Child	kg	15	EPA, 2015c
ATc	Averaging Time, Carcinogen	years	70	EPA, 2015c
ATnc	Averaging Time, Non-carcinogen	years	26	EPA, 2015c
ATnc,a	Averaging Time, Non-carcinogen, Adult only	years	20	EPA, 2015c
ATnc,c	Averaging Time, Non-carcinogen, Child only	years	6	EPA, 2015c
--	Days in One Year	days/year	365	--
SFo	Slope Factor, Oral	$(mg/kg\text{-}day)^{-1}$	Chemical-specific	See Table 4
SFd	Slope Factor, Dermal	$(mg/kg\text{-}day)^{-1}$	Chemical-specific	See Table 4
URFi	Inhalation Unit Risk Factor	$(mg/m^3)^{-1}$	Chemical-specific	See Table 4
RfDo	Reference Dose, Oral	mg/kg-day	Chemical-specific	See Table 4
RfDd	Reference Dose, Dermal	mg/kg-day	Chemical-specific	See Table 4
RfCi	Inhalation Reference Concentration	mg/m^3	Chemical-specific	See Table 4
ED	Exposure Duration	years	26	EPA, 2015c
EDa	Exposure Duration, Adult only	years	20	EPA, 2015c
EDc	Exposure Duration, Child only	years	6	EPA, 2015c
$ED_{0\text{-}2}$	Exposure Duration, Ages 0-2 years	years	2	EPA, 2015c
$ED_{2\text{-}6}$	Exposure Duration, Ages 2-6 years	years	4	EPA, 2015c
$ED_{6\text{-}16}$	Exposure Duration, Ages 6-16 years	years	10	EPA, 2015c
$ED_{16\text{-}26}$	Exposure Duration, Ages 16-26 years	years	10	EPA, 2015c
CAFo	TCE Cancer Adjustment Factor, oral	--	0.804	EPA, 2015c
MAFo	TCE Mutagen Adjustment Factor, oral	--	0.202	EPA, 2015c
CAFi	TCE Cancer Adjustment Factor, inhalation	--	0.756	EPA, 2015c
MAFi	TCE Mutagen Adjustment Factor, inhalation	--	0.244	EPA, 2015c
CF	Conversion Factor	kg/mg	0.000001	--
CF_2	Conversion Factor	L/cm^3	0.001	--
CF_3	Conversion Factor	µg/mg	1,000	--
CF_4	Conversion Factor	mg/µg	0.001	--
Soil Specific				
EFs	Exposure Frequency, Soil	days/year	200	ADEC, 2015
EFd	Exposure Frequency, Diet	days/year	365	ADEC, 2015
IRs,a	Ingestion Rate, Soil, Adult	mg/day	100	EPA, 2015c
IRs,c	Ingestion Rate, Soil, Child	mg/day	200	EPA, 2015c
IFSMadj	Mutagenic Soil Ingestion Rate, Age-adjusted	mg-year/kg-day	476.7	Calculated based on EPA, 2015c ((ED0-2*IRs,c*10/BWc) + (ED2-6*IRs,c*3/BWc) + (ED6-16*IRs,a*3/BWa) + (ED16-26*IRs,a*1/BWa))
IFSadj	Age-adjusted Soil Ingestion Rate	mg-year/kg-day	105	Calculated based on EPA, 2015c ((EDc*IRs,c/BWc) + (EDa*IRs,a/BWa))
AFa	Soil Adherence Factor, Adult	mg/cm^2	0.07	EPA, 2015c
AFc	Soil Adherence Factor, Child	mg/cm^2	0.2	EPA, 2015c
SAs,a	Skin Surface Area, Soil Exposure, Adult	cm^2/day	6,032	EPA, 2015c
SAs,c	Skin Surface Area, Soil Exposure, Child	cm^2/day	2,373	EPA, 2015c
ABSd	Dermal Absorption Factor	--	Chemical-specific	See Table 4
DFSMadj	Mutagenic Soil Dermal Contact Factor, Age-adjusted	mg-year/kg-day	1,224	Calculated based on EPA, 2015c ((ED0-2*AFc*SAs,c*10/BWc) + (ED2-6*AFc*SAs,c*3/BWc) + (ED6-16*AFa*SAs,a*3/BWa) + (ED16-26*AFa*SAs,a*1/BWa))
DFSadj	Age-adjusted Soil Dermal Contact Factor	mg-year/kg-day	295	Calculated based on EPA, 2015c ((EDc*AFc*SAs,c/BWc) + (EDa*AFa*SAs,a/BWa))
IRd,a	Ingestion Rate, Diet, Adult	mg/day	250,000	ADF&G, 2002
IRd,c	Ingestion Rate, Diet, Child	mg/day	112,500	ADF&G, 2002 modified for child based on EPA, 2011b
IFDMadj	Mutagenic Dietary Ingestion Rate, Age-adjusted	mg-year/kg-day	365,000	Calculated based on EPA, 2015c ((ED0-2*IRd,c*10/BWc) + (ED2-6*IRd,c*3/BWc) + (ED6-16*IRd,a*3/BWa) + (ED16-26*IRd,a*1/BWa))
IFDadj	Age-adjusted Dietary Ingestion Rate	mg-year/kg-day	107,500	Calculated based on EPA, 2015c ((EDc*IRd,c/BWc) + (EDa*IRd,a/BWa))
BTF	Beef Transfer Coefficient	day/kg	Chemical-specific	See Table 4
CRp	Plant Ingestion Rate by Caribou	kg/day (wet weight)	20	Holleman et al., 1979
BV	Soil-to-Plant Uptake	unitless	Chemical-specific	See Table 4
VF	Volatilization Factor from Soil	m^3/kg	Chemical-specific	See Table 4
PEF	Particulate Emission Factor from Soil	m^3/kg	4.63E+09	EPA, 1991
Surface Water Specific				
EFw	Exposure Frequency, Water	days/year	350	ADEC, 2015
EFf	Exposure Frequency, Fish	days/year	365	ADEC, 2015
IRw,a	Ingestion Rate, Water, Adult	L/day	2.5	EPA, 2015c
IRw,c	Ingestion Rate, Water, Child	L/day	0.78	EPA, 2015c
IFWMadj	Mutagenic Water Ingestion Rate, Age-adjusted	L-year/kg-day	2.91	Calculated based on EPA, 2015c ((ED0-2*IRw,c*10/BWc) + (ED2-6*IRw,c*3/BWc) + (ED6-16*IRw,a*3/BWa) + (ED16-26*IRw,a*1/BWa))
IFWadj	Age-adjusted Water Ingestion Rate	L-year/kg-day	0.937	Calculated based on EPA, 2015c ((EDc*IRw,c/BWc) + (EDa*IRw,a/BWa))
IRf,a	Ingestion Rate, Fish, Adult	kg/day	0.265	ADF&G, 2002
IRf,c	Ingestion Rate, Fish, Child	kg/day	0.109	ADF&G, 2002 modified for child based on EPA, 2011b
IFFMadj	Mutagenic Fish Ingestion Rate, Age-adjusted	year/day	0.365	Calculated based on EPA, 2015c ((ED0-2*IRf,c*10/BWc) + (ED2-6*IRf,c*3/BWc) + (ED6-16*IRf,a*3/BWa) + (ED16-26*IRf,a*1/BWa))
IFFadj	Age-adjusted Fish Ingestion Rate	year/day	0.110	Calculated based on EPA, 2015c ((EDc*IRf,c/BWc) + (EDa*IRf,a/BWa))
BCF	Fish Bioaccumulation Factor	L/kg	Chemical-specific	See Table 4
K	Volatilization Factor from Water	L/m^3	0.5	EPA, 2015c
EV	Event Frequency	events/day	1	EPA, 2004
FA	Fraction Absorbed Water	--	Chemical-specific	See Table 4
Kp	Dermal Permeability Coefficient of Compound in Water	cm/hour	Chemical-specific	See Table 4
τ	Lag Time per Event	hours/event	Chemical-specific	See Table 4
$t_{event, c}$	Event Duration, Child	hours/event	0.54	EPA, 2015c
$t_{event, a}$	Event Duration, Adult	hours/event	0.71	EPA, 2015c
$t_{event, adj}$	Age-Adjusted Event Duration	hours/event	0.6708	Calculated based on EPA, 2015c $(((EDc*t_{event, c}) + (EDa*t_{event,a})) / ED)$
$t_{event, madj}$	Mutagenic Event Duration, Age-adjusted	hours/event	0.6708	Calculated based on EPA, 2015c $(((ED0\text{-}2*t_{event, c}) + (ED2\text{-}6*t_{event, c}) + (ED6\text{-}16*t_{event, a}) + (ED16\text{-}26*t_{event,a}))$ $/ (ED0\text{-}2 + ED2\text{-}6 + ED6\text{-}16 + ED16\text{-}26))$
SAw,a	Skin Surface Area, Showering, Adult	cm^2	20,900	EPA, 2015c
SAw,c	Skin Surface Area, Showering, Child	cm^2	6,378	EPA, 2015c
DFWMadj	Mutagenic Dermal Water Contact Factor, Age-adjusted	cm^2-years/kg	24,056	Calculated based on EPA, 2015c ((ED0-2*SAw,c*10/BWc) + (ED2-6*SAw,c*3/BWc) + (ED6-16*SAw,a*3/BWa) + (ED16-26*SAw,a*1/BWa))
DFWadj	Age-adjusted Dermal Water Contact Factor	cm^2-years/kg	7,776	Calculated based on EPA, 2015c ((EDc*SAw,c/BWc) + (EDa*SAw,a/BWa))

Units Abbreviations:
mg: milligram
kg: kilogram
µg: microgram
L: liter
cm: centimeter
cm^2: square centimeter
cm^3: cubic centimeter
m^3: cubic meter
--: not applicable
TCE: trichloroethene

References:

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Table 7
Subsistence Dietary Intake for Nuiqsut Community
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Resources	1985		1993		Both Years	
	Lbs. per Capita	% Contribution of Major Food Group to Total Subsistence Diet	Lbs. per Capita	% Contribution of Major Food Group to Total Subsistence Diet	Average Lbs per Capita	Average % Contribution of Major Food Group to Total Subsistence Diet
Total for all Food Groups	**399**		**741**		**570**	
Total for All Fish	**176**	**44**	**250**	**34**	**213**	**37**
Unspecified Fish (Rod and Reel)	0	0	3	0.4	1.5	0.3
Salmon	3	0.8	2	0.3	2.5	0.4
Burbot	6	2	16	2	11	2
Char	7	2	4	0.5	5.5	1
Grayling	9	2	11	1	10	2
Whitefish	148	37	215	29	182	32
Total for Land Mammals	**169**	**42**	**242**	**33**	**206**	**36**
Brown Bear	2	0.5	2	0.3	2	0
Caribou	149	37	227	31	188	33
Moose	16	4	12	2	14	2
Squirrel	0.61	0.2	0.23	0.03	0.4	0.07
Total for Marine Mammals	**33**	**8**	**236**	**32**	**135**	**24**
Seal	11	3	23	3	17	3
Walrus	3	0.8	0	0	1.5	0.3
Whale	18	5	213	29	116	20
Total for Bird and Eggs	**20**	**5**	**11**	**1**	**16**	**3**
Ducks	1	0.3	3	0.4	2	0.4
Geese	15	4	6	0.8	11	2
Ptarmigan	3	0.8	1	0.1	2	0.4
Bird Eggs	0.1	0.03	0.03	0.004	0.07	0.01
Total for Vegetation	**0.42**	**0.1**	**1**	**0.1**	**0.7**	**0.1**
Berries	0.41	0.1	0.93	0.1	0.7	0.1
Plants/Greens/Mushrooms	0.01	0.003	0.2	0.03	0.1	0.02

Highlighted values represent sources used for estimating subsistence use food ingestion rates.

Abbreviations:
Lbs.: pounds
%: percent

References:
Community Subsistence Information System: CSIS. Public Review Draft. State of Alaska. On line: http: www.subsistence.adfg.ak.us/sub/public/CSIS

Table 8
Tier I Screening Level Summary Table
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Tier I Screening Levels			
		Soil (mg/kg)		Water (µg/L)	
CAS #	**Chemical Name**	**Human Health**	**Ecological**	**Human Health**	**Ecological**
Volatiles					
67-64-1	Acetone	5.6E+03	**4.0E-02**	**1.0E+03**	1.5E+03
107-02-8	Acrolein	1.4E-02	**1.0E-04**	**4.1E-03**	3.0E+00
71-43-2	Benzene	1.2E+00	**1.2E-01**	**3.9E-01**	2.1E+01
78-93-3	2-Butanone	2.7E+03	**1.0E+00**	**4.6E+02**	1.4E+04
56-23-5	Carbon tetrachloride	4.3E-01	**5.0E-02**	**3.3E-01**	9.8E+00
108-90-7	Chlorobenzene	2.8E+01	**2.4E+00**	5.2E+00	**1.3E+00**
75-00-3	Chloroethane	**3.4E+00**	NA	**2.9E+01**	NA
67-66-3	Chloroform	3.2E-01	**5.0E-02**	**1.9E-01**	1.8E+00
106-93-4	1,2-Dibromoethane	**3.6E-02**	NA	**5.0E-03**	NA
95-50-1	1,2-Dichlorobenzene	1.8E+02	**9.0E-02**	4.0E+00	**7.0E-01**
75-34-3	1,1-Dichloroethane	3.6E+00	**1.4E-01**	**2.3E+00**	4.7E+01
107-06-2	1,2-Dichloroethane	4.6E-01	**4.0E-01**	**1.5E-01**	1.0E+02
75-35-4	1,1-Dichloroethene	1.2E-01	**4.0E-02**	**7.0E-01**	2.5E+01
156-59-2	cis-1,2-Dichloroethene	1.6E+01	**4.0E-02**	**1.5E+00**	6.2E+02
156-60-5	trans-1,2-Dichloroethene	2.2E+01	**4.0E-02**	**1.0E+01**	5.6E+02
60-29-7	Diethyl ether	**1.6E+03**	NA	**2.2E+02**	NA
123-91-1	1,4-Dioxane	**5.3E+00**	6.3E+01	**4.4E-01**	4.0E+03
100-41-4	Ethylbenzene	5.8E+00	**2.7E-01**	**6.1E-01**	7.3E+00
50-00-0	Formaldehyde	**1.7E+01**	3.9E+03	**4.3E-01**	7.4E+01
67-56-1	Methanol	1.2E+04	**6.3E+03**	1.7E+03	**3.3E+02**
75-09-2	Methylene chloride	2.1E+01	**2.1E-01**	**5.0E-01**	9.8E+01
108-10-1	4-Methyl-2-pentanone	**5.3E+02**	NA	**9.0E+01**	1.7E+02
103-65-1	n-Propylbenzene	**3.3E+01**	NA	**3.7E+01**	1.3E+02
127-18-4	Tetrachloroethene	8.8E-01	**6.0E-02**	**5.0E-01**	5.3E+01
108-88-3	Toluene	4.9E+02	**1.5E-01**	5.7E+01	**2.0E+00**
71-55-6	1,1,1-Trichloroethane	5.7E+02	**4.0E-02**	2.0E+01	**1.1E+01**
79-01-6	Trichloroethene	8.2E-02	**6.0E-02**	**1.7E-01**	2.1E+01
95-63-6	1,2,4-Trimethylbenzene	7.3E+00	**9.0E-02**	1.8E+02	**1.5E+01**
108-67-8	1,3,5-Trimethylbenzene	6.3E+00	**1.6E-01**	1.8E+02	**2.6E+01**
75-01-4	Vinyl chloride	5.9E-02	**3.0E-02**	**1.1E-02**	9.3E+02
1330-20-7	Xylenes	6.5E+01	**1.0E-01**	1.7E+01	**1.3E+01**
Semi-Volatiles					
83-32-9	Acenaphthene	3.6E+02	**2.5E-01**	**1.1E+00**	5.8E+00
208-96-8	Acenaphthylene	3.8E+02	**1.2E+02**	2.2E+02	**1.3E+01**
120-12-7	Anthracene	1.8E+03	**6.8E+00**	2.3E+00	**1.2E-02**
56-55-3	Benzo(a)anthracene	**1.3E-01**	1.0E+00	**9.3E-04**	1.8E-02
50-32-8	Benzo(a)pyrene	**1.1E-02**	5.3E+01	**5.1E-06**	1.4E-02
205-99-2	Benzo(b)fluoranthene	**1.3E-01**	1.8E+01	**8.7E-05**	2.6E+00
191-24-2	Benzo(g,h,i)perylene	1.9E+02	**2.4E+01**	1.1E+02	**4.4E-01**
207-08-9	Benzo(k)fluoranthene	**1.1E+00**	6.2E+01	**5.3E-04**	6.4E-01
218-01-9	Chrysene	1.3E+01	**2.4E+00**	**8.3E-03**	4.7E+00
53-70-3	Dibenz(a,h)anthracene	**7.3E-03**	1.2E+01	**2.7E-06**	2.8E-01
105-67-9	2,4-Dimethylphenol	1.3E+02	**4.0E-02**	**1.2E+01**	1.5E+01
84-74-2	Di-n-butylphthalate	6.3E+02	**1.1E-02**	**7.5E+00**	1.9E+01
206-44-0	Fluoranthene	2.4E+02	**1.0E+01**	1.5E-01	**4.0E-02**
86-73-7	Fluorene	2.4E+02	**3.7E+00**	**1.0E+00**	3.0E+00
193-39-5	Indeno(1,2,3-cd)pyrene	**7.6E-02**	6.2E+01	**2.1E-05**	2.8E-01
90-12-0	1-Methylnaphthalene	**2.8E+01**	NA	1.5E+01	**2.1E+00**
91-57-6	2-Methylnaphthalene	2.4E+01	**1.6E+01**	**6.7E-01**	4.7E+00
95-48-7	2-Methylphenol	3.2E+02	**1.0E-01**	3.8E+01	**1.3E+01**
108-39-4	3-Methylphenol	3.2E+02	**9.0E-02**	**4.2E+01**	6.2E+01
106-44-5	4-Methylphenol	4.8E+01	**8.0E-02**	**1.8E+01**	5.3E+01
34mp	3&4-Methylphenol [a]	4.8E+01	**8.0E-02**	**1.8E+01**	5.3E+01
91-20-3	Naphthalene	3.8E+00	**1.0E+00**	**1.7E-01**	1.1E+00
85-01-8	Phenanthrene	2.8E+03	**5.5E+00**	1.1E+03	**4.0E-01**
108-95-2	Phenol	1.9E+03	**7.9E-01**	1.7E+02	**4.0E+00**
129-00-0	Pyrene	1.8E+02	**1.0E+01**	2.7E-01	**2.5E-02**
Metals					
7429-90-5	Aluminum [b]	--	--	5.0E+03	**7.5E+01**
7440-36-0	Antimony	2.7E+00	**2.7E-01**	**5.1E-02**	3.0E+01
7440-38-2	Arsenic	**4.4E-01**	1.0E+01	**1.4E-03**	5.0E+00
7440-39-3	Barium	1.5E+03	**8.5E+01**	2.0E+02	**4.0E+00**
7440-43-9	Cadmium	5.5E+00	**3.6E-01**	6.4E-02	**1.3E-02**
7440-47-3	Chromium	4.1E+01	**4.0E-01**	**1.0E+01**	8.5E+01
16065-83-1	Chromium (III)	2.1E+04	**4.0E+00**	5.5E+03	**9.0E+01**
18540-29-9	Chromium (VI)	4.1E+01	**3.5E-01**	**1.0E+01**	1.1E+01
7440-50-8	Copper	**2.5E+01**	2.8E+01	2.7E+00	**2.1E-01**
7439-92-1	Lead	4.0E+02	**1.1E+01**	1.5E+01	**3.5E-01**
7439-96-5	Manganese [b]	--	--	**5.0E+01**	9.3E+01
7439-97-6	Mercury	**3.6E-03**	1.3E-02	**3.8E-03**	2.6E-02
7440-02-0	Nickel	9.6E+01	**3.0E+01**	**2.6E+00**	5.0E+00
7782-49-2	Selenium	2.3E+01	**5.2E-01**	**3.3E-01**	1.0E+00
7440-22-4	Silver	9.6E+00	**2.0E+00**	5.6E+00	**6.0E-02**
7440-62-2	Vanadium	3.9E+01	**2.0E+00**	**8.6E+00**	2.0E+01
7440-66-6	Zinc	**7.6E+00**	4.6E+01	**4.1E+00**	2.1E+01
Inorganics					
57-12-5	Cyanide	2.7E-01	**1.0E-01**	**1.5E-01**	1.2E+00

Bold values indicate Tier I screening value drivers.

Abbreviations:
CAS #: Chemical Abstract Service registry number
mg/kg: milligrams per kilogram
µg/L: micrograms per liter
NA: not available
--: not applicable

Footnotes:

[a] Screening levels for the more toxic of the coeluting compounds used to represent this mixture.

[b] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil. For water, only Alaska Water Quality Criteria are relevant for these two target analytes.

Table 9
Selection of and Rationale for Indicator Species
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Guild	Indicator Species	Basis
Primary Producer (Terrestrial Plants)	None	Basis of terrestrial food web; addressed at community level
Primary Producer (Aquatic Plants)	None	Basis of aquatic food web; addressed at community level
Zooplankton	None	Primary food source; addressed at community level
Benthic Invertebrates	None	Primary food source; addressed at community level
Fish	None	Year-round resident in deeper ponds that do not freeze only; addressed at community level
Terrestrial Herbivorous Mammals	Brown lemming	Year-round resident; eats grasses
Terrestrial Omnivorous Mammals	Arctic/tundra shrew	Smallest mammal at site; highest metabolic rate; eats plants and insects
Terrestrial Carnivorous Mammals	Least weasel	Smallest resident carnivore; eats lemmings
Herbivorous Terrestrial Birds	Willow ptarmigan	Small terrestrial year-round resident herbivorous bird
Insectivorous Terrestrial Birds	Lapland longspur	Small, common terrestrial insectivorous bird that nests on the slope
Herbivorous Aquatic Birds	Snow goose	Herbivorous; nests and feeds in terrestrial and aquatic areas. Migratory (no resident waterfowl)
Carnivorous Terrestrial Birds	Snowy owl	Carnivorous; nests and feeds on the slope, sometimes overwinters on the slope
Carnivorous Aquatic Birds	Arctic loon	Diving predator; nests in ponds (no resident aquatic birds)

Table 10

Threatened and Endangered Species Identified on the North Slope

Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels

Prudhoe Bay Facility, Alaska

BP Exploration (Alaska) Inc.

Taxonomic Group	Scientific Name	Common Name	Status
Mammals	*Ursus maritimus*	polar bear	Federally Endangered
Mammals	*Balaena mysticetus*	bowhead whale	Federally Endangered
Birds	*Somateria fischeri*	spectacled eider	Federally Threatened
Birds	*Polysticta stelleri*	Steller's eider	Federally Threatened

Source:
http://www.adfg.state.ak.us/special/esa/esa_home.php#statelist

Table 11
Wildlife Exposure Factors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Indicator Species	Diet	Water Content of Diet [a] WC (percent)	Wet Food Ingestion Rate [b] FIR_{ww} (kg/kg-d) ww	Dry Food Ingestion Rate [b,c] FIR_{dw} (kg/kg-d) dw	Area Use Factor AUF (unitless)	Seasonal Use Factor [b] SUF (unitless)	Proportion Soil in Diet [b] P_s (unitless)	Water Ingestion Rate [b] WIR (L/kg-d)
Mammals								
Brown lemming	Plants	85	--	0.32	1	1	0.024	--
Tundra shrew	Invertebrates (earthworms)	84	0.62	0.099	1	1	0.026	--
Least weasel	Small mammals	68	0.36	0.12	1	1	0.028	--
Birds								
Willow ptarmigan	Plants	85	--	0.14	1	1	0.093	--
Snow goose	Plants	85	0.30	0.045	1	1	0.082	--
Lapland longspur	Invertebrates (earthworms)	84	--	0.24	1	0.25	0.16	--
Snowy owl	Small mammals	68	0.14	0.045	1	1	0.057	--
Arctic loon	Fish	--	0.23	--	1	1	0	0.037

Abbreviations:
kg: kilograms
L: liters
d: day
ww: wet weight
dw: dry weight
--: not applicable

Footnotes:

[a] Diet water content from EPA (2005).

[b] From Tables 15 through 22.

[c] $FIR_{dw} = FIR_{ww} * (1 - (WC/100))$.

Reference:

U.S. Environmental Protection Agency (EPA). 2005. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response. November 2003. Revised February 2005. http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

Table 12
Bioaccumulation Factors for Tier II AL Development
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Biota Uptake Factors			
		Terrestrial			Aquatic
CAS #	**Chemical Name**	**Soil to Plants[a] (dry weight)**	**Soil to Invertebrate[b] (dry weight)**	**Soil to Mammal[c] (dry weight)**	**Water to Fish[d] (wet weight)**
Volatiles					
67-64-1	Acetone	$C_p = C_s * 53$	$C_i = C_s * 0.2995$	$C_m = 0$	$C_f = C_w * 3.16$
107-02-8	Acrolein	$C_p = C_s * 39$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 3.16$
71-43-2	Benzene	$C_p = C_s * 2.24$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 4.27$
78-93-3	2-Butanone	$C_p = C_s * 26.1$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 3.16$
56-23-5	Carbon tetrachloride	$C_p = C_s * 0.879$	$C_i = C_s * 71.88$	$C_m = 0$	$C_f = C_w * 7.4$
108-90-7	Chlorobenzene	$C_p = C_s * 0.867$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 17.8$
75-00-3	Chloroethane	$C_p = C_s * 5.7$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 4.08$
67-66-3	Chloroform	$C_p = C_s * 2.77$	$C_i = C_s * 16.8918$	$C_m = 0$	$C_f = C_w * 13$
106-93-4	1,2-Dibromoethane	$C_p = C_s * 2.81$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 15$
95-50-1	1,2-Dichlorobenzene	$C_p = C_s * 0.395$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 270$
75-34-3	1,1-Dichloroethane	$C_p = C_s * 3.53$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 7.05$
107-06-2	1,2-Dichloroethane	$C_p = C_s * 5.33$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 4.4$
75-35-4	1,1-Dichloroethene	$C_p = C_s * 2.24$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 13$
156-59-2	cis-1,2-Dichloroethene	$C_p = C_s * 3.21$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 11.1$
156-60-5	trans-1,2-Dichloroethene	$C_p = C_s * 2.36$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 11.1$
60-29-7	Diethyl ether	$C_p = C_s * 11.7$	$C_i = 0$	$C_m = 0$	Cf = Cw * 5.4
123-91-1	1,4-Dioxane	$C_p = C_s * 55.2$	$C_i = C_s * 0.24$	$C_m = 0$	$C_f = C_w * 0.50$
100-41-4	Ethylbenzene	$C_p = C_s * 0.573$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 55.6$
50-00-0	Formaldehyde	$C_p = C_s * 24.1$	$C_i = C_s * 0.84$	$C_m = 0$	$C_f = C_w * 3.16$
67-56-1	Methanol	$C_p = C_s * 108$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 3.16$
75-09-2	Methylene chloride	$C_p = C_s * 7.25$	$C_i = C_s * 0.2995$	$C_m = 0$	$C_f = C_w * 23.1$
108-10-1	4-Methyl-2-pentanone	$C_p = C_s * 6.69$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 3.4$
103-65-1	n-Propylbenzene	$C_p = C_s * 0.279$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 126$
127-18-4	Tetrachloroethene	$C_p = C_s * 0.411$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 52$
108-88-3	Toluene	$C_p = C_s * 1$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 8.32$
71-55-6	1,1,1-Trichloroethane	$C_p = C_s * 1.38$	$C_i = 0$	$C_m = 0$	Cf = Cw * 5
79-01-6	Trichloroethene	$C_p = C_s * 1.52$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 16$
95-63-6	1,2,4-Trimethylbenzene	$C_p = C_s * 0.302$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 120$
108-67-8	1,3,5-Trimethylbenzene	$C_p = C_s * 0.40$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 186$
75-01-4	Vinyl chloride	$C_p = C_s * 4.42$	$C_i = C_s * 3.7$	$C_m = 0$	$C_f = C_w * 5.47$
1330-20-7	Xylenes	$C_p = C_s * 0.566$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 14.8$
Semivolatiles					
83-32-9	Acenaphthene	$\ln(C_p)= -0.8556 * \ln(C_s) - 5.562$	$C_i = C_s * 1.47$	$C_m = 0$	$C_f = C_w * 755$
208-96-8	Acenaphthylene	$\ln(C_p)= 0.791 * \ln(C_s) - 1.144$	$C_i = C_s * 22.9$	$C_m = 0$	$C_f = C_w * 271$
120-12-7	Anthracene	$\ln(C_p)= 0.7784 * \ln(C_s) - 0.9887$	$C_i = C_s * 2.42$	$C_m = 0$	$C_f = C_w * 1800$
56-55-3	Benzo(a)anthracene	$\ln(C_p)= 0.5944 * \ln(C_s) - 2.7078$	$C_i = C_s * 1.59$	$C_m = 0$	$C_f = C_w * 260$
50-32-8	Benzo(a)pyrene	$\ln(C_p)= 0.975 * \ln(C_s) - 2.0615$	$C_i = C_s * 1.33$	$C_m = 0$	$C_f = C_w * 5150$
205-99-2	Benzo(b)fluoranthene	$C_p = C_s * 0.310$	$C_i = C_s * 2.6$	$C_m = 0$	$C_f = C_w * 3020$
191-24-2	Benzo(g,h,i)perylene	$\ln(C_p)= 1.1829 * \ln(C_s) - 0.9313$	$C_i = C_s * 2.94$	$C_m = 0$	$C_f = C_w * 11000$
207-08-9	Benzo(k)fluoranthene	$\ln(C_p)= 0.8595 * \ln(C_s) - 2.1579$	$C_i = C_s * 2.6$	$C_m = 0$	$C_f = C_w * 4990$
218-01-9	Chrysene	$\ln(C_p)= 0.5944 * \ln(C_s) - 2.7078$	$C_i = C_s * 2.29$	$C_m = 0$	$C_f = C_w * 3170$
53-70-3	Dibenz(a,h)anthracene	$C_p = C_s * 0.13$	$C_i = C_s * 2.31$	$C_m = 0$	$C_f = C_w * 9600$
105-67-9	2,4-Dimethylphenol	$C_p = C_s * 1.78$	NA	$C_m = 0$	$C_f = C_w * 15.3$
84-74-2	Di-n-butylphthalate	$C_p = C_s * 0.0945$	$C_i = C_s * 1.6$	$C_m = 0$	$C_f = C_w * 167$
206-44-0	Fluoranthene	$C_p = C_s * 0.50$	$C_i = C_s * 3.04$	$C_m = 0$	$C_f = C_w * 3630$
86-73-7	Fluorene	$\ln(C_p)= -0.8556 * \ln(C_s) - 5.562$	$C_i = C_s * 9.57$	$C_m = 0$	$C_f = C_w * 525$
193-39-5	Indeno(1,2,3-cd)pyrene	$C_p = C_s * 0.11$	$C_i = C_s * 2.986$	$C_m = 0$	$C_f = C_w * 12200$
90-12-0	1-Methylnaphthalene	$C_p = C_s * 0.219$	NA	$C_m = 0$	$C_f = C_w * 53.3$
91-57-6	2-Methylnaphthalene	$C_p = C_s * 0.222$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 74.7$
95-48-7	2-Methylphenol	$C_p = C_s * 2.85$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 10.7$
108-39-4	3-Methylphenol	$C_p = C_s * 2.81$	$C_i = C_s * 0.2995$	$C_m = 0$	$C_f = C_w * 9.12$
106-44-5	4-Methylphenol	$C_p = C_s * 2.89$	$C_i = 0$	$C_m = 0$	$C_f = C_w * 8.85$
34mp	3&4-Methylphenol	--	--	--	--
91-20-3	Naphthalene	$C_p = C_s * 12.2$	$C_i = C_s * 4.40$	$C_m = 0$	$C_f = C_w * 84.5$
85-01-8	Phenanthrene	$\ln(C_p)= 0.6203 * \ln(C_s) - 0.1665$	$C_i = C_s * 1.72$	$C_m = 0$	$C_f = C_w * 2510$
108-95-2	Phenol	$C_p = C_s * 5.48$	$C_i = C_s * 0.2995$	$C_m = 0$	$C_f = C_w * 17.4$
129-00-0	Pyrene	$C_p = C_s * 0.72$	$C_i = C_s * 1.75$	$C_m = 0$	$C_f = C_w * 1510$

Table 12
Bioaccumulation Factors for Tier II AL Development
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Biota Uptake Factors			
		Terrestrial			Aquatic
CAS #	Chemical Name	Soil to Plants[a] (dry weight)	Soil to Invertebrate[b] (dry weight)	Soil to Mammal[c] (dry weight)	Water to Fish[d] (wet weight)
Metals					
7429-90-5	Aluminum [e]	--	--	--	--
7440-36-0	Antimony	$\ln(C_p) = 0.938 * \ln(C_s) - 3.233$	$C_i = C_s * 1.0$	$C_m = 0.0001 * 50 * Ci$	$C_f = C_w * 100$
7440-38-2	Arsenic	$C_p = C_s * 0.03752$	$\ln(C_i) = 0.706 * \ln(C_s) - 1.421$	$\ln(C_m) = 0.8188 * \ln(C_s) - 4.8471$	$C_f = C_w * 300$
7440-39-3	Barium	$C_p = C_s * 0.156$	$C_i = C_s * 0.091$	$C_m = 0.00015 * 50 * Ci$	$C_f = C_w * 4$
7440-43-9	Cadmium	$\ln(C_p) = 0.546 * \ln(C_s) - 0.475$	$\ln(C_i) = 0.795 * \ln(C_s) + 2.114$	$\ln(C_m) = 0.4723 * \ln(C_s) - 1.2571$	$C_f = C_w * 200$
7440-47-3	Chromium	$C_p = C_s * 0.041$	$C_i = C_s * 0.306$	$\ln(C_m) = 0.7338 * \ln(C_s) - 1.4599$	$C_f = C_w * 200$
16065-83-1	Chromium (III)	$C_p = C_s * 0.041$	$C_i = C_s * 0.306$	$\ln(C_m) = 0.7338 * \ln(C_s) - 1.4599$	NA
18540-29-9	Chromium (VI)	$C_p = C_s * 0.041$	$C_i = C_s * 0.306$	$\ln(C_m) = 0.7338 * \ln(C_s) - 1.4599$	$C_f = C_w * 200$
7440-50-8	Copper	$\ln(C_p) = 0.394 * \ln(C_s) + 0.668$	$C_i = C_s * 0.515$	$\ln(C_m) = 1.444 * \ln(C_s) + 2.042$	$C_f = C_w * 200$
7439-92-1	Lead	$\ln(C_p) = 0.561 * \ln(C_s) - 1.328$	$\ln(C_i) = 0.807 * \ln(C_s) - 0.218$	$\ln(C_m) = 0.4422 * \ln(C_s) + 0.0761$	$C_f = C_w * 300$
7439-96-5	Manganese [e]	--	--	--	--
7439-97-6	Mercury	$C_p = C_s * 0.03752$	$C_i = C_s * 3.1$	$C_m = C_s * 0.00024$	$C_f = C_w * 1000$
7440-02-0	Nickel	$\ln(C_p) = 0.748 * \ln(C_s) - 2.223$	$C_i = C_s * 0.12$	$\ln(C_m) = 0.4658 * \ln(C_s) - 0.2462$	$C_f = C_w * 100$
7782-49-2	Selenium	$\ln(C_p) = 1.104 * \ln(C_s) - 0.677$	$\ln(C_i) = 0.733 * \ln(C_s) - 0.075$	$\ln(C_m) = 0.3764 * \ln(C_s) - 0.4158$	$C_f = C_w * 200$
7440-22-4	Silver	$C_p = C_s * 0.014$	$C_i = C_s * 2.045$	$C_m = C_s * 0.004$	$C_f = C_w * 5$
7440-62-2	Vanadium	$C_p = C_s * 0.00485$	$C_i = C_s * 0.042$	$C_m = C_s * 0.0123$	--
7440-66-6	Zinc	$\ln(C_p) = 0.554 * \ln(C_s) + 1.575$	$\ln(C_i) = 0.328 * \ln(C_s) + 4.449$	$\ln(C_m) = 0.0706 * \ln(C_s) + 4.3632$	$C_f = C_w * 1000$
Inorganics					
57-12-5	Cyanide	$C_p = C_s * 53.8$	$C_i = C_s * 6.7088$	NA	--

Abbreviations:
AL: action level
VOC: volatile organic compound
SVOC: semi-volatile organic compound
Cs: concentration in soil (mg/kg)
Cp: concentration in above-ground plant parts (mg/kg)
Ci: concentration in invertebrate (i.e., earthworm) tissues (mg/kg)
Cm: concentration in small mammal tissues (mg/kg)
Cf: concentration in fish (mg/kg)
Cw: concentration in water (mg/L)
mg/kg: milligrams per kilogram
mg/L: milligrams per liter
NA: not available
--: not applicable

Footnotes:

[a] Soil to plant uptake factors for VOCs, 2,4-dimethylphenol, di-n-butylphthalate, 1-methylnaphthalene, 2-methylnaphthalene, 2-, 3-, and 4-methylphenol, phenol, and cyanide are from ORNL (2015). Values for metals are from EPA (2005), Attachment 4-1, except for mercury which is the value for mercuric chloride from EPA (1999b). Values for SVOCs not listed above are from EPA (2005), Attachment 4-1.

[b] Soil to earthworm uptake factors for SVOCs and metals from EPA (2005), Attachment 4-1, were used for invertebrates. Values for nickel and cyanide are from EPA, 1999b (Appendix C); value for mercury represents high end of range of values from Burton et al. (2006). Value for di-n-butylphthalate is the upper end of the range of values for agricultural and forest soil from Hu et al. (2005). Values for methylene chloride, 3-methylphenol and phenol from DOE (1999). Uptake of VOCs into invertebrates is considered insignificant. EPA (2005) does not have uptake factors for VOCs, and these VOCs are not considered bioaccumulative chemicals in ADEC guidance (ADEC, 2010). Values used for VOCs (other than methylene chloride) represent those available from EPA, 1999b (Appendix C). Values from EPA (1999b), DOE (1999), and Hu et al. (2005) were converted from a wet weight to dry weight basis using a conversion factor of 5.99, as described in EPA, 1999b (Appendix C).

[c] Soil to mammal uptake factors for metals are from EPA (2005), Attachment 4-1, except for mercury which is the mercuric chloride value from EPA, 1999b (Appendix D). Uptake of SVOCs into mammal tissues is considered insignificant by EPA (2005). As with invertebrates, uptake of VOCs into mammal tissues is also considered insignificant. The mercury value from EPA, 1999b (Appendix D) was converted from a wet weight to dry weight basis by dividing by 0.30, based on the 70 percent moisture content assumed for cows as described in EPA, 1999b (Appendix D).

[d] Fish BCFs from ORNL (2015). Value for xylenes is for m- and p- xylenes (higher of values for three isomers). Mercury value is for mercuric chloride.

[e] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes and no Tier II AL values were developed.

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Table 13
Mammal TRVs
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Lemming TRV	Shrew TRV	Weasel TRV	TRV Endpoint	TRV Source [a]
CAS #	**Chemical Name**	**(mg/kg-d)**	**(mg/kg-d)**	**(mg/kg-d)**		
Volatiles						
67-64-1	Acetone	105	53	53	Reproduction	Appendix C
107-02-8	Acrolein	1.4	0.70	0.70	Mortality	Appendix C
71-43-2	Benzene	0.50	0.25	0.25	Organ histopathology and growth	Appendix C
78-93-3	2-Butanone	120	60	60	Reproduction	Appendix C
56-23-5	Carbon tetrachloride	5.0	2.5	2.5	Growth	Appendix C
108-90-7	Chlorobenzene	53	26	26	Embryotoxicity, teratogenic potential, mortality	Appendix C
75-00-3	Chloroethane	NA	NA	NA	--	--
67-66-3	Chloroform	37	19	19	Reproduction	Appendix C
106-93-4	1,2-Dibromoethane	14	7.0	7.0	Growth, reproduction	Appendix C
95-50-1	1,2-Dichlorobenzene	6.0	3.0	3.0	Hematological histological morphology	Appendix C
75-34-3	1,1-Dichloroethane	NA	NA	NA	--	--
107-06-2	1,2-Dichloroethane	25	13	13	Growth, reproduction	Appendix C
75-35-4	1,1-Dichloroethene	7.4	3.7	3.7	Growth, reproduction, development, mortality	Appendix C
156-59-2	cis-1,2-Dichloroethene	45	45	45	Body and organ weight, blood chemistry, hepatic function	Sample benchmark
156-60-5	trans-1,2-Dichloroethene	45	45	45	Body and organ weight, blood chemistry, hepatic function	Sample benchmark
60-29-7	Diethyl ether	3,610	1,805	1,805	Growth, reproduction	Appendix C
123-91-1	1,4-Dioxane	50	25	25	Reproduction	Appendix C
100-41-4	Ethylbenzene	68	34	34	Liver/kidney histopathology and growth	Appendix C
50-00-0	Formaldehyde	3.6	3.6	7.2	Growth, development, reproduction	Appendix C
67-56-1	Methanol	50	25	25	Growth	Appendix C
75-09-2	Methylene chloride	40	20	20	Growth, reproduction	Appendix C
108-10-1	4-Methyl-2-pentanone	25	25	25	Liver/kidney function	Sample benchmark
103-65-1	n-Propylbenzene	51	25	25	Ototoxicity	Appendix C
127-18-4	Tetrachloroethene	1.4	0.70	0.70	Organ weights	Appendix C
108-88-3	Toluene	1.2	0.62	0.62	Hematological histological morphology	Appendix C
71-55-6	1,1,1-Trichloroethane	47	23	23	Reproductive, developmental	Appendix C
79-01-6	Trichloroethene	2.2	1.1	1.1	Body weights, kidney nephropathy, mortality	Appendix C
95-63-6	1,2,4-Trimethylbenzene	46	23	23	Developmental toxicity	Appendix C
108-67-8	1,3,5-Trimethylbenzene	1.9	0.97	0.97	Developmental toxicity	Appendix C
75-01-4	Vinyl chloride	22	11	11	Growth, fetal anomalies	Appendix C
1330-20-7	Xylenes	125	63	63	Growth, fetal development	Appendix C
Semivolatiles						
83-32-9	Acenaphthene	8.8	4.4	4.4	Liver, spleen, ovary	Appendix C
208-96-8	Acenaphthylene	NA	NA	NA	--	--
120-12-7	Anthracene	NA	NA	NA	--	--
56-55-3	Benzo(a)anthracene	NA	NA	NA	--	--
50-32-8	Benzo(a)pyrene	0.25	0.12	0.12	Reproduction	Appendix C
205-99-2	Benzo(b)fluoranthene	NA	NA	NA	--	--
191-24-2	Benzo(g,h,i)perylene	NA	NA	NA	--	--
207-08-9	Benzo(k)fluoranthene	NA	NA	NA	--	--
218-01-9	Chrysene	NA	NA	NA	--	--
53-70-3	Dibenz(a,h)anthracene	NA	NA	NA	--	--
105-67-9	2,4-Dimethylphenol	6.0	3.0	3.0	Growth	Appendix C
84-74-2	Di-n-butylphthalate	5.1	2.6	2.6	Reproduction	Appendix C
206-44-0	Fluoranthene	NA	NA	NA	--	--
86-73-7	Fluorene	6.3	3.1	3.1	Body weight, hematology, pathology	Appendix C
193-39-5	Indeno(1,2,3-cd)pyrene	NA	NA	NA	--	--
90-12-0	1-Methylnaphthalene	70	35	35	Growth	Appendix C
91-57-6	2-Methylnaphthalene	5.0	2.5	2.5	Systemic effects	Appendix C
95-48-7	2-Methylphenol	67	67	268	Reproduction	Appendix C
108-39-4	3-Methylphenol	NA	NA	NA	--	--
106-44-5	4-Methylphenol	NA	NA	NA	--	--
34mp	3&4-Methylphenol	--	--	--	--	--
91-20-3	Naphthalene	48	24	24	Reproduction, growth	Appendix C
85-01-8	Phenanthrene	66	66	66	Growth	EcoSSL
108-95-2	Phenol	35	18	18	Reproduction	Appendix C
129-00-0	Pyrene	7.5	3.8	3.8	Hematology/serum chemistry	Appendix C

Table 13
Mammal TRVs
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Lemming TRV (mg/kg-d)	Shrew TRV (mg/kg-d)	Weasel TRV (mg/kg-d)	TRV Endpoint	TRV Source [a]
CAS #	**Chemical Name**					
Metals						
7429-90-5	Aluminum [b]	--	--	--	--	--
7440-36-0	Antimony	0.059	0.059	0.059	Reproduction (progeny weight)	EcoSSL
7440-38-2	Arsenic	1.0	1.0	1.0	Growth	EcoSSL
7440-39-3	Barium	52	52	52	Reproduction and growth	EcoSSL
7440-43-9	Cadmium	0.77	0.77	0.77	Growth	EcoSSL
7440-47-3	Chromium	NA	NA	NA	--	--
16065-83-1	Chromium (III)	2.4	2.4	2.4	Reproduction and growth	EcoSSL
18540-29-9	Chromium (VI)	5.7	5.7	5.7	Growth	EcoSSL
7440-50-8	Copper	5.6	5.6	5.6	Growth, mortality	EcoSSL
7439-92-1	Lead	4.7	4.7	4.7	Growth (body weight)	EcoSSL
7439-96-5	Manganese [b]	--	--	--	--	--
7439-97-6	Mercury [c]	0.16	0.080	1.0	Reproduction (weasel); Kidney nephropathy (lemming/shrew)	Calculated (no EcoSSL)
7440-02-0	Nickel	1.7	1.7	1.7	Reproduction (sperm cell counts)	EcoSSL
7782-49-2	Selenium	0.14	0.14	0.14	Growth	EcoSSL
7440-22-4	Silver	6.0	6.0	6.0	Growth	EcoSSL
7440-62-2	Vanadium	4.2	4.2	4.2	Reproduction, growth, and mortality	EcoSSL
7440-66-6	Zinc	75	75	75	Reproduction and growth	EcoSSL
Inorganics						
57-12-5	Cyanide	63	31	31	Reproduction	Appendix C

Abbreviations:
VOC: volatile organic compound
SVOC: semi-volatile organic compound
TRV: toxicity reference value
mg/kg-d: milligrams chemical per kilogram body weight per day
NA: not available
--: not applicable

Footnotes:

[a] The following source hierarchy was used to identify TRVs: 1) EcoSSL TRVs (EPA, 2005), 2) calculated TRVs (Appendix C), and 3) Sample benchmarks (Sample et al., 1996).

[b] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes and no TRVs or Tier II ALs were developed.

[c] Values are for mercuric chloride.

References:

EPA. 2005. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response. November 2003. Revised February 2005. http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

Sample, B.E.; Opresko, D.M.; and Suter II, G.W. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. June.

Table 14
Bird TRVs
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Ptarmigan TRV (mg/kg-d)	Goose TRV (mg/kg-d)	Lapland Longspur TRV (mg/kg-d)	Snowy Owl TRV (mg/kg-d)	Arctic Loon TRV (mg/kg-d)	TRV Endpoint	TRV Source [a]
CAS #	Chemical Name							
Volatiles								
67-64-1	Acetone	5,000	20,000	5,000	5,000	5,000	Reproduction	Appendix C
107-02-8	Acrolein	NA	NA	NA	NA	NA	--	--
71-43-2	Benzene	NA	NA	NA	NA	NA	--	--
78-93-3	2-Butanone	NA	NA	NA	NA	NA	--	--
56-23-5	Carbon tetrachloride	3.6	1.8	1.8	1.8	1.8	Reproduction	Appendix C
108-90-7	Chlorobenzene	NA	NA	NA	NA	NA	--	--
75-00-3	Chloroethane	NA	NA	NA	NA	NA	--	--
67-66-3	Chloroform	NA	NA	NA	NA	NA	--	--
106-93-4	1,2-Dibromoethane	0.14	0.070	0.070	0.070	0.070	Reproduction	Appendix C
95-50-1	1,2-Dichlorobenzene	NA	NA	NA	NA	NA	--	--
75-34-3	1,1-Dichloroethane	NA	NA	NA	NA	NA	--	--
107-06-2	1,2-Dichloroethane	1.8	0.44	0.44	0.44	0.44	Reproduction	Appendix C
75-35-4	1,1-Dichloroethene	NA	NA	NA	NA	NA	--	--
156-59-2	cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	--	--
156-60-5	trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	--	--
60-29-7	Diethyl ether	NA	NA	NA	NA	NA	--	--
123-91-1	1,4-Dioxane	NA	NA	NA	NA	NA	--	--
100-41-4	Ethylbenzene	NA	NA	NA	NA	NA	--	--
50-00-0	Formaldehyde	NA	NA	NA	NA	NA	--	--
67-56-1	Methanol	NA	NA	NA	NA	NA	--	--
75-09-2	Methylene chloride	NA	NA	NA	NA	NA	--	--
108-10-1	4-Methyl-2-pentanone	NA	NA	NA	NA	NA	--	--
103-65-1	n-Propylbenzene	NA	NA	NA	NA	NA	--	--
127-18-4	Tetrachloroethene	NA	NA	NA	NA	NA	--	--
108-88-3	Toluene	NA	NA	NA	NA	NA	--	--
71-55-6	1,1,1-Trichloroethane	NA	NA	NA	NA	NA	--	--
79-01-6	Trichloroethene	NA	NA	NA	NA	NA	--	--
95-63-6	1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	--	--
108-67-8	1,3,5-Trimethylbenzene	NA	NA	NA	NA	NA	--	--
75-01-4	Vinyl chloride	NA	NA	NA	NA	NA	--	--
1330-20-7	Xylenes	NA	NA	NA	NA	NA	--	--
Semivolatiles								
83-32-9	Acenaphthene	NA	NA	NA	NA	NA	--	--
208-96-8	Acenaphthylene	NA	NA	NA	NA	NA	--	--
120-12-7	Anthracene	NA	NA	NA	NA	NA	--	--
56-55-3	Benzo(a)anthracene	NA	NA	NA	NA	NA	--	--
50-32-8	Benzo(a)pyrene	NA	NA	NA	NA	NA	--	--
205-99-2	Benzo(b)fluoranthene	NA	NA	NA	NA	NA	--	--
191-24-2	Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	--	--
207-08-9	Benzo(k)fluoranthene	NA	NA	NA	NA	NA	--	--
218-01-9	Chrysene	NA	NA	NA	NA	NA	--	--
53-70-3	Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	--	--
105-67-9	2,4-Dimethylphenol	NA	NA	NA	NA	NA	--	--
84-74-2	Di-n-butylphthalate	0.11	0.11	0.11	0.11	0.11	Reproduction	Sample benchmark
206-44-0	Fluoranthene	NA	NA	NA	NA	NA	--	--
86-73-7	Fluorene	NA	NA	NA	NA	NA	--	--
193-39-5	Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	--	--
90-12-0	1-Methylnaphthalene	NA	NA	NA	NA	NA	--	--
91-57-6	2-Methylnaphthalene	NA	NA	NA	NA	NA	--	--
95-48-7	2-Methylphenol	NA	NA	NA	NA	NA	--	--
108-39-4	3-Methylphenol	NA	NA	NA	NA	NA	--	--
106-44-5	4-Methylphenol	NA	NA	NA	NA	NA	--	--
34mp	3&4-Methylphenol	--	--	--	--	--	--	--
91-20-3	Naphthalene	NA	NA	NA	NA	NA	--	--
85-01-8	Phenanthrene	NA	NA	NA	NA	NA	--	--
108-95-2	Phenol	NA	NA	NA	NA	NA	--	--
129-00-0	Pyrene	NA	NA	NA	NA	NA	--	--
Metals								
7429-90-5	Aluminum [b]	--	--	--	--	--	--	--
7440-36-0	Antimony	NA	NA	NA	NA	NA	--	--
7440-38-2	Arsenic	2.2	2.2	2.2	2.2	2.2	Reproduction, growth, and mortality	EcoSSL
7440-39-3	Barium	25	6.2	6.2	6.2	6.2	Growth	Calculated
7440-43-9	Cadmium	1.5	1.5	1.5	1.5	1.5	Reproduction and growth	EcoSSL
7440-47-3	Chromium	NA	NA	NA	NA	NA	--	--
16065-83-1	Chromium (III)	2.7	2.7	2.7	2.7	2.7	Reproduction and growth	EcoSSL
18540-29-9	Chromium (VI)	NA	NA	NA	NA	NA	--	--
7440-50-8	Copper	4.1	4.1	4.1	4.1	4.1	Reproduction	EcoSSL
7439-92-1	Lead	1.6	1.6	1.6	1.6	1.6	Reproduction	EcoSSL
7439-96-5	Manganese [b]	--	--	--	--	--	--	--
7439-97-6	Mercury [c]	0.83	0.21	0.21	0.21	0.21	Reproduction	Calculated
7440-02-0	Nickel	6.7	6.7	6.7	6.7	6.7	Reproduction and growth	EcoSSL
7782-49-2	Selenium	0.29	0.29	0.29	0.29	0.29	Mortality	EcoSSL
7440-22-4	Silver	2.0	2.0	2.0	2.0	2.0	Growth	EcoSSL
7440-62-2	Vanadium	0.34	0.34	0.34	0.34	0.34	Growth	EcoSSL
7440-66-6	Zinc	66	66	66	66	66	Reproduction and growth	EcoSSL
Inorganics								
57-12-5	Cyanide	NA	NA	NA	NA	NA	--	--

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
TRV: toxicity reference value
mg/kg-d: milligrams chemical per kilogram body weight per day
NA: not available
--: not applicable

Footnotes:

[a] The following source hierarchy was used to identify TRVs: 1) EcoSSL TRVs (EPA, 2005), 2) calculated TRVs (Appendix C), and 3) Sample benchmarks (Sample et al., 1996).

[b] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes and no TRVs or Tier II ALs were developed.

[c] Values are for mercuric chloride.

References:

EPA. 2005. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response. November 2003. Revised February 2005. http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

Sample, B.E.; Opresko, D.M.; and Suter II, G.W. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. June.

Table 15
Tier II Soil AL for Brown Lemming
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Reference Value [a] TRV	Plant Bioaccumulation Factor BAF	Plant Concentration [b] C_p	Area Use Factor [c] AUF	Seasonal Use Factor [d] SUF	Dry Food Ingestion Rate [e] FIR_{dw}	Proportion Soil in Diet [f] P_s	Tier II Soil Action Level [g] AL
CAS #	**Chemical Name**	**(mg/kg-d)**	**(unitless)**	**(mg/kg) dw**	**(Unitless)**	**(Unitless)**	**(kg/kg-d) dw**	**(unitless)**	**(mg/kg)**
Volatiles									
67-64-1	Acetone	105	53	--	1	1	0.32	0.024	6.2E+00
107-02-8	Acrolein	1.4	39	--	1	1	0.32	0.024	1.1E-01
71-43-2	Benzene	0.50	2.2	--	1	1	0.32	0.024	6.9E-01
78-93-3	2-Butanone	120	26	--	1	1	0.32	0.024	1.4E+01
56-23-5	Carbon tetrachloride	5.0	0.88	--	1	1	0.32	0.024	1.7E+01
108-90-7	Chlorobenzene	53	0.87	--	1	1	0.32	0.024	1.9E+02
75-00-3	Chloroethane	NA	--	--	1	1	0.32	0.024	NA
67-66-3	Chloroform	37	2.8	--	1	1	0.32	0.024	4.2E+01
106-93-4	1,2-Dibromoethane	14	2.8	--	1	1	0.32	0.024	1.5E+01
95-50-1	1,2-Dichlorobenzene	6.0	0.40	--	1	1	0.32	0.024	4.5E+01
75-34-3	1,1-Dichloroethane	NA	--	--	1	1	0.32	0.024	NA
107-06-2	1,2-Dichloroethane	25	5.3	--	1	1	0.32	0.024	1.5E+01
75-35-4	1,1-Dichloroethene	7.4	2.2	--	1	1	0.32	0.024	1.0E+01
156-59-2	cis-1,2-Dichloroethene	45	3.2	--	1	1	0.32	0.024	4.4E+01
156-60-5	trans-1,2-Dichloroethene	45	2.4	--	1	1	0.32	0.024	5.9E+01
60-29-7	Diethyl ether	3610	12	--	1	1	0.32	0.024	9.6E+02
123-91-1	1,4-Dioxane	50	55	--	1	1	0.32	0.024	2.8E+00
100-41-4	Ethylbenzene	68	0.57	--	1	1	0.32	0.024	3.6E+02
50-00-0	Formaldehyde	3.6	24	--	1	1	0.32	0.024	4.7E-01
67-56-1	Methanol	50	108	--	1	1	0.32	0.024	1.4E+00
75-09-2	Methylene chloride	40	7.3	--	1	1	0.32	0.024	1.7E+01
108-10-1	4-Methyl-2-pentanone	25	6.7	--	1	1	0.32	0.024	1.2E+01
103-65-1	n-Propylbenzene	51	0.28	--	1	1	0.32	0.024	5.2E+02
127-18-4	Tetrachloroethene	1.4	0.41	--	1	1	0.32	0.024	1.0E+01
108-88-3	Toluene	1.2	1.0	--	1	1	0.32	0.024	3.8E+00
71-55-6	1,1,1-Trichloroethane	47	1.4	--	1	1	0.32	0.024	1.0E+02
79-01-6	Trichloroethene	2.2	1.5	--	1	1	0.32	0.024	4.5E+00
95-63-6	1,2,4-Trimethylbenzene	46	0.30	--	1	1	0.32	0.024	4.4E+02
108-67-8	1,3,5-Trimethylbenzene	1.9	0.40	--	1	1	0.32	0.024	1.4E+01
75-01-4	Vinyl chloride	22	4.4	--	1	1	0.32	0.024	1.5E+01
1330-20-7	Xylenes	125	0.57	--	1	1	0.32	0.024	6.6E+02
Semivolatiles									
83-32-9	Acenaphthene	8.8	$e^{(-0.8556*ln(Cs)-5.562)}$	0.0000093	1	1	0.32	0.024	1.1E+03
208-96-8	Acenaphthylene	NA	--	--	1	1	0.32	0.024	NA
120-12-7	Anthracene	NA	--	--	1	1	0.32	0.024	NA
56-55-3	Benzo(a)anthracene	NA	--	--	1	1	0.32	0.024	NA
50-32-8	Benzo(a)pyrene	0.25	$e^{(0.975*ln(Cs)-2.0615)}$	0.65	1	1	0.32	0.024	5.4E+00
205-99-2	Benzo(b)fluoranthene	NA	--	--	1	1	0.32	0.024	NA
191-24-2	Benzo(g,h,i)perylene	NA	--	--	1	1	0.32	0.024	NA
207-08-9	Benzo(k)fluoranthene	NA	--	--	1	1	0.32	0.024	NA
218-01-9	Chrysene	NA	--	--	1	1	0.32	0.024	NA
53-70-3	Dibenz(a,h)anthracene	NA	--	--	1	1	0.32	0.024	NA
105-67-9	2,4-Dimethylphenol	6.0	1.8	--	1	1	0.32	0.024	1.0E+01
84-74-2	Di-n-butylphthalate	5.1	0.095	--	1	1	0.32	0.024	1.3E+02
206-44-0	Fluoranthene	NA	--	--	1	1	0.32	0.024	NA
86-73-7	Fluorene	6.3	$e^{(-0.8556*ln(Cs)-5.562)}$	0.000012	1	1	0.32	0.024	8.1E+02
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	--	1	1	0.32	0.024	NA
90-12-0	1-Methylnaphthalene	70	0.22	--	1	1	0.32	0.024	9.0E+02
91-57-6	2-Methylnaphthalene	5.0	0.22	--	1	1	0.32	0.024	6.4E+01
95-48-7	2-Methylphenol	67	2.9	--	1	1	0.32	0.024	7.3E+01
108-39-4	3-Methylphenol	NA	--	--	1	1	0.32	0.024	NA
106-44-5	4-Methylphenol	NA	--	--	1	1	0.32	0.024	NA
34mp	3&4-Methylphenol [h]	--	--	--	--	--	--	--	NA
91-20-3	Naphthalene	48	12	--	1	1	0.32	0.024	1.2E+01
85-01-8	Phenanthrene	66	$e^{(0.6203*ln(Cs)-0.1665)}$	127	1	1	0.32	0.024	3.2E+03
108-95-2	Phenol	35	5.5	--	1	1	0.32	0.024	2.0E+01
129-00-0	Pyrene	7.5	0.72	--	1	1	0.32	0.024	3.2E+01
Metals									
7429-90-5	Aluminum [i]	--	--	--	--	--	--	--	--
7440-36-0	Antimony	0.059	$e^{(0.938*ln(Cs)-0.3233)}$	0.18	1	1	0.32	0.024	2.3E-01
7440-38-2	Arsenic	1.0	0.038	--	1	1	0.32	0.024	5.3E+01
7440-39-3	Barium	52	0.16	--	1	1	0.32	0.024	9.0E+02
7440-43-9	Cadmium	0.77	$e^{(0.546*ln(Cs)-0.475)}$	2.2	1	1	0.32	0.024	9.9E+00
7440-47-3	Chromium	NA	--	--	1	1	0.32	0.024	NA
16065-83-1	Chromium (III)	2.4	0.041	--	1	1	0.32	0.024	1.2E+02
18540-29-9	Chromium (VI)	5.7	0.041	--	1	1	0.32	0.024	2.7E+02
7440-50-8	Copper	5.6	$e^{(0.394*ln(Cs)+0.668)}$	14	1	1	0.32	0.024	1.5E+02
7439-92-1	Lead	4.7	$e^{(0.561*ln(Cs)-1.328)}$	6.8	1	1	0.32	0.024	3.3E+02
7439-96-5	Manganese [i]	--	--	--	--	--	--	--	--
7439-97-6	Mercury	0.16	0.038	--	1	1	0.32	0.024	8.1E+00
7440-02-0	Nickel	1.7	$e^{(0.748*ln(Cs)-2.223)}$	3.1	1	1	0.32	0.024	9.0E+01
7782-49-2	Selenium	0.14	$e^{(1.104*ln(Cs)-0.677)}$	0.43	1	1	0.32	0.024	8.5E-01
7440-22-4	Silver	6.0	0.014	--	1	1	0.32	0.024	5.0E+02
7440-62-2	Vanadium	4.2	0.0049	--	1	1	0.32	0.024	4.5E+02
7440-66-6	Zinc	75	$e^{(0.554*ln(Cs)+1.575)}$	213	1	1	0.32	0.024	9.3E+02
Inorganics									
57-12-5	Cyanide	63	53.8	--	1	1	0.32	0.024	3.6E+00

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
mg/kg: milligrams per kilogram
mg/kg-d: milligrams chemical per kilogram body weight per day
kg/kg-d: kilograms food per kilogram body weight per day
dw: dry weight
NA: not available
--: not applicable

Footnotes:

[a] Mammal TRVs from Table 13.

[b] C_p calculated using equations in Table 12.

[c] Home range size of 2 acres (Banks et al., 1975). Conservatively assumed an AUF of 1 (e.g., animals forage only at a site).

[d] Year-round resident, so SUF of 1 was used.

[e] From Alaskan study (Bliss et al., 1973).

[f] EPA (1993) value for meadow vole (same feeding guild) used.

[g] For chemicals with BAFs that are a constant function of soil concentration, Tier II AL is calculated as follows: Tier II AL = $TRV/(AUF*SUF*FIR_{dw}*(BAF+P_s))$.
For chemicals with BAFs that are a log linear function of soil concentration, Tier II AL is calculated by setting the soil concentration (C_s) to give an HQ of 1, where HQ = $(AUF*SUF*FIR_{dw}*(C_p+(C_s*P_s)))/TRV$.

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

References:

Banks, E.M., R.J. Brooks, and J. Schnell. 1975. A Radiotracking Study of Home Range and Activity of the Brown Lemming (*Lemmus trimucronatus*). J. Mammal. 56(4):888-901.
Bliss, L.C., G.M. Courtin, D.L. Pattie, R.R. Riewe, D.W.A. Whitfield, and P. Widden. 1973. Arctic Tundra Ecosystems. Ann. Rev. Ecol. Systemat. 4:359-399.
U.S. Environmental Protection Agency (EPA). 1993. Wildlife Exposure Factors Handbook. EPA/600/R-93/187. December.

Table 16
Tier II Soil AL for Tundra Shrew
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Reference Value [a] TRV	Invertebrate Bioaccumulation Factor BAF	Invertebrate Concentration [b] C_i	Area Use Factor [c] AUF	Seasonal Use Factor [d] SUF	Dry Food Ingestion Rate [e] FIR_{dw}	Proportion Soil in Diet [f] P_s	Tier II Soil Action Level [g] AL
CAS #	**Chemical Name**	**(mg/kg-d)**	**(unitless)**	**(mg/kg) dw**	**(Unitless)**	**(Unitless)**	**(kg/kg-d) dw**	**(unitless)**	**(mg/kg)**
Volatiles									
67-64-1	Acetone	53	0.30	--	1	1	0.099	0.026	1.6E+03
107-02-8	Acrolein	0.70	0	--	1	1	0.099	0.026	2.7E+02
71-43-2	Benzene	0.25	0	--	1	1	0.099	0.026	9.7E+01
78-93-3	2-Butanone	60	0	--	1	1	0.099	0.026	2.3E+04
56-23-5	Carbon tetrachloride	2.5	72	--	1	1	0.099	0.026	3.5E-01
108-90-7	Chlorobenzene	26	0	--	1	1	0.099	0.026	1.0E+04
75-00-3	Chloroethane	NA	--	--	1	1	0.099	0.026	NA
67-66-3	Chloroform	19	17	--	1	1	0.099	0.026	1.1E+01
106-93-4	1,2-Dibromoethane	7.0	0	--	1	1	0.099	0.026	2.7E+03
95-50-1	1,2-Dichlorobenzene	3.0	0	--	1	1	0.099	0.026	1.2E+03
75-34-3	1,1-Dichloroethane	NA	--	--	1	1	0.099	0.026	NA
107-06-2	1,2-Dichloroethane	13	0	--	1	1	0.099	0.026	4.8E+03
75-35-4	1,1-Dichloroethene	3.7	0	--	1	1	0.099	0.026	1.4E+03
156-59-2	cis-1,2-Dichloroethene	45	0	--	1	1	0.099	0.026	1.8E+04
156-60-5	trans-1,2-Dichloroethene	45	0	--	1	1	0.099	0.026	1.8E+04
60-29-7	Diethyl ether	1805	0	--	1	1	0.099	0.026	7.0E+05
123-91-1	1,4-Dioxane	25	0.24	--	1	1	0.099	0.026	9.5E+02
100-41-4	Ethylbenzene	34	0	--	1	1	0.099	0.026	1.3E+04
50-00-0	Formaldehyde	3.6	0.84	--	1	1	0.099	0.026	4.2E+01
67-56-1	Methanol	25	0	--	1	1	0.099	0.026	9.7E+03
75-09-2	Methylene chloride	20	0.30	--	1	1	0.099	0.026	6.1E+02
108-10-1	4-Methyl-2-pentanone	25	0	--	1	1	0.099	0.026	9.7E+03
103-65-1	n-Propylbenzene	25	0	--	1	1	0.099	0.026	9.9E+03
127-18-4	Tetrachloroethene	0.70	0	--	1	1	0.099	0.026	2.7E+02
108-88-3	Toluene	0.62	0	--	1	1	0.099	0.026	2.4E+02
71-55-6	1,1,1-Trichloroethane	23	0	--	1	1	0.099	0.026	9.0E+03
79-01-6	Trichloroethene	1.1	0	--	1	1	0.099	0.026	4.3E+02
95-63-6	1,2,4-Trimethylbenzene	23	0	--	1	1	0.099	0.026	9.0E+03
108-67-8	1,3,5-Trimethylbenzene	0.97	0	--	1	1	0.099	0.026	3.8E+02
75-01-4	Vinyl chloride	11	3.7	--	1	1	0.099	0.026	2.9E+01
1330-20-7	Xylenes	63	0	--	1	1	0.099	0.026	2.4E+04
Semivolatiles									
83-32-9	Acenaphthene	4.4	1.5	--	1	1	0.099	0.026	3.0E+01
208-96-8	Acenaphthylene	NA	--	--	1	1	0.099	0.026	NA
120-12-7	Anthracene	NA	--	--	1	1	0.099	0.026	NA
56-55-3	Benzo(a)anthracene	NA	--	--	1	1	0.099	0.026	NA
50-32-8	Benzo(a)pyrene	0.12	1.3	--	1	1	0.099	0.026	8.9E-01
205-99-2	Benzo(b)fluoranthene	NA	--	--	1	1	0.099	0.026	NA
191-24-2	Benzo(g,h,i)perylene	NA	--	--	1	1	0.099	0.026	NA
207-08-9	Benzo(k)fluoranthene	NA	--	--	1	1	0.099	0.026	NA
218-01-9	Chrysene	NA	--	--	1	1	0.099	0.026	NA
53-70-3	Dibenz(a,h)anthracene	NA	--	--	1	1	0.099	0.026	NA
105-67-9	2,4-Dimethylphenol	3.0	NA	--	1	1	0.099	0.026	1.2E+03
84-74-2	Di-n-butylphthalate	2.6	1.6	--	1	1	0.099	0.026	1.6E+01
206-44-0	Fluoranthene	NA	--	--	1	1	0.099	0.026	NA
86-73-7	Fluorene	3.1	9.6	--	1	1	0.099	0.026	3.3E+00
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	--	1	1	0.099	0.026	NA
90-12-0	1-Methylnaphthalene	35	NA	--	1	1	0.099	0.026	1.4E+04
91-57-6	2-Methylnaphthalene	2.5	0	--	1	1	0.099	0.026	9.8E+02
95-48-7	2-Methylphenol	67	0	--	1	1	0.099	0.026	2.6E+04
108-39-4	3-Methylphenol	NA	--	--	1	1	0.099	0.026	NA
106-44-5	4-Methylphenol	NA	--	--	1	1	0.099	0.026	NA
34mp	3&4-Methylphenol [h]	--	--	--	--	--	--	--	NA
91-20-3	Naphthalene	24	4.4	--	1	1	0.099	0.026	5.5E+01
85-01-8	Phenanthrene	66	1.7	--	1	1	0.099	0.026	3.8E+02
108-95-2	Phenol	18	0.30	--	1	1	0.099	0.026	5.4E+02
129-00-0	Pyrene	3.8	1.8	--	1	1	0.099	0.026	2.2E+01
Metals									
7429-90-5	Aluminum [i]	--	--	--	--	--	--	--	--
7440-36-0	Antimony	0.059	1.0	--	1	1	0.099	0.026	5.8E-01
7440-38-2	Arsenic	1.0	$e^{(0.706*ln(Cs)-1.421)}$	7.3	1	1	0.099	0.026	1.2E+02
7440-39-3	Barium	52	0.091	--	1	1	0.099	0.026	4.5E+03
7440-43-9	Cadmium	0.77	$e^{(0.795*ln(Cs)+2.114)}$	7.7	1	1	0.099	0.026	9.2E-01
7440-47-3	Chromium	NA	--	--	1	1	0.099	0.026	NA
16065-83-1	Chromium (III)	2.4	0.31	--	1	1	0.099	0.026	7.3E+01
18540-29-9	Chromium (VI)	5.7	0.31	--	1	1	0.099	0.026	1.7E+02
7440-50-8	Copper	5.6	0.52	--	1	1	0.099	0.026	1.0E+02
7439-92-1	Lead	4.7	$e^{(0.807*ln(Cs)-0.218)}$	44	1	1	0.099	0.026	1.4E+02
7439-96-5	Manganese [i]	--	--	--	--	--	--	--	--
7439-97-6	Mercury	0.080	3.1	--	1	1	0.099	0.026	2.6E-01
7440-02-0	Nickel	1.7	0.12	--	1	1	0.099	0.026	1.2E+02
7782-49-2	Selenium	0.14	$e^{(0.733*ln(Cs)-0.075)}$	1.4	1	1	0.099	0.026	1.7E+00
7440-22-4	Silver	6.0	2.0	--	1	1	0.099	0.026	2.9E+01
7440-62-2	Vanadium	4.2	0.042	--	1	1	0.099	0.026	6.2E+02
7440-66-6	Zinc	75	$e^{(0.328*ln(Cs)+4.449)}$	741	1	1	0.099	0.026	7.2E+02
Inorganics									
57-12-5	Cyanide	31	6.7	--	1	1	0.099	0.026	4.7E+01

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
mg/kg: milligrams per kilogram
mg/kg-d: milligrams chemical per kilogram body weight per day
kg/kg-d: kilograms food per kilogram body weight per day
dw: dry weight
NA: not available
--: not applicable

Footnotes:

[a] Mammal TRVs from Table 13.

[b] C_i calculated using equations in Table 12.

[c] Home range size of 1.4 acres for Arctic shrew (Buckner, 1966). Conservatively assumed an AUF of 1 (e.g., animals only forage at a site).

[d] Year-round resident, so SUF of 1 was used.

[e] Converted wet weight FIR for the surrogate short-tailed shrew (EPA, 1993) to dry weight FIR assuming diet water content of 84% (Table 11).

[f] Average of EPA (1993) values for meadow vole (same Family) and red fox (same feeding guild) used.

[g] For chemicals with BAFs that are a constant function of soil concentration, Tier II AL is calculated as follows: Tier II AL = $TRV/(AUF*SUF*FIR_{dw}*(BAF+P_s))$.
For chemicals with BAFs that are a log linear function of soil concentration, Tier II AL is calculated by setting the soil concentration (C_s) to give an HQ of 1, where HQ = $(AUF*SUF*FIR_{dw}*(C_i+(C_s*P_s)))/TRV$.

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

References:

Buckner, C.H. 1966. Populations and Ecological Relationships of Shrews in Tamarack Bogs of Southeastern Manitoba. J. Mammal. 47(2):181-194.
U.S. Environmental Protection Agency (EPA). 1993. Wildlife Exposure Factors Handbook. EPA/600/R-93/187. December.

Table 17
Tier II Soil AL for Least Weasel
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Reference Value [a] TRV (mg/kg-d)	Mammal Bioaccumulation Factor BAF (unitless)	Mammal Concentration [b] C_m (mg/kg) dw	Area Use Factor [c] AUF (Unitless)	Seasonal Use Factor [d] SUF (Unitless)	Dry Food Ingestion Rate [e] FIR_{dw} (kg/kg-d) dw	Proportion Soil in Diet [f] P_s (unitless)	Tier II Soil Action Level [g] AL (mg/kg)
CAS #	Chemical Name								
Volatiles									
67-64-1	Acetone	53	0	--	1	1	0.12	0.028	1.6E+04
107-02-8	Acrolein	0.70	0	--	1	1	0.12	0.028	2.2E+02
71-43-2	Benzene	0.25	0	--	1	1	0.12	0.028	7.8E+01
78-93-3	2-Butanone	60	0	--	1	1	0.12	0.028	1.9E+04
56-23-5	Carbon tetrachloride	2.5	0	--	1	1	0.12	0.028	7.8E+02
108-90-7	Chlorobenzene	26	0	--	1	1	0.12	0.028	8.1E+03
75-00-3	Chloroethane	NA	--	--	1	1	0.12	0.028	NA
67-66-3	Chloroform	19	0	--	1	1	0.12	0.028	5.8E+03
106-93-4	1,2-Dibromoethane	7.0	0	--	1	1	0.12	0.028	2.2E+03
95-50-1	1,2-Dichlorobenzene	3.0	0	--	1	1	0.12	0.028	9.3E+02
75-34-3	1,1-Dichloroethane	NA	--	--	1	1	0.12	0.028	NA
107-06-2	1,2-Dichloroethane	13	0	--	1	1	0.12	0.028	3.9E+03
75-35-4	1,1-Dichloroethene	3.7	0	--	1	1	0.12	0.028	1.1E+03
156-59-2	cis-1,2-Dichloroethene	45	0	--	1	1	0.12	0.028	1.4E+04
156-60-5	trans-1,2-Dichloroethene	45	0	--	1	1	0.12	0.028	1.4E+04
60-29-7	Diethyl ether	1805	0	--	1	1	0.12	0.028	5.6E+05
123-91-1	1,4-Dioxane	25	0	--	1	1	0.12	0.028	7.8E+03
100-41-4	Ethylbenzene	34	0	--	1	1	0.12	0.028	1.1E+04
50-00-0	Formaldehyde	7.2	0	--	1	1	0.12	0.028	2.2E+03
67-56-1	Methanol	25	0	--	1	1	0.12	0.028	7.8E+03
75-09-2	Methylene chloride	20	0	--	1	1	0.12	0.028	6.1E+03
108-10-1	4-Methyl-2-pentanone	25	0	--	1	1	0.12	0.028	7.8E+03
103-65-1	n-Propylbenzene	25	0	--	1	1	0.12	0.028	7.9E+03
127-18-4	Tetrachloroethene	0.70	0	--	1	1	0.12	0.028	2.2E+02
108-88-3	Toluene	0.62	0	--	1	1	0.12	0.028	1.9E+02
71-55-6	1,1,1-Trichloroethane	23	0	--	1	1	0.12	0.028	7.2E+03
79-01-6	Trichloroethene	1.1	0	--	1	1	0.12	0.028	3.4E+02
95-63-6	1,2,4-Trimethylbenzene	23	0	--	1	1	0.12	0.028	7.2E+03
108-67-8	1,3,5-Trimethylbenzene	0.97	0	--	1	1	0.12	0.028	3.0E+02
75-01-4	Vinyl chloride	11	0	--	1	1	0.12	0.028	3.3E+03
1330-20-7	Xylenes	63	0	--	1	1	0.12	0.028	2.0E+04
Semivolatiles									
83-32-9	Acenaphthene	4.4	0	--	1	1	0.12	0.028	1.4E+03
208-96-8	Acenaphthylene	NA	--	--	1	1	0.12	0.028	NA
120-12-7	Anthracene	NA	--	--	1	1	0.12	0.028	NA
56-55-3	Benzo(a)anthracene	NA	--	--	1	1	0.12	0.028	NA
50-32-8	Benzo(a)pyrene	0.12	0	--	1	1	0.12	0.028	3.7E+01
205-99-2	Benzo(b)fluoranthene	NA	--	--	1	1	0.12	0.028	NA
191-24-2	Benzo(g,h,i)perylene	NA	--	--	1	1	0.12	0.028	NA
207-08-9	Benzo(k)fluoranthene	NA	--	--	1	1	0.12	0.028	NA
218-01-9	Chrysene	NA	--	--	1	1	0.12	0.028	NA
53-70-3	Dibenz(a,h)anthracene	NA	--	--	1	1	0.12	0.028	NA
105-67-9	2,4-Dimethylphenol	3.0	0	--	1	1	0.12	0.028	9.3E+02
84-74-2	Di-n-butylphthalate	2.6	0	--	1	1	0.12	0.028	8.0E+02
206-44-0	Fluoranthene	NA	--	--	1	1	0.12	0.028	NA
86-73-7	Fluorene	3.1	0	--	1	1	0.12	0.028	9.7E+02
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	--	1	1	0.12	0.028	NA
90-12-0	1-Methylnaphthalene	35	0	--	1	1	0.12	0.028	1.1E+04
91-57-6	2-Methylnaphthalene	2.5	0	--	1	1	0.12	0.028	7.8E+02
95-48-7	2-Methylphenol	268	0	--	1	1	0.12	0.028	8.3E+04
108-39-4	3-Methylphenol	NA	--	--	1	1	0.12	0.028	NA
106-44-5	4-Methylphenol	NA	--	--	1	1	0.12	0.028	NA
34mp	3&4-Methylphenol [h]	--	--	--	--	--	--	--	NA
91-20-3	Naphthalene	24	0	--	1	1	0.12	0.028	7.5E+03
85-01-8	Phenanthrene	66	0	--	1	1	0.12	0.028	2.0E+04
108-95-2	Phenol	18	0	--	1	1	0.12	0.028	5.4E+03
129-00-0	Pyrene	3.8	0	--	1	1	0.12	0.028	1.2E+03
Metals									
7429-90-5	Aluminum [i]	--	--	--	--	--	--	--	--
7440-36-0	Antimony	0.059	0.0050	--	1	1	0.12	0.028	1.6E+01
7440-38-2	Arsenic	1.0	$e^{(0.8188*ln(Cs)-4.8471)}$	0.822	1	1	0.12	0.028	2.9E+02
7440-39-3	Barium	52	0.00068	--	1	1	0.12	0.028	1.6E+04
7440-43-9	Cadmium	0.77	$e^{(0.4723*ln(Cs)-1.2571)}$	2.8903	1	1	0.12	0.028	1.4E+02
7440-47-3	Chromium	NA	--	--	1	1	0.12	0.028	NA
16065-83-1	Chromium (III)	2.4	$e^{(0.7338*ln(Cs)-1.4599)}$	13.62	1	1	0.12	0.028	2.6E+02
18540-29-9	Chromium (VI)	5.7	$e^{(0.7338*ln(Cs)-1.4599)}$	28.99	1	1	0.12	0.028	7.2E+02
7440-50-8	Copper	5.6	$e^{(1.444*ln(Cs)+2.042)}$	49	1	1	0.12	0.028	3.6E+00
7439-92-1	Lead	4.7	$e^{(0.4422*ln(Cs)+0.0761)}$	20.0	1	1	0.12	0.028	7.4E+02
7439-96-5	Manganese [i]	--	--	--	--	--	--	--	--
7439-97-6	Mercury	1.0	0.00024	--	1	1	0.12	0.028	3.2E+02
7440-02-0	Nickel	1.7	$e^{(0.4658*ln(Cs)-0.2462)}$	9.19	1	1	0.12	0.028	2.0E+02
7782-49-2	Selenium	0.14	$e^{(0.3764*ln(Cs)-0.4158)}$	1.13	1	1	0.12	0.028	4.1E+00
7440-22-4	Silver	6.0	0.0040	--	1	1	0.12	0.028	1.6E+03
7440-62-2	Vanadium	4.2	0.012	--	1	1	0.12	0.028	9.0E+02
7440-66-6	Zinc	75	$e^{(0.0706*ln(Cs)+4.3632)}$	157	1	1	0.12	0.028	1.8E+04
Inorganics									
57-12-5	Cyanide	31	NA	--	1	1	0.12	0.028	9.7E+03

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
mg/kg: milligrams per kilogram
mg/kg-d: milligrams chemical per kilogram body weight per day
kg/kg-d: kilograms food per kilogram body weight per day
dw: dry weight
NA: not available
--: not applicable

Footnotes:

[a] Mammal TRVs from Table 13.

[b] C_m calculated using equations in Table 12.

[c] Home range size of 5 acres (Svendsen, 1982). Conservatively assumed an AUF of 1 (e.g., animals only forage at a site).

[d] Year-round resident, so SUF of 1 was used.

[e] Converted wet weight FIR for females (Moors, 1977) to dry weight FIR by assuming diet water content of 68% (Table 11).

[f] EPA (1993) value for the red fox (same feeding guild) used.

[g] For chemicals with BAFs that are a constant function of soil concentration, Tier II AL is calculated as follows: Tier II AL = $TRV/(AUF*SUF*FIR_{dw}*(BAF+P_s))$.
For chemicals with BAFs that are a log linear function of soil concentration, Tier II AL is calculated by setting the soil concentration (C_s) to give an HQ of 1, where HQ = (AUF*SUF*FIRdw*(Cm+(Cs*Ps)))/TRV.

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

References:

Moors, P.J. 1977. Studies of the Metabolism, Food Consumption, and Assimilation Efficiency of a Small Carnivore, the Weasel (*Mustela nivalis* L.). Oecologia 27(3):185-202.

Svendsen, G.E. 1982. Weasels. Pages 613-628 in: J.A. Chapman and G.A. Feldhamer, eds., Wild Mammals of North America: Biology, Management, and Economics. The Johns Hopkins Univ. Press, Baltimore, Maryland.

U.S. Environmental Protection Agency (EPA). 1993. Wildlife Exposure Factors Handbook. EPA/600/R-93/187. December.

Table 18
Tier II Soil AL for Willow Ptarmigan
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Reference Value [a] TRV (mg/kg-d)	Plant Bioaccumulation Factor BAF (unitless)	Plant Concentration [b] C_p (mg/kg) dw	Area Use Factor [c] AUF (Unitless)	Seasonal Use Factor [d] SUF (Unitless)	Dry Food Ingestion Rate [e] FIR_{dw} (kg/kg-d) dw	Proportion Soil in Diet [f] P_s (unitless)	Tier II Soil Action Level [g] AL (mg/kg)
CAS #	**Chemical Name**								
Volatiles									
67-64-1	Acetone	5,000	53	--	1	1	0.14	0.093	6.7E+02
107-02-8	Acrolein	NA	--	--	1	1	0.14	0.093	NA
71-43-2	Benzene	NA	--	--	1	1	0.14	0.093	NA
78-93-3	2-Butanone	NA	--	--	1	1	0.14	0.093	NA
56-23-5	Carbon tetrachloride	3.6	0.88	--	1	1	0.14	0.093	2.6E+01
108-90-7	Chlorobenzene	NA	--	--	1	1	0.14	0.093	NA
75-00-3	Chloroethane	NA	--	--	1	1	0.14	0.093	NA
67-66-3	Chloroform	NA	--	--	1	1	0.14	0.093	NA
106-93-4	1,2-Dibromoethane	0.14	2.8	--	1	1	0.14	0.093	3.4E-01
95-50-1	1,2-Dichlorobenzene	NA	--	--	1	1	0.14	0.093	NA
75-34-3	1,1-Dichloroethane	NA	--	--	1	1	0.14	0.093	NA
107-06-2	1,2-Dichloroethane	1.8	5.3	--	1	1	0.14	0.093	2.3E+00
75-35-4	1,1-Dichloroethene	NA	--	--	1	1	0.14	0.093	NA
156-59-2	cis-1,2-Dichloroethene	NA	--	--	1	1	0.14	0.093	NA
156-60-5	trans-1,2-Dichloroethene	NA	--	--	1	1	0.14	0.093	NA
60-29-7	Diethyl ether	NA	--	--	1	1	0.14	0.093	NA
123-91-1	1,4-Dioxane	NA	--	--	1	1	0.14	0.093	NA
100-41-4	Ethylbenzene	NA	--	--	1	1	0.14	0.093	NA
50-00-0	Formaldehyde	NA	--	--	1	1	0.14	0.093	NA
67-56-1	Methanol	NA	--	--	1	1	0.14	0.093	NA
75-09-2	Methylene chloride	NA	--	--	1	1	0.14	0.093	NA
108-10-1	4-Methyl-2-pentanone	NA	--	--	1	1	0.14	0.093	NA
103-65-1	n-Propylbenzene	NA	--	--	1	1	0.14	0.093	NA
127-18-4	Tetrachloroethene	NA	--	--	1	1	0.14	0.093	NA
108-88-3	Toluene	NA	--	--	1	1	0.14	0.093	NA
71-55-6	1,1,1-Trichloroethane	NA	--	--	1	1	0.14	0.093	NA
79-01-6	Trichloroethene	NA	--	--	1	1	0.14	0.093	NA
95-63-6	1,2,4-Trimethylbenzene	NA	--	--	1	1	0.14	0.093	NA
108-67-8	1,3,5-Trimethylbenzene	NA	--	--	1	1	0.14	0.093	NA
75-01-4	Vinyl chloride	NA	--	--	1	1	0.14	0.093	NA
1330-20-7	Xylenes	NA	--	--	1	1	0.14	0.093	NA
Semivolatiles									
83-32-9	Acenaphthene	NA	--	--	1	1	0.14	0.093	NA
208-96-8	Acenaphthylene	NA	--	--	1	1	0.14	0.093	NA
120-12-7	Anthracene	NA	--	--	1	1	0.14	0.093	NA
56-55-3	Benzo(a)anthracene	NA	--	--	1	1	0.14	0.093	NA
50-32-8	Benzo(a)pyrene	NA	--	--	1	1	0.14	0.093	NA
205-99-2	Benzo(b)fluoranthene	NA	--	--	1	1	0.14	0.093	NA
191-24-2	Benzo(g,h,i)perylene	NA	--	--	1	1	0.14	0.093	NA
207-08-9	Benzo(k)fluoranthene	NA	--	--	1	1	0.14	0.093	NA
218-01-9	Chrysene	NA	--	--	1	1	0.14	0.093	NA
53-70-3	Dibenz(a,h)anthracene	NA	--	--	1	1	0.14	0.093	NA
105-67-9	2,4-Dimethylphenol	NA	--	--	1	1	0.14	0.093	NA
84-74-2	Di-n-butylphthalate	0.11	0.095	--	1	1	0.14	0.093	4.2E+00
206-44-0	Fluoranthene	NA	--	--	1	1	0.14	0.093	NA
86-73-7	Fluorene	NA	--	--	1	1	0.14	0.093	NA
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	--	1	1	0.14	0.093	NA
90-12-0	1-Methylnaphthalene	NA	--	--	1	1	0.14	0.093	NA
91-57-6	2-Methylnaphthalene	NA	--	--	1	1	0.14	0.093	NA
95-48-7	2-Methylphenol	NA	--	--	1	1	0.14	0.093	NA
108-39-4	3-Methylphenol	NA	--	--	1	1	0.14	0.093	NA
106-44-5	4-Methylphenol	NA	--	--	1	1	0.14	0.093	NA
34mp	3&4-Methylphenol [h]	--	--	--	--	--	--	--	NA
91-20-3	Naphthalene	NA	--	--	1	1	0.14	0.093	NA
85-01-8	Phenanthrene	NA	--	--	1	1	0.14	0.093	NA
108-95-2	Phenol	NA	--	--	1	1	0.14	0.093	NA
129-00-0	Pyrene	NA	--	--	1	1	0.14	0.093	NA
Metals									
7429-90-5	Aluminum [i]	--	--	--	--	--	--	--	--
7440-36-0	Antimony	NA	--	--	1	1	0.14	0.093	NA
7440-38-2	Arsenic	2.2	0.038	--	1	1	0.14	0.093	1.2E+02
7440-39-3	Barium	25	0.16	--	1	1	0.14	0.093	7.1E+02
7440-43-9	Cadmium	1.5	$e^{(0.546*ln(Cs)-0.475)}$	5.5	1	1	0.14	0.093	5.4E+01
7440-47-3	Chromium	NA	--	--	1	1	0.14	0.093	NA
16065-83-1	Chromium (III)	2.7	0.041	--	1	1	0.14	0.093	1.4E+02
18540-29-9	Chromium (VI)	NA	--	--	1	1	0.14	0.093	NA
7440-50-8	Copper	4.1	$e^{(0.394*ln(Cs)+0.668)}$	14	1	1	0.14	0.093	1.6E+02
7439-92-1	Lead	1.6	$e^{(0.561*ln(Cs)-1.328)}$	3.3	1	1	0.14	0.093	9.0E+01
7439-96-5	Manganese [i]	--	--	--	--	--	--	--	--
7439-97-6	Mercury	0.83	0.038	--	1	1	0.14	0.093	4.5E+01
7440-02-0	Nickel	6.7	$e^{(0.748*ln(Cs)-2.223)}$	9.8	1	1	0.14	0.093	4.1E+02
7782-49-2	Selenium	0.29	$e^{(1.104*ln(Cs)-0.677)}$	1.8	1	1	0.14	0.093	3.1E+00
7440-22-4	Silver	2.0	0.014	--	1	1	0.14	0.093	1.3E+02
7440-62-2	Vanadium	0.34	0.0049	--	1	1	0.14	0.093	2.5E+01
7440-66-6	Zinc	66	$e^{(0.554*ln(Cs)+1.575)}$	306	1	1	0.14	0.093	1.8E+03
Inorganics									
57-12-5	Cyanide	NA	--	--	1	1	0.14	0.093	NA

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
mg/kg: milligrams per kilogram
mg/kg-d: milligrams chemical per kilogram body weight per day
kg/kg-d: kilograms food per kilogram body weight per day
dw: dry weight
NA: not available
--: not applicable

Footnotes:

[a] Bird TRVs from Table 14.

[b] C_p calculated using equations in Table 12.

[c] Home range size of 6.9 acres (Erickstad et al., 1985). Conservatively assumed an AUF of 1 (e.g., birds only forage at a site).

[d] Year-round resident, so SUF of 1 was used.

[e] Midpoint of winter and spring dry weight FIR adjusted using midpoint of winter and spring body weights (Andreev, 1990).

[f] Turkey used as surrogate for soil ingestion as a fraction of dry weight diet (Beyer et al., 1994).

[g] For chemicals with BAFs that are a constant function of soil concentration, Tier II AL is calculated as follows: Tier II AL = $TRV/(AUF*SUF*FIR_{dw}*(BAF+P_s))$.
For chemicals with BAFs that are a log linear function of soil concentration, Tier II AL is calculated by setting the soil concentration (C_s) to give an HQ of 1, where HQ = (AUF*SUF*FIRdw*(Cp+(Cs*Ps)))/TRV.

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

References:

Andreev, A.V. 1990. Winter Adaptations in the Willow Ptarmigan. Arctic 44(2):106-114.
Beyer, W.N., E.E. Connor, and S. Gerould. 1994. Estimates of Soil Ingestion by Wildlife. J. Wildl. Manage. 58(2):375-382.
Erikstad, K.E., H.C. Pederson, and J.B. Steen. 1985. Growth and Survival of Willow Grouse Chicks in Relation to Home Range Size, Brood Movements and Habitat Selection. Ornis Scand. 16:181-190.

Table 19
Tier II Soil AL for Snow Goose
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Reference Value [a] TRV	Plant Bioaccumulation Factor BAF	Plant Concentration [b] C_p	Area Use Factor [c] AUF	Seasonal Use Factor [d] SUF	Dry Food Ingestion Rate [e] FIR_{dw}	Proportion Soil in Diet [f] P_s	Tier II Soil Action Level [g] AL
CAS #	**Chemical Name**	**(mg/kg-d)**	**(unitless)**	**(mg/kg) dw**	**(Unitless)**	**(Unitless)**	**(kg/kg-d) dw**	**(unitless)**	**(mg/kg)**
Volatiles									
67-64-1	Acetone	20,000	53	--	1	1	0.045	0.082	8.4E+03
107-02-8	Acrolein	NA	--	--	1	1	0.045	0.082	NA
71-43-2	Benzene	NA	--	--	1	1	0.045	0.082	NA
78-93-3	2-Butanone	NA	--	--	1	1	0.045	0.082	NA
56-23-5	Carbon tetrachloride	1.8	0.88	--	1	1	0.045	0.082	4.1E+01
108-90-7	Chlorobenzene	NA	--	--	1	1	0.045	0.082	NA
75-00-3	Chloroethane	NA	--	--	1	1	0.045	0.082	NA
67-66-3	Chloroform	NA	--	--	1	1	0.045	0.082	NA
106-93-4	1,2-Dibromoethane	0.070	2.8	--	1	1	0.045	0.082	5.4E-01
95-50-1	1,2-Dichlorobenzene	NA	--	--	1	1	0.045	0.082	NA
75-34-3	1,1-Dichloroethane	NA	--	--	1	1	0.045	0.082	NA
107-06-2	1,2-Dichloroethane	0.44	5.3	--	1	1	0.045	0.082	1.8E+00
75-35-4	1,1-Dichloroethene	NA	--	--	1	1	0.045	0.082	NA
156-59-2	cis-1,2-Dichloroethene	NA	--	--	1	1	0.045	0.082	NA
156-60-5	trans-1,2-Dichloroethene	NA	--	--	1	1	0.045	0.082	NA
60-29-7	Diethyl ether	NA	--	--	1	1	0.045	0.082	NA
123-91-1	1,4-Dioxane	NA	--	--	1	1	0.045	0.082	NA
100-41-4	Ethylbenzene	NA	--	--	1	1	0.045	0.082	NA
50-00-0	Formaldehyde	NA	--	--	1	1	0.045	0.082	NA
67-56-1	Methanol	NA	--	--	1	1	0.045	0.082	NA
75-09-2	Methylene chloride	NA	--	--	1	1	0.045	0.082	NA
108-10-1	4-Methyl-2-pentanone	NA	--	--	1	1	0.045	0.082	NA
103-65-1	n-Propylbenzene	NA	--	--	1	1	0.045	0.082	NA
127-18-4	Tetrachloroethene	NA	--	--	1	1	0.045	0.082	NA
108-88-3	Toluene	NA	--	--	1	1	0.045	0.082	NA
71-55-6	1,1,1-Trichloroethane	NA	--	--	1	1	0.045	0.082	NA
79-01-6	Trichloroethene	NA	--	--	1	1	0.045	0.082	NA
95-63-6	1,2,4-Trimethylbenzene	NA	--	--	1	1	0.045	0.082	NA
108-67-8	1,3,5-Trimethylbenzene	NA	--	--	1	1	0.045	0.082	NA
75-01-4	Vinyl chloride	NA	--	--	1	1	0.045	0.082	NA
1330-20-7	Xylenes	NA	--	--	1	1	0.045	0.082	NA
Semivolatiles									
83-32-9	Acenaphthene	NA	--	--	1	1	0.045	0.082	NA
208-96-8	Acenaphthylene	NA	--	--	1	1	0.045	0.082	NA
120-12-7	Anthracene	NA	--	--	1	1	0.045	0.082	NA
56-55-3	Benzo(a)anthracene	NA	--	--	1	1	0.045	0.082	NA
50-32-8	Benzo(a)pyrene	NA	--	--	1	1	0.045	0.082	NA
205-99-2	Benzo(b)fluoranthene	NA	--	--	1	1	0.045	0.082	NA
191-24-2	Benzo(g,h,i)perylene	NA	--	--	1	1	0.045	0.082	NA
207-08-9	Benzo(k)fluoranthene	NA	--	--	1	1	0.045	0.082	NA
218-01-9	Chrysene	NA	--	--	1	1	0.045	0.082	NA
53-70-3	Dibenz(a,h)anthracene	NA	--	--	1	1	0.045	0.082	NA
105-67-9	2,4-Dimethylphenol	NA	--	--	1	1	0.045	0.082	NA
84-74-2	Di-n-butylphthalate	0.11	0.095	--	1	1	0.045	0.082	1.4E+01
206-44-0	Fluoranthene	NA	--	--	1	1	0.045	0.082	NA
86-73-7	Fluorene	NA	--	--	1	1	0.045	0.082	NA
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	--	1	1	0.045	0.082	NA
90-12-0	1-Methylnaphthalene	NA	--	--	1	1	0.045	0.082	NA
91-57-6	2-Methylnaphthalene	NA	--	--	1	1	0.045	0.082	NA
95-48-7	2-Methylphenol	NA	--	--	1	1	0.045	0.082	NA
108-39-4	3-Methylphenol	NA	--	--	1	1	0.045	0.082	NA
106-44-5	4-Methylphenol	NA	--	--	1	1	0.045	0.082	NA
34mp	3&4-Methylphenol [h]	--	--	--	--	--	--	--	NA
91-20-3	Naphthalene	NA	--	--	1	1	0.045	0.082	NA
85-01-8	Phenanthrene	NA	--	--	1	1	0.045	0.082	NA
108-95-2	Phenol	NA	--	--	1	1	0.045	0.082	NA
129-00-0	Pyrene	NA	--	--	1	1	0.045	0.082	NA
Metals									
7429-90-5	Aluminum [i]	--	--	--	--	--	--	--	--
7440-36-0	Antimony	NA	--	--	1	1	0.045	0.082	NA
7440-38-2	Arsenic	2.2	0.038	--	1	1	0.045	0.082	4.2E+02
7440-39-3	Barium	6.2	0.16	--	1	1	0.045	0.082	5.8E+02
7440-43-9	Cadmium	1.5	$e^{(0.546*ln(Cs)-0.475)}$	13	1	1	0.045	0.082	2.5E+02
7440-47-3	Chromium	NA	--	--	1	1	0.045	0.082	NA
16065-83-1	Chromium (III)	2.7	0.041	--	1	1	0.045	0.082	4.8E+02
18540-29-9	Chromium (VI)	NA	--	--	1	1	0.045	0.082	NA
7440-50-8	Copper	4.1	$e^{(0.394*ln(Cs)+0.668)}$	27	1	1	0.045	0.082	7.7E+02
7439-92-1	Lead	1.6	$e^{(0.561*ln(Cs)-1.328)}$	7.1	1	1	0.045	0.082	3.5E+02
7439-96-5	Manganese [i]	--	--	--	--	--	--	--	--
7439-97-6	Mercury	0.21	0.038	--	1	1	0.045	0.082	3.9E+01
7440-02-0	Nickel	6.7	$e^{(0.748*ln(Cs)-2.223)}$	26	1	1	0.045	0.082	1.5E+03
7782-49-2	Selenium	0.29	$e^{(1.104*ln(Cs)-0.677)}$	5.7	1	1	0.045	0.082	8.9E+00
7440-22-4	Silver	2.0	0.014	--	1	1	0.045	0.082	4.7E+02
7440-62-2	Vanadium	0.34	0.0049	--	1	1	0.045	0.082	8.8E+01
7440-66-6	Zinc	66	$e^{(0.554*ln(Cs)+1.575)}$	743	1	1	0.045	0.082	8.9E+03
Inorganics									
57-12-5	Cyanide	NA	--	--	1	1	0.045	0.082	NA

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
mg/kg: milligrams per kilogram
mg/kg-d: milligrams chemical per kilogram body weight per day
kg/kg-d: kilograms food per kilogram body weight per day
dw: dry weight
NA: not available
--: not applicable

Footnotes:

[a] Bird TRVs from Table 14.

[b] C_p calculated using equations in Table 12.

[c] Home range size of 1,680 acres (Hughes et al., 1994) is larger than any individual site; nevertheless an AUF of 1 was conservatively used.

[d] The snow goose is a migratory species; however, a SUF of 1 was conservatively assumed.

[e] USGS (2002) reported geese in Alaska consumed 30% of body weight per day (wet weight). Converted to dry weight FIR by assuming diet water content of 85% (Table 11).

[f] Canada goose used as surrogate for soil ingestion as a fraction of dry weight diet (Beyer et al., 1994).

[g] For chemicals with BAFs that are a constant function of soil concentration, Tier II AL is calculated as follows: Tier II AL = $TRV/(AUF*SUF*FIR_{dw}*(BAF+P_s))$.

For chemicals with BAFs that are a log linear function of soil concentration, Tier II AL iscalculated by setting the soil concentration (C_s) to give an HQ of 1, where HQ = (AUF*SUF*FIRdw*(Cp+(Cs*Ps)))/TRV.

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

References:

Beyer, W.N., E.E. Connor, and S. Gerould. 1994. Estimates of Soil Ingestion by Wildlife. J. Wildl. Manage. 58(2):375-382.

Hughes, R.J., A. Reed, and G. Gauthier. 1994. Space and Habitat Use by Greater Snow Goose Broods on Bylot Island, Northwest Territories. J. Wildl. Manage. 58(3):536-545.

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Table 20
Tier II Soil AL for Lapland Longspur
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Reference Value [a] TRV	Invertebrate Bioaccumulation Factor BAF	Invertebrate Concentration [b] C_i	Area Use Factor [c] AUF	Seasonal Use Factor [d] SUF	Dry Food Ingestion Rate [e] FIR_{dw}	Proportion Soil in Diet [f] P_s	Tier II Soil Action Level [g] AL
CAS #	Chemical Name	(mg/kg-d)	(unitless)	(mg/kg) dw	(Unitless)	(Unitless)	(kg/kg-d) dw	(unitless)	(mg/kg)
Volatiles									
67-64-1	Acetone	5,000	0.30	--	1	0.25	0.24	0.16	1.8E+05
107-02-8	Acrolein	NA	--	--	1	0.25	0.24	0.16	NA
71-43-2	Benzene	NA	--	--	1	0.25	0.24	0.16	NA
78-93-3	2-Butanone	NA	--	--	1	0.25	0.24	0.16	NA
56-23-5	Carbon tetrachloride	1.8	72	--	1	0.25	0.24	0.16	4.1E-01
108-90-7	Chlorobenzene	NA	--	--	1	0.25	0.24	0.16	NA
75-00-3	Chloroethane	NA	--	--	1	0.25	0.24	0.16	NA
67-66-3	Chloroform	NA	--	--	1	0.25	0.24	0.16	NA
106-93-4	1,2-Dibromoethane	0.070	0	--	1	0.25	0.24	0.16	7.1E+00
95-50-1	1,2-Dichlorobenzene	NA	--	--	1	0.25	0.24	0.16	NA
75-34-3	1,1-Dichloroethane	NA	--	--	1	0.25	0.24	0.16	NA
107-06-2	1,2-Dichloroethane	0.44	0	--	1	0.25	0.24	0.16	4.4E+01
75-35-4	1,1-Dichloroethene	NA	--	--	1	0.25	0.24	0.16	NA
156-59-2	cis-1,2-Dichloroethene	NA	--	--	1	0.25	0.24	0.16	NA
156-60-5	trans-1,2-Dichloroethene	NA	--	--	1	0.25	0.24	0.16	NA
60-29-7	Diethyl ether	NA	--	--	1	0.25	0.24	0.16	NA
123-91-1	1,4-Dioxane	NA	--	--	1	0.25	0.24	0.16	NA
100-41-4	Ethylbenzene	NA	--	--	1	0.25	0.24	0.16	NA
50-00-0	Formaldehyde	NA	--	--	1	0.25	0.24	0.16	NA
67-56-1	Methanol	NA	--	--	1	0.25	0.24	0.16	NA
75-09-2	Methylene chloride	NA	--	--	1	0.25	0.24	0.16	NA
108-10-1	4-Methyl-2-pentanone	NA	--	--	1	0.25	0.24	0.16	NA
103-65-1	n-Propylbenzene	NA	--	--	1	0.25	0.24	0.16	NA
127-18-4	Tetrachloroethene	NA	--	--	1	0.25	0.24	0.16	NA
108-88-3	Toluene	NA	--	--	1	0.25	0.24	0.16	NA
71-55-6	1,1,1-Trichloroethane	NA	--	--	1	0.25	0.24	0.16	NA
79-01-6	Trichloroethene	NA	--	--	1	0.25	0.24	0.16	NA
95-63-6	1,2,4-Trimethylbenzene	NA	--	--	1	0.25	0.24	0.16	NA
108-67-8	1,3,5-Trimethylbenzene	NA	--	--	1	0.25	0.24	0.16	NA
75-01-4	Vinyl chloride	NA	--	--	1	0.25	0.24	0.16	NA
1330-20-7	Xylenes	NA	--	--	1	0.25	0.24	0.16	NA
Semivolatiles									
83-32-9	Acenaphthene	NA	--	--	1	0.25	0.24	0.16	NA
208-96-8	Acenaphthylene	NA	--	--	1	0.25	0.24	0.16	NA
120-12-7	Anthracene	NA	--	--	1	0.25	0.24	0.16	NA
56-55-3	Benzo(a)anthracene	NA	--	--	1	0.25	0.24	0.16	NA
50-32-8	Benzo(a)pyrene	NA	--	--	1	0.25	0.24	0.16	NA
205-99-2	Benzo(b)fluoranthene	NA	--	--	1	0.25	0.24	0.16	NA
191-24-2	Benzo(g,h,i)perylene	NA	--	--	1	0.25	0.24	0.16	NA
207-08-9	Benzo(k)fluoranthene	NA	--	--	1	0.25	0.24	0.16	NA
218-01-9	Chrysene	NA	--	--	1	0.25	0.24	0.16	NA
53-70-3	Dibenz(a,h)anthracene	NA	--	--	1	0.25	0.24	0.16	NA
105-67-9	2,4-Dimethylphenol	NA	--	--	1	0.25	0.24	0.16	NA
84-74-2	Di-n-butylphthalate	0.11	1.6	--	1	0.25	0.24	0.16	1.0E+00
206-44-0	Fluoranthene	NA	--	--	1	0.25	0.24	0.16	NA
86-73-7	Fluorene	NA	--	--	1	0.25	0.24	0.16	NA
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	--	1	0.25	0.24	0.16	NA
90-12-0	1-Methylnaphthalene	NA	--	--	1	0.25	0.24	0.16	NA
91-57-6	2-Methylnaphthalene	NA	--	--	1	0.25	0.24	0.16	NA
95-48-7	2-Methylphenol	NA	--	--	1	0.25	0.24	0.16	NA
108-39-4	3-Methylphenol	NA	--	--	1	0.25	0.24	0.16	NA
106-44-5	4-Methylphenol	NA	--	--	1	0.25	0.24	0.16	NA
34mp	3&4-Methylphenol [h]	--	--	--	--	--	--	--	NA
91-20-3	Naphthalene	NA	--	--	1	0.25	0.24	0.16	NA
85-01-8	Phenanthrene	NA	--	--	1	0.25	0.24	0.16	NA
108-95-2	Phenol	NA	--	--	1	0.25	0.24	0.16	NA
129-00-0	Pyrene	NA	--	--	1	0.25	0.24	0.16	NA
Metals									
7429-90-5	Aluminum [i]	--	--	--	--	--	--	--	--
7440-36-0	Antimony	NA	--	--	1	0.25	0.24	0.16	NA
7440-38-2	Arsenic	2.2	$e^{(0.706*\ln(Cs)-1.421)}$	9.1	1	0.25	0.24	0.16	1.7E+02
7440-39-3	Barium	6.2	0.091	--	1	0.25	0.24	0.16	4.0E+02
7440-43-9	Cadmium	1.5	$e^{(0.795*\ln(Cs)+2.114)}$	24	1	0.25	0.24	0.16	3.8E+00
7440-47-3	Chromium	NA	--	--	1	0.25	0.24	0.16	NA
16065-83-1	Chromium (III)	2.7	0.31	--	1	0.25	0.24	0.16	9.4E+01
18540-29-9	Chromium (VI)	NA	--	--	1	0.25	0.24	0.16	NA
7440-50-8	Copper	4.1	0.52	--	1	0.25	0.24	0.16	9.9E+01
7439-92-1	Lead	1.6	$e^{(0.807*\ln(Cs)-0.218)}$	19	1	0.25	0.24	0.16	5.0E+01
7439-96-5	Manganese [i]	--	--	--	--	--	--	--	--
7439-97-6	Mercury	0.21	3.1	--	1	0.25	0.24	0.16	1.1E+00
7440-02-0	Nickel	6.7	0.12	--	1	0.25	0.24	0.16	3.9E+02
7782-49-2	Selenium	0.29	$e^{(0.733*\ln(Cs)-0.075)}$	3.7	1	0.25	0.24	0.16	6.6E+00
7440-22-4	Silver	2.0	2.0	--	1	0.25	0.24	0.16	1.5E+01
7440-62-2	Vanadium	0.34	0.042	--	1	0.25	0.24	0.16	2.8E+01
7440-66-6	Zinc	66	$e^{(0.328*\ln(Cs)+4.449)}$	888	1	0.25	0.24	0.16	1.3E+03
Inorganics									
57-12-5	Cyanide	NA	--	--	1	0.25	0.24	0.16	NA

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
mg/kg: milligrams per kilogram
mg/kg-d: milligrams chemical per kilogram body weight per day
kg/kg-d: kilograms food per kilogram body weight per day
dw: dry weight
NA: not available
--: not applicable
g dry wt/d: grams of food (dry weight) per day

Footnotes:

[a] Bird TRVs from Table 14.

[b] C_i calculated using equations in Table 12.

[c] Home range size of 4.35 acres (Seastedt and MacLean, 1979) is smaller than some sites; therefore, an AUF of one was used.

[d] The Lapland longspur is a seasonal migrant and was assumed to be present for no more than three months per year.

[e] FIR (g dry wt/d) = 0.398 * Weight$^{0.850}$ based on equation for passerines in EPA (1993). Using body weight of 28 grams, dry weight FIR = 0.241 kg/kg-d.

[f] From EPA (2005); based on value for woodcock (same feeding guild).

[g] For chemicals with BAFs that are a constant function of soil concentration, Tier II AL is calculated as follows: Tier II AL = TRV/(AUF*SUF*FIR_{dw}*(BAF+P_s)).
For chemicals with BAFs that are a log linear function of soil concentration, Tier II AL is calculated by setting the soil concentration (C_s) to give an HQ of 1, where
HQ = (AUF*SUF*FIRdw*(Ci+(Cs*Ps)))/TRV.

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

References:
Seastedt, T.R., and S.F. MacLean. 1979. Territory size and composition in relation to resource abundance in Lapland longspurs breeding in Arctic Alaska. The Auk, 96:131-142.
U.S. Environmental Protection Agency (EPA). 1993. Wildlife Exposure Factors Handbook. EPA/600/R-93/187. December.
EPA. 2005. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response. November 2003. Revised February 2005.
http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

Table 21
Tier II Soil AL for Snowy Owl
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Reference Value [a] TRV	Mammal Bioaccumulation Factor BAF	Mammal Concentration [b] C_m	Area Use Factor [c] AUF	Seasonal Use Factor [d] SUF	Dry Food Ingestion Rate [e] FIR_{dw}	Proportion Soil in Diet [f] P_s	Tier II Soil Action Level [g] AL
CAS #	Chemical Name	(mg/kg-d)	(unitless)	(mg/kg) dw	(Unitless)	(Unitless)	(kg/kg-d) dw	(unitless)	(mg/kg)
Volatiles									
67-64-1	Acetone	5,000	0	--	1	1	0.045	0.057	1.9E+06
107-02-8	Acrolein	NA	--	--	1	1	0.045	0.057	NA
71-43-2	Benzene	NA	--	--	1	1	0.045	0.057	NA
78-93-3	2-Butanone	NA	--	--	1	1	0.045	0.057	NA
56-23-5	Carbon tetrachloride	1.8	0	--	1	1	0.045	0.057	6.9E+02
108-90-7	Chlorobenzene	NA	--	--	1	1	0.045	0.057	NA
75-00-3	Chloroethane	NA	--	--	1	1	0.045	0.057	NA
67-66-3	Chloroform	NA	--	--	1	1	0.045	0.057	NA
106-93-4	1,2-Dibromoethane	0.070	0	--	1	1	0.045	0.057	2.7E+01
95-50-1	1,2-Dichlorobenzene	NA	--	--	1	1	0.045	0.057	NA
75-34-3	1,1-Dichloroethane	NA	--	--	1	1	0.045	0.057	NA
107-06-2	1,2-Dichloroethane	0.44	0	--	1	1	0.045	0.057	1.7E+02
75-35-4	1,1-Dichloroethene	NA	--	--	1	1	0.045	0.057	NA
156-59-2	cis-1,2-Dichloroethene	NA	--	--	1	1	0.045	0.057	NA
156-60-5	trans-1,2-Dichloroethene	NA	--	--	1	1	0.045	0.057	NA
60-29-7	Diethyl ether	NA	--	--	1	1	0.045	0.057	NA
123-91-1	1,4-Dioxane	NA	--	--	1	1	0.045	0.057	NA
100-41-4	Ethylbenzene	NA	--	--	1	1	0.045	0.057	NA
50-00-0	Formaldehyde	NA	--	--	1	1	0.045	0.057	NA
67-56-1	Methanol	NA	--	--	1	1	0.045	0.057	NA
75-09-2	Methylene chloride	NA	--	--	1	1	0.045	0.057	NA
108-10-1	4-Methyl-2-pentanone	NA	--	--	1	1	0.045	0.057	NA
103-65-1	n-Propylbenzene	NA	--	--	1	1	0.045	0.057	NA
127-18-4	Tetrachloroethene	NA	--	--	1	1	0.045	0.057	NA
108-88-3	Toluene	NA	--	--	1	1	0.045	0.057	NA
71-55-6	1,1,1-Trichloroethane	NA	--	--	1	1	0.045	0.057	NA
79-01-6	Trichloroethene	NA	--	--	1	1	0.045	0.057	NA
95-63-6	1,2,4-Trimethylbenzene	NA	--	--	1	1	0.045	0.057	NA
108-67-8	1,3,5-Trimethylbenzene	NA	--	--	1	1	0.045	0.057	NA
75-01-4	Vinyl chloride	NA	--	--	1	1	0.045	0.057	NA
1330-20-7	Xylenes	NA	--	--	1	1	0.045	0.057	NA
Semivolatiles									
83-32-9	Acenaphthene	NA	--	--	1	1	0.045	0.057	NA
208-96-8	Acenaphthylene	NA	--	--	1	1	0.045	0.057	NA
120-12-7	Anthracene	NA	--	--	1	1	0.045	0.057	NA
56-55-3	Benzo(a)anthracene	NA	--	--	1	1	0.045	0.057	NA
50-32-8	Benzo(a)pyrene	NA	--	--	1	1	0.045	0.057	NA
205-99-2	Benzo(b)fluoranthene	NA	--	--	1	1	0.045	0.057	NA
191-24-2	Benzo(g,h,i)perylene	NA	--	--	1	1	0.045	0.057	NA
207-08-9	Benzo(k)fluoranthene	NA	--	--	1	1	0.045	0.057	NA
218-01-9	Chrysene	NA	--	--	1	1	0.045	0.057	NA
53-70-3	Dibenz(a,h)anthracene	NA	--	--	1	1	0.045	0.057	NA
105-67-9	2,4-Dimethylphenol	NA	--	--	1	1	0.045	0.057	NA
84-74-2	Di-n-butylphthalate	0.11	0	--	1	1	0.045	0.057	4.3E+01
206-44-0	Fluoranthene	NA	--	--	1	1	0.045	0.057	NA
86-73-7	Fluorene	NA	--	--	1	1	0.045	0.057	NA
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	--	1	1	0.045	0.057	NA
90-12-0	1-Methylnaphthalene	NA	--	--	1	1	0.045	0.057	NA
91-57-6	2-Methylnaphthalene	NA	--	--	1	1	0.045	0.057	NA
95-48-7	2-Methylphenol	NA	--	--	1	1	0.045	0.057	NA
108-39-4	3-Methylphenol	NA	--	--	1	1	0.045	0.057	NA
106-44-5	4-Methylphenol	NA	--	--	1	1	0.045	0.057	NA
34mp	3&4-Methylphenol [h]	--	--	--	--	--	--	--	NA
91-20-3	Naphthalene	NA	--	--	1	1	0.045	0.057	NA
85-01-8	Phenanthrene	NA	--	--	1	1	0.045	0.057	NA
108-95-2	Phenol	NA	--	--	1	1	0.045	0.057	NA
129-00-0	Pyrene	NA	--	--	1	1	0.045	0.057	NA
Metals									
7429-90-5	Aluminum [i]	--	--	--	--	--	--	--	--
7440-36-0	Antimony	NA	--	--	1	1	0.045	0.057	NA
7440-38-2	Arsenic	2.2	$e^{(0.8188*ln(Cs)-4.8471)}$	1.9	1	1	0.045	0.057	8.4E+02
7440-39-3	Barium	6.2	0.00068	--	1	1	0.045	0.057	2.4E+03
7440-43-9	Cadmium	1.5	$e^{(0.4723*ln(Cs)-1.2571)}$	5.2	1	1	0.045	0.057	4.8E+02
7440-47-3	Chromium	NA	--	--	1	1	0.045	0.057	NA
16065-83-1	Chromium (III)	2.7	$e^{(0.7338*ln(Cs)-1.4599)}$	25	1	1	0.045	0.057	5.9E+02
18540-29-9	Chromium (VI)	NA	--	--	1	1	0.045	0.057	NA
7440-50-8	Copper	4.1	$e^{(1.444*ln(Cs)+2.042)}$	89	1	1	0.045	0.057	5.5E+00
7439-92-1	Lead	1.6	$e^{(0.4422*ln(Cs)+0.0761)}$	15	1	1	0.045	0.057	3.7E+02
7439-96-5	Manganese [i]	--	--	--	--	--	--	--	--
7439-97-6	Mercury	0.21	0.00024	--	1	1	0.045	0.057	8.1E+01
7440-02-0	Nickel	6.7	$e^{(0.4658*ln(Cs)-0.2462)}$	28	1	1	0.045	0.057	2.1E+03
7782-49-2	Selenium	0.29	$e^{(0.3764*ln(Cs)-0.4158)}$	3.1	1	1	0.045	0.057	5.9E+01
7440-22-4	Silver	2.0	0.0040	--	1	1	0.045	0.057	7.3E+02
7440-62-2	Vanadium	0.34	0.012	--	1	1	0.045	0.057	1.1E+02
7440-66-6	Zinc	66	$e^{(0.0706*ln(Cs)+4.3632)}$	159	1	1	0.045	0.057	2.3E+04
Inorganics									
57-12-5	Cyanide	NA	--	--	1	1	0.045	0.057	NA

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
mg/kg: milligrams per kilogram
mg/kg-d: milligrams chemical per kilogram body weight per day
kg/kg-d: kilograms food per kilogram body weight per day
dw: dry weight
NA: not available
--: not applicable
g/d: grams of food per day
kg: kilograms

Footnotes:

[a] Bird TRVs from Table 14.

[b] C_m calculated using equations in Table 12.

[c] Foraging area of 1,063 acres (Parmelee, 1992) is larger than any single site; however an AUF of one was conservatively used.

[d] The snowy owl often migrates, but was conservatively assumed to be present year-round.

[e] Midpoint of daily wet weight (g/d) FIR from Gessaman (1972), adjusted for diet water content of 68% (Table 11) and body weight of 2.28 kg.

[f] From EPA (2005) using red-tail hawk (same feeding guild) as a surrogate.

[g] For chemicals with BAFs that are a constant function of soil concentration, Tier II AL is calculated as follows: Tier II AL = $TRV/(AUF*SUF*FIR_{dw}*(BAF+P_s))$.
For chemicals with BAFs that are a log linear function of soil concentration, Tier II AL is calculated by setting the soil concentration (C_s) to give an HQ of 1, where
HQ = (AUF*SUF*FIRdw*(Cm+(Cs*Ps)))/TRV.

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

References:

Gessaman, J.A. 1972. Bioenergetics of the Snowy Owl (*Nyctea scandiaca*). *Arctic and Alpine Research,* Vol. 4, No. 3, pp. 223-238.

Parmelee, D. 1992. Snowy Owl (Nyctea scandiaca). Pp. 1-20 in A. Poole, P. Stettenheim, F. Gill, eds. The Birds of North America, Vol. 10. Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

U.S. Environmental Protection Agency (EPA). 2005. Guidance for Developing Ecological Soil Screening Levels. Office of Solid Waste and Emergency Response. November 2003. Revised February 2005. http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

Table 22
Tier II Water AL for Arctic Loon
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Reference Value [a] TRV (mg/kg-d)	Fish Bioconcentration Factor [b] BCF (L/kg)	Area Use Factor [c] AUF (Unitless)	Seasonal Use Factor [d] SUF (Unitless)	Wet Food Ingestion Rate [e] FIR_{ww} (kg/kg-d) ww	Water Ingestion Rate [f] WIR (L/kg-d)	Tier II Water Action Level [g] AL (mg/L)
CAS #	Chemical Name							
Volatiles								
67-64-1	Acetone	5,000	3.2	1	1	0.23	0.037	6.5E+03
107-02-8	Acrolein	NA	--	1	1	0.23	0.037	NA
71-43-2	Benzene	NA	--	1	1	0.23	0.037	NA
78-93-3	2-Butanone	NA	--	1	1	0.23	0.037	NA
56-23-5	Carbon tetrachloride	1.8	7.4	1	1	0.23	0.037	1.0E+00
108-90-7	Chlorobenzene	NA	--	1	1	0.23	0.037	NA
75-00-3	Chloroethane	NA	--	1	1	0.23	0.037	NA
67-66-3	Chloroform	NA	--	1	1	0.23	0.037	NA
106-93-4	1,2-Dibromoethane	0.070	15	1	1	0.23	0.037	2.0E-02
95-50-1	1,2-Dichlorobenzene	NA	--	1	1	0.23	0.037	NA
75-34-3	1,1-Dichloroethane	NA	--	1	1	0.23	0.037	NA
107-06-2	1,2-Dichloroethane	0.44	4.4	1	1	0.23	0.037	4.2E-01
75-35-4	1,1-Dichloroethene	NA	--	1	1	0.23	0.037	NA
156-59-2	cis-1,2-Dichloroethene	NA	--	1	1	0.23	0.037	NA
156-60-5	trans-1,2-Dichloroethene	NA	--	1	1	0.23	0.037	NA
60-29-7	Diethyl ether	NA	--	1	1	0.23	0.037	NA
123-91-1	1,4-Dioxane	NA	--	1	1	0.23	0.037	NA
100-41-4	Ethylbenzene	NA	--	1	1	0.23	0.037	NA
50-00-0	Formaldehyde	NA	--	1	1	0.23	0.037	NA
67-56-1	Methanol	NA	--	1	1	0.23	0.037	NA
75-09-2	Methylene chloride	NA	--	1	1	0.23	0.037	NA
108-10-1	4-Methyl-2-pentanone	NA	--	1	1	0.23	0.037	NA
103-65-1	n-Propylbenzene	NA	--	1	1	0.23	0.037	NA
127-18-4	Tetrachloroethene	NA	--	1	1	0.23	0.037	NA
108-88-3	Toluene	NA	--	1	1	0.23	0.037	NA
71-55-6	1,1,1-Trichloroethane	NA	--	1	1	0.23	0.037	NA
79-01-6	Trichloroethene	NA	--	1	1	0.23	0.037	NA
95-63-6	1,2,4-Trimethylbenzene	NA	--	1	1	0.23	0.037	NA
108-67-8	1,3,5-Trimethylbenzene	NA	--	1	1	0.23	0.037	NA
75-01-4	Vinyl chloride	NA	--	1	1	0.23	0.037	NA
1330-20-7	Xylenes	NA	--	1	1	0.23	0.037	NA
Semivolatiles								
83-32-9	Acenaphthene	NA	--	1	1	0.23	0.037	NA
208-96-8	Acenaphthylene	NA	--	1	1	0.23	0.037	NA
120-12-7	Anthracene	NA	--	1	1	0.23	0.037	NA
56-55-3	Benzo(a)anthracene	NA	--	1	1	0.23	0.037	NA
50-32-8	Benzo(a)pyrene	NA	--	1	1	0.23	0.037	NA
205-99-2	Benzo(b)fluoranthene	NA	--	1	1	0.23	0.037	NA
191-24-2	Benzo(g,h,i)perylene	NA	--	1	1	0.23	0.037	NA
207-08-9	Benzo(k)fluoranthene	NA	--	1	1	0.23	0.037	NA
218-01-9	Chrysene	NA	--	1	1	0.23	0.037	NA
53-70-3	Dibenz(a,h)anthracene	NA	--	1	1	0.23	0.037	NA
105-67-9	2,4-Dimethylphenol	NA	--	1	1	0.23	0.037	NA
84-74-2	Di-n-butylphthalate	0.11	167	1	1	0.23	0.037	2.9E-03
206-44-0	Fluoranthene	NA	--	1	1	0.23	0.037	NA
86-73-7	Fluorene	NA	--	1	1	0.23	0.037	NA
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	1	1	0.23	0.037	NA
90-12-0	1-Methylnaphthalene	NA	--	1	1	0.23	0.037	NA
91-57-6	2-Methylnaphthalene	NA	--	1	1	0.23	0.037	NA
95-48-7	2-Methylphenol	NA	--	1	1	0.23	0.037	NA
108-39-4	3-Methylphenol	NA	--	1	1	0.23	0.037	NA
106-44-5	4-Methylphenol	NA	--	1	1	0.23	0.037	NA
34mp	3&4-Methylphenol [h]	--	--	--	--	--	--	NA
91-20-3	Naphthalene	NA	--	1	1	0.23	0.037	NA
85-01-8	Phenanthrene	NA	--	1	1	0.23	0.037	NA
108-95-2	Phenol	NA	--	1	1	0.23	0.037	NA
129-00-0	Pyrene	NA	--	1	1	0.23	0.037	NA
Metals								
7429-90-5	Aluminum [i]	--	--	--	--	--	--	--
7440-36-0	Antimony	NA	--	1	1	0.23	0.037	NA
7440-38-2	Arsenic	2.2	300	1	1	0.23	0.037	3.2E-02
7440-39-3	Barium	6.2	4.0	1	1	0.23	0.037	6.5E+00
7440-43-9	Cadmium	1.5	200	1	1	0.23	0.037	3.2E-02
7440-47-3	Chromium	NA	--	1	1	0.23	0.037	NA
16065-83-1	Chromium (III)	NA	--	1	1	0.23	0.037	NA
18540-29-9	Chromium (VI)	NA	--	1	1	0.23	0.037	NA
7440-50-8	Copper	4.1	200	1	1	0.23	0.037	8.8E-02
7439-92-1	Lead	1.6	300	1	1	0.23	0.037	2.4E-02
7439-96-5	Manganese [i]	--	--	--	--	--	--	--
7439-97-6	Mercury	0.21	1,000	1	1	0.23	0.037	9.1E-04
7440-02-0	Nickel	6.7	100	1	1	0.23	0.037	2.9E-01
7782-49-2	Selenium	0.29	200	1	1	0.23	0.037	6.3E-03
7440-22-4	Silver	2.0	5.0	1	1	0.23	0.037	1.7E+00
7440-62-2	Vanadium	0.34	0	1	1	0.23	0.037	9.3E+00
7440-66-6	Zinc	66	1,000	1	1	0.23	0.037	2.9E-01
Inorganics								
57-12-5	Cyanide	NA	--	1	1	0.23	0.037	NA

Abbreviations:

VOC: volatile organic compound
SVOC: semi-volatile organic compound
mg/L: milligrams per liter
mg/kg-d: milligrams chemical per kilogram body weight per day
ww: wet weight
L/kg: liters of water per kilogram of fish
L/kg-d: liters of water per kilogram body weight per day
kg/kg-d: kilograms food per kilogram body weight per day
NA: not available
--: not applicable
kg: kilograms

Footnotes:

[a] Bird TRVs from Table 14.

[b] Fish bioaccumulation factors from Table 12.

[c] Home range size of 62 acres (Sjolander and Agren, 1972) is smaller than some sites; therefore, an AUF of one was conservatively used.

[d] The Arctic loon often migrates, but was conservatively assumed to be present year-round.

[e] Based on surrogate common loon (same family) from Barr (1996), FIR of 960 grams wet weight per day was adjusted for body weight of 4,130 grams.

[f] WIR (L/kg-d) = 0.059 * Weight $^{0.67}$ based on equation in EPA (1993). Adjusted for body weight of 4.13 kg.

[g] Tier II AL = TRV/(AUF*SUF*((FIR_{ww}*BCF)+(WIR))).

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes and no Tier II ALs were developed.

References:

Barr, J.F. 1996. Aspects of Common Loon (*Gavia immer*) Feeding Biology on its Breeding Ground. Hydrobiologica 321:119-144.
Sjolander, S. and G. Agren. 1972. Reproductive Behavior of the Common Loon. Wilson Bull. 84:296-308.
U.S. Environmental Protection Agency (EPA). 1993. Wildlife Exposure Factors Handbook. EPA/600/R-93/187. December.

Table 23
Summary of Soil Ecological ALs
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Terrestrial Indicator Species								Lowest Tier II AL (mg/kg)
		Mammal ALs (mg/kg)			Bird ALs (mg/kg)				Plant ALs [a] (mg/kg)	
CAS #	**Chemical Name**	**Arctic Shrew**	**Brown Lemming**	**Least Weasel**	**Willow Ptarmigan**	**Snow Goose**	**Lapland Longspur**	**Snowy Owl**		
Volatiles										
67-64-1	Acetone	1.6E+03	**6.2E+00**	1.6E+04	6.7E+02	8.4E+03	1.8E+05	1.9E+06	NA	6.2E+00
107-02-8	Acrolein	2.7E+02	**1.1E-01**	2.2E+02	NA	NA	NA	NA	NA	1.1E-01
71-43-2	Benzene	9.7E+01	**6.9E-01**	7.8E+01	NA	NA	NA	NA	NA	6.9E-01
78-93-3	2-Butanone	2.3E+04	**1.4E+01**	1.9E+04	NA	NA	NA	NA	NA	1.4E+01
56-23-5	Carbon tetrachloride	**3.5E-01**	1.7E+01	7.8E+02	2.6E+01	4.1E+01	4.1E-01	6.9E+02	NA	3.5E-01
108-90-7	Chlorobenzene	1.0E+04	**1.9E+02**	8.1E+03	NA	NA	NA	NA	NA	1.9E+02
75-00-3	Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
67-66-3	Chloroform	**1.1E+01**	4.2E+01	5.8E+03	NA	NA	NA	NA	NA	1.1E+01
106-93-4	1,2-Dibromoethane	2.7E+03	1.5E+01	2.2E+03	**3.4E-01**	5.4E-01	7.1E+00	2.7E+01	NA	3.4E-01
95-50-1	1,2-Dichlorobenzene	1.2E+03	**4.5E+01**	9.3E+02	NA	NA	NA	NA	NA	4.5E+01
75-34-3	1,1-Dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
107-06-2	1,2-Dichloroethane	4.8E+03	1.5E+01	3.9E+03	2.3E+00	**1.8E+00**	4.4E+01	1.7E+02	NA	1.8E+00
75-35-4	1,1-Dichloroethene	1.4E+03	**1.0E+01**	1.1E+03	NA	NA	NA	NA	NA	1.0E+01
156-59-2	cis-1,2-Dichloroethene	1.8E+04	**4.4E+01**	1.4E+04	NA	NA	NA	NA	NA	4.4E+01
156-60-5	trans-1,2-Dichloroethene	1.8E+04	**5.9E+01**	1.4E+04	NA	NA	NA	NA	NA	5.9E+01
60-29-7	Diethyl ether	7.0E+05	**9.6E+02**	5.6E+05	NA	NA	NA	NA	NA	9.6E+02
123-91-1	1,4-Dioxane	9.5E+02	**2.8E+00**	7.8E+03	NA	NA	NA	NA	NA	2.8E+00
100-41-4	Ethylbenzene	1.3E+04	**3.6E+02**	1.1E+04	NA	NA	NA	NA	NA	3.6E+02
50-00-0	Formaldehyde	4.2E+01	**4.7E-01**	2.2E+03	NA	NA	NA	NA	NA	4.7E-01
67-56-1	Methanol	9.7E+03	**1.4E+00**	7.8E+03	NA	NA	NA	NA	NA	1.4E+00
75-09-2	Methylene chloride	6.1E+02	**1.7E+01**	6.1E+03	NA	NA	NA	NA	NA	1.7E+01
108-10-1	4-Methyl-2-pentanone	9.7E+03	**1.2E+01**	7.8E+03	NA	NA	NA	NA	NA	1.2E+01
103-65-1	n-Propylbenzene	9.9E+03	**5.2E+02**	7.9E+03	NA	NA	NA	NA	NA	5.2E+02
127-18-4	Tetrachloroethene	2.7E+02	**1.0E+01**	2.2E+02	NA	NA	NA	NA	NA	1.0E+01
108-88-3	Toluene	2.4E+02	**3.8E+00**	1.9E+02	NA	NA	NA	NA	6.8E+02	3.8E+00
71-55-6	1,1,1-Trichloroethane	9.0E+03	**1.0E+02**	7.2E+03	NA	NA	NA	NA	NA	1.0E+02
79-01-6	Trichloroethene	4.3E+02	**4.5E+00**	3.4E+02	NA	NA	NA	NA	NA	4.5E+00
95-63-6	1,2,4-Trimethylbenzene	9.0E+03	**4.4E+02**	7.2E+03	NA	NA	NA	NA	NA	4.4E+02
108-67-8	1,3,5-Trimethylbenzene	3.8E+02	**1.4E+01**	3.0E+02	NA	NA	NA	NA	NA	1.4E+01
75-01-4	Vinyl chloride	2.9E+01	**1.5E+01**	3.3E+03	NA	NA	NA	NA	NA	1.5E+01
1330-20-7	Xylenes	2.4E+04	**6.6E+02**	2.0E+04	NA	NA	NA	NA	NA	6.6E+02
Semivolatiles										
83-32-9	Acenaphthene	**3.0E+01**	1.1E+03	1.4E+03	NA	NA	NA	NA	NA	3.0E+01
208-96-8	Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
120-12-7	Anthracene	NA	NA	NA	NA	NA	NA	NA	**5.6E+01**	5.6E+01
56-55-3	Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
50-32-8	Benzo(a)pyrene	**8.9E-01**	5.4E+00	3.7E+01	NA	NA	NA	NA	NA	8.9E-01
205-99-2	Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
191-24-2	Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
218-01-9	Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA
53-70-3	Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
105-67-9	2,4-Dimethylphenol	1.2E+03	**1.0E+01**	9.3E+02	NA	NA	NA	NA	NA	1.0E+01
84-74-2	Di-n-butylphthalate	1.6E+01	1.3E+02	8.0E+02	4.2E+00	1.4E+01	**1.0E+00**	4.3E+01	NA	1.0E+00
206-44-0	Fluoranthene	NA	NA	NA	NA	NA	NA	NA	**9.8E+01**	9.8E+01
86-73-7	Fluorene	**3.3E+00**	8.1E+02	9.7E+02	NA	NA	NA	NA	NA	3.3E+00
193-39-5	Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
90-12-0	1-Methylnaphthalene	1.4E+04	**9.0E+02**	1.1E+04	NA	NA	NA	NA	NA	9.0E+02
91-57-6	2-Methylnaphthalene	9.8E+02	**6.4E+01**	7.8E+02	NA	NA	NA	NA	NA	6.4E+01
95-48-7	2-Methylphenol	2.6E+04	**7.3E+01**	8.3E+04	NA	NA	NA	NA	NA	7.3E+01
108-39-4	3-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA
106-44-5	4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA
34mp	3&4-Methylphenol [b]	NA	NA	NA	NA	NA	NA	NA	NA	NA
91-20-3	Naphthalene	5.5E+01	**1.2E+01**	7.5E+03	NA	NA	NA	NA	NA	1.2E+01
85-01-8	Phenanthrene	**3.8E+02**	3.2E+03	2.0E+04	NA	NA	NA	NA	NA	3.8E+02
108-95-2	Phenol	5.4E+02	2.0E+01	5.4E+03	NA	NA	NA	NA	**6.8E+00**	6.8E+00
129-00-0	Pyrene	**2.2E+01**	3.2E+01	1.2E+03	NA	NA	NA	NA	NA	2.2E+01
Metals										
7429-90-5	Aluminum [c]	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	5.8E-01	**2.3E-01**	1.6E+01	NA	NA	NA	NA	NA	2.3E-01
7440-38-2	Arsenic	1.2E+02	5.3E+01	2.9E+02	1.2E+02	4.2E+02	1.7E+02	8.4E+02	**1.0E+01**	1.0E+01
7440-39-3	Barium	4.5E+03	9.0E+02	1.6E+04	7.1E+02	5.8E+02	**4.0E+02**	2.4E+03	5.0E+02	4.0E+02
7440-43-9	Cadmium	**9.2E-01**	9.9E+00	1.4E+02	5.4E+01	2.5E+02	3.8E+00	4.8E+02	1.8E+01	9.2E-01
7440-47-3	Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA
16065-83-1	Chromium (III)	7.3E+01	1.2E+02	2.6E+02	1.4E+02	4.8E+02	9.4E+01	5.9E+02	**1.0E+01**	1.0E+01
18540-29-9	Chromium (VI)	1.7E+02	2.7E+02	7.2E+02	NA	NA	NA	NA	**4.0E-01**	4.0E-01
7440-50-8	Copper	1.0E+02	1.5E+02	**3.6E+00**	1.6E+02	7.7E+02	9.9E+01	5.5E+00	3.7E+01	3.6E+00
7439-92-1	Lead	1.4E+02	3.3E+02	7.4E+02	9.0E+01	3.5E+02	**5.0E+01**	3.7E+02	1.0E+02	5.0E+01
7439-96-5	Manganese [c]	--	--	--	--	--	--	--	--	--
7439-97-6	Mercury	**2.6E-01**	8.1E+00	3.2E+02	4.5E+01	3.9E+01	1.1E+00	8.1E+01	5.0E+00	2.6E-01
7440-02-0	Nickel	1.2E+02	**9.0E+01**	2.0E+02	4.1E+02	1.5E+03	3.9E+02	2.1E+03	NA	9.0E+01
7782-49-2	Selenium	1.7E+00	**8.5E-01**	4.1E+00	3.1E+00	8.9E+00	6.6E+00	5.9E+01	1.0E+00	8.5E-01
7440-22-4	Silver	2.9E+01	5.0E+02	1.6E+03	1.3E+02	4.7E+02	**1.5E+01**	7.3E+02	NA	1.5E+01
7440-62-2	Vanadium	6.2E+02	4.5E+02	9.0E+02	**2.5E+01**	8.8E+01	2.8E+01	1.1E+02	NA	2.5E+01
7440-66-6	Zinc	**7.2E+02**	9.3E+02	1.8E+04	1.8E+03	8.9E+03	1.3E+03	2.3E+04	3.0E+03	7.2E+02
Inorganics										
57-12-5	Cyanide	4.7E+01	**3.6E+00**	9.7E+03	NA	NA	NA	NA	NA	3.6E+00

Values in bold represent lowest Tier II ALs.

Abbreviations:
CAS #: Chemical Abstract Service registry number
AL: action level
mg/kg: milligrams per kilogram
NA: not available
--: not applicable

Footnotes:

[a] Plant ALs from Appendix C.

[b] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[c] Aluminum and manganese are only regulated as water quality constituents by ADEC and are therefore not target analytes for soil.

Table 24
Summary of Water Ecological ALs
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Aquatic Receptor ALs (µg/L)[a]				Lowest Tier II AL (µg/L)
CAS #	**Chemical Name**	**Loon**	**Algae**	**Zooplankton**	**Fish**	
Volatiles						
67-64-1	Acetone	6.5E+06	3.4E+06	**4.8E+05**	6.2E+05	4.8E+05
107-02-8	Acrolein	NA	NA	1.7E+01	**1.1E+01**	1.1E+01
71-43-2	Benzene	NA	2.9E+03	1.5E+03	**5.3E+02**	5.3E+02
78-93-3	2-Butanone	NA	NA	NA	NA	NA
56-23-5	Carbon tetrachloride	1.0E+03	**7.2E+01**	1.5E+03	2.7E+03	7.2E+01
108-90-7	Chlorobenzene	NA	1.3E+03	**5.3E+02**	7.7E+02	5.3E+02
75-00-3	Chloroethane	NA	NA	NA	NA	NA
67-66-3	Chloroform	NA	3.6E+03	6.3E+03	**4.9E+00**	4.9E+00
106-93-4	1,2-Dibromoethane	**2.0E+01**	NA	3.6E+02	5.8E+03	2.0E+01
95-50-1	1,2-Dichlorobenzene	NA	1.7E+03	**3.6E+02**	4.8E+02	3.6E+02
75-34-3	1,1-Dichloroethane	NA	NA	NA	**2.0E+04**	2.0E+04
107-06-2	1,2-Dichloroethane	**4.2E+02**	NA	1.1E+04	5.8E+03	4.2E+02
75-35-4	1,1-Dichloroethene	NA	NA	NA	NA	NA
156-59-2	cis-1,2-Dichloroethene	NA	NA	2.2E+04	**2.0E+04**	2.0E+04
156-60-5	trans-1,2-Dichloroethene	NA	NA	2.2E+04	**2.0E+04**	2.0E+04
60-29-7	Diethyl ether	NA	NA	NA	**2.6E+05**	2.6E+05
123-91-1	1,4-Dioxane	NA	NA	NA	NA	NA
100-41-4	Ethylbenzene	NA	4.6E+02	**2.2E+02**	4.2E+02	2.2E+02
50-00-0	Formaldehyde	NA	3.7E+03	**1.9E+03**	2.9E+04	1.9E+03
67-56-1	Methanol	NA	NA	**3.3E+05**	1.6E+06	3.3E+05
75-09-2	Methylene chloride	NA	5.6E+04	1.4E+04	**1.0E+04**	1.0E+04
108-10-1	4-Methyl-2-pentanone	NA	5.8E+05	**3.9E+03**	5.7E+04	3.9E+03
103-65-1	n-Propylbenzene	NA	1.8E+02	2.0E+02	**1.6E+02**	1.6E+02
127-18-4	Tetrachloroethene	NA	NA	NA	NA	NA
108-88-3	Toluene	NA	1.3E+03	**7.0E+02**	4.0E+03	7.0E+02
71-55-6	1,1,1-Trichloroethane	NA	3.1E+04	**1.3E+03**	9.0E+03	1.3E+03
79-01-6	Trichloroethene	NA	NA	NA	NA	NA
95-63-6	1,2,4-Trimethylbenzene	NA	NA	**3.6E+02**	7.7E+02	3.6E+02
108-67-8	1,3,5-Trimethylbenzene	NA	NA	NA	NA	NA
75-01-4	Vinyl chloride	NA	NA	NA	NA	NA
1330-20-7	Xylenes	NA	NA	**8.6E+02**	4.2E+03	8.6E+02
Semivolatiles						
83-32-9	Acenaphthene	NA	NA	**6.0E+01**	3.5E+02	6.0E+01
208-96-8	Acenaphthylene	NA	NA	NA	NA	NA
120-12-7	Anthracene	NA	NA	**2.1E+00**	1.2E+01	2.1E+00
56-55-3	Benzo(a)anthracene	NA	NA	**1.0E+00**	NA	1.0E+00
50-32-8	Benzo(a)pyrene	NA	**5.0E-01**	**5.0E-01**	NA	5.0E-01
205-99-2	Benzo(b)fluoranthene	NA	NA	**1.0E+00**	NA	1.0E+00
191-24-2	Benzo(g,h,i)perylene	NA	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	NA	NA	NA	NA	NA
218-01-9	Chrysene	NA	NA	**4.0E+02**	NA	4.0E+02
53-70-3	Dibenz(a,h)anthracene	NA	NA	**4.6E-01**	NA	4.6E-01
105-67-9	2,4-Dimethylphenol	NA	NA	**8.1E+02**	2.0E+03	8.1E+02
84-74-2	Di-n-butylphthalate	**2.9E+00**	2.1E+02	9.6E+02	3.2E+02	2.9E+00
206-44-0	Fluoranthene	NA	NA	**1.4E+00**	**1.4E+00**	1.4E+00
86-73-7	Fluorene	NA	NA	**2.8E+03**	NA	2.8E+03
193-39-5	Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA
90-12-0	1-Methylnaphthalene	NA	6.0E+03	**1.4E+02**	9.0E+02	1.4E+02
91-57-6	2-Methylnaphthalene	NA	**4.5E+02**	1.5E+05	NA	4.5E+02
95-48-7	2-Methylphenol	NA	NA	NA	NA	NA
108-39-4	3-Methylphenol	NA	NA	1.9E+03	**8.9E+02**	8.9E+02
106-44-5	4-Methylphenol	NA	4.6E+03	**1.4E+02**	5.6E+03	1.4E+02
34mp	3&4-Methylphenol[b]	NA	4.6E+03	**1.4E+02**	8.9E+02	1.4E+02
91-20-3	Naphthalene	NA	**2.8E+02**	1.0E+03	4.5E+02	2.8E+02
85-01-8	Phenanthrene	NA	9.4E+01	**4.8E+01**	NA	4.8E+01
108-95-2	Phenol	NA	1.8E+05	**5.5E+02**	3.6E+03	5.5E+02
129-00-0	Pyrene	NA	NA	**4.6E-01**	2.2E+01	4.6E-01
Metals						
7429-90-5	Aluminum[c]	--	--	--	--	--
7440-36-0	Antimony	NA	NA	**6.9E+01**	6.2E+03	6.9E+01
7440-38-2	Arsenic	**3.2E+01**	NA	1.7E+02	1.8E+03	3.2E+01
7440-39-3	Barium	6.5E+03	NA	**5.8E+03**	NA	5.8E+03
7440-43-9	Cadmium	3.2E+01	**3.2E-01**	3.2E+00	NA	3.2E-01
7440-47-3	Chromium	NA	NA	NA	NA	NA
16065-83-1	Chromium (III)	NA	NA	NA	NA	NA
18540-29-9	Chromium (VI)	NA	NA	NA	NA	NA
7440-50-8	Copper	8.8E+01	2.9E+01	**1.1E+00**	7.0E+00	1.1E+00
7439-92-1	Lead	**2.4E+01**	2.1E+03	5.3E+01	NA	2.4E+01
7439-96-5	Manganese[c]	--	--	--	--	--
7439-97-6	Mercury	**9.1E-01**	NA	NA	NA	9.1E-01
7440-02-0	Nickel	2.9E+02	NA	**1.0E+02**	NA	1.0E+02
7782-49-2	Selenium	6.3E+00	NA	**2.0E+00**	**2.0E+00**	2.0E+00
7440-22-4	Silver	1.7E+03	6.6E-01	5.3E-01	**2.0E-02**	2.0E-02
7440-62-2	Vanadium	9.3E+03	NA	**1.7E+03**	NA	1.7E+03
7440-66-6	Zinc	2.9E+02	NA	**7.5E+01**	1.3E+04	7.5E+01
Inorganics						
57-12-5	Cyanide	NA	1.6E+02	2.5E+02	**5.2E+00**	5.2E+00

Values in bold represent lowest Tier II ALs.

Abbreviations:

CAS #: Chemical Abstract Service registry number
AL: action level
µg/L: micrograms per liter
NA: not available
--: not applicable

Footnotes:

[a] Algae, zooplankton, and fish ALs from Appendix C.

[b] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[c] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes and no Tier II ALs were developed.

Table 25
Tier II Human Health Action Level Development
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Soil				Water			
CAS #	Chemical Name	Lowest Tier II Soil AL (mg/kg)	Industrial Worker Value [a] (mg/kg)	Future Resident Subsistence User Value [b] (mg/kg)	Current Nonresident Subsistence User Value [c] (mg/kg)	Lowest Tier II Water AL (µg/L)	Industrial Worker Dermal Value [a] (µg/L)	Future Resident Subsistence User Value [b] (µg/L)	Current Nonresident Subsistence User Value [c] (µg/L)
Volatiles									
67-64-1	Acetone	2.0E+04	1.3E+05	**2.0E+04**	4.1E+05	1.4E+03	NA	**1.4E+03**	3.9E+04
107-02-8	Acrolein	3.9E-02	8.4E-02	**3.9E-02**	2.6E-01	4.2E-03	3.9E+03	**4.2E-03**	2.2E+01
71-43-2	Benzene	1.8E+00	4.1E+00	**1.8E+00**	1.2E+01	4.5E-01	1.8E+02	**4.5E-01**	2.6E+01
78-93-3	2-Butanone	8.1E+03	2.9E+04	**8.1E+03**	8.9E+04	5.4E+02	3.4E+06	**5.4E+02**	2.6E+04
56-23-5	Carbon tetrachloride	1.5E+00	3.3E+00	**1.5E+00**	9.7E+00	4.4E-01	8.4E+01	**4.4E-01**	1.2E+01
108-90-7	Chlorobenzene	4.1E+01	9.6E+01	**4.1E+01**	2.9E+02	7.4E+00	3.2E+03	**7.4E+00**	1.5E+02
75-00-3	Chloroethane	3.0E+03 s	6.5E+03	**3.0E+03**	2.0E+04	2.1E+03	NA	**2.1E+03**	NA
67-66-3	Chloroform	6.2E-01	1.4E+00	**6.2E-01**	4.2E+00	2.2E-01	5.7E+02	**2.2E-01**	1.6E+01
106-93-4	1,2-Dibromoethane	6.8E-02	1.6E-01	**6.8E-02**	4.6E-01	7.2E-03	1.4E+01	**7.2E-03**	2.1E-01
95-50-1	1,2-Dichlorobenzene	2.7E+02	6.5E+02	**2.7E+02**	2.0E+03	1.8E+01	7.2E+03	**1.8E+01**	4.6E+01
75-34-3	1,1-Dichloroethane	7.2E+00	1.6E+01	**7.2E+00**	4.8E+01	2.7E+00	3.4E+03	**2.7E+00**	1.6E+02
107-06-2	1,2-Dichloroethane	8.7E-01	2.0E+00	**8.7E-01**	5.8E+00	1.7E-01	3.5E+02	**1.7E-01**	1.6E+01
75-35-4	1,1-Dichloroethene	5.3E+01	1.2E+02	**5.3E+01**	3.6E+02	2.7E+01	2.1E+04	**2.7E+01**	5.3E+02
156-59-2	cis-1,2-Dichloroethene	5.4E+01	5.8E+02	**5.4E+01**	1.7E+03	3.5E+00	NA	**3.5E+00**	2.5E+01
156-60-5	trans-1,2-Dichloroethene	5.4E+02	5.8E+03	**5.4E+02**	1.6E+04	3.2E+01	8.7E+03	**3.2E+01**	2.5E+02
60-29-7	Diethyl ether	5.4E+03	5.8E+04	**5.4E+03**	1.8E+05	3.6E+02	4.6E+05	**3.6E+02**	5.1E+03
123-91-1	1,4-Dioxane	1.4E+01	4.0E+01	**1.4E+01**	1.2E+02	4.6E-01	4.2E+03	**4.6E-01**	1.3E+02
100-41-4	Ethylbenzene	7.8E+00	1.8E+01	**7.8E+00**	5.2E+01	1.3E+00	2.3E+02	**1.3E+00**	1.0E+01
50-00-0	Formaldehyde	4.5E+01	1.0E+02	**4.5E+01**	3.0E+02	4.3E-01	7.0E+05	**4.3E-01**	8.7E+03
67-56-1	Methanol	3.5E+04	1.9E+05	**3.5E+04**	6.0E+05	2.0E+03	3.9E+07	**2.0E+03**	8.7E+04
75-09-2	Methylene chloride	1.0E+02	4.6E+02	**1.0E+02**	1.4E+03	8.2E+00	8.6E+03	**8.2E+00**	3.6E+01
108-10-1	4-Methyl-2-pentanone	1.7E+03	9.4E+03	**1.7E+03**	2.9E+04	1.2E+02	1.2E+05	**1.2E+02**	3.2E+03
103-65-1	n-Propylbenzene	6.6E+02 s	1.8E+03	**6.6E+02**	5.3E+03	5.3E+01	NA	**5.3E+01**	1.1E+02
127-18-4	Tetrachloroethene	1.6E+01	3.7E+01	**1.6E+01**	1.1E+02	3.2E+00	5.7E+02	**3.2E+00**	1.6E+01
108-88-3	Toluene	1.3E+03 s	5.2E+03	**1.3E+03**	1.5E+04	1.0E+02	1.3E+04	**1.0E+02**	1.3E+03
71-55-6	1,1,1-Trichloroethane	1.7E+03 s	3.8E+03	**1.7E+03**	1.2E+04	7.9E+02	6.2E+05	**7.9E+02**	5.5E+04
79-01-6	Trichloroethene	7.9E-01	1.8E+00	**7.9E-01**	5.5E+00	2.7E-01	1.7E+02	**2.7E-01**	4.3E+00
95-63-6	1,2,4-Trimethylbenzene	7.1E+00	1.5E+01	**7.1E+00**	4.7E+01	1.4E+00	NA	**1.4E+00**	5.7E+01
108-67-8	1,3,5-Trimethylbenzene	5.1E+00	1.1E+01	**5.1E+00**	3.4E+01	1.0E+00	NA	**1.0E+00**	7.4E+00
75-01-4	Vinyl chloride	7.2E-02	2.6E+00	**7.2E-02**	6.3E+00	1.8E-02	2.6E+01	**1.8E-02**	2.9E-01
1330-20-7	Xylenes	8.5E+01	1.9E+02	**8.5E+01**	5.7E+02	1.9E+01	1.8E+04	**1.9E+01**	1.9E+03
Semivolatiles									
83-32-9	Acenaphthene	1.2E+03	1.1E+04	**1.2E+03**	1.9E+04	1.0E+01	NA	**1.0E+01**	1.1E+01
208-96-8	Acenaphthylene [d]	NA	NA	NA	NA	NA	NA	NA	NA
120-12-7	Anthracene	5.6E+03	5.7E+04	**5.6E+03**	5.6E+04	2.2E+01	NA	**2.2E+01**	2.3E+01
56-55-3	Benzo(a)anthracene	3.6E-01	7.0E+00	**3.6E-01**	9.9E-01	5.5E-03	NA	**5.5E-03**	1.0E-02
50-32-8	Benzo(a)pyrene	3.1E-02	7.2E-01	**3.1E-02**	7.1E-02	5.0E-05	NA	**5.0E-05**	5.1E-05
205-99-2	Benzo(b)fluoranthene	3.6E-01	7.2E+00	**3.6E-01**	9.7E-01	8.5E-04	NA	**8.5E-04**	8.7E-04
191-24-2	Benzo(g,h,i)perylene [d]	NA	NA	NA	NA	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	3.2E+00	7.2E+01	**3.2E+00**	7.2E+00	5.2E-03	NA	**5.2E-03**	5.3E-03
218-01-9	Chrysene	3.5E+01	7.2E+02	**3.5E+01**	9.5E+01	8.1E-02	NA	**8.1E-02**	8.3E-02
53-70-3	Dibenz(a,h)anthracene	2.3E-02	7.2E-01	**2.3E-02**	3.9E-02	2.7E-05	NA	**2.7E-05**	2.7E-05
105-67-9	2,4-Dimethylphenol	4.4E+02	4.1E+03	**4.4E+02**	1.1E+04	3.0E+01	7.7E+03	**3.0E+01**	1.8E+02
84-74-2	Di-n-butylphthalate	2.0E+03	2.1E+04	**2.0E+03**	1.8E+04	4.3E+01	4.1E+03	**4.3E+01**	8.2E+01
206-44-0	Fluoranthene	6.8E+02	7.5E+03	**6.8E+02**	3.8E+03	1.5E+00	NA	**1.5E+00**	1.5E+00
86-73-7	Fluorene	7.7E+02	7.5E+03	**7.7E+02**	9.7E+03	9.3E+00	NA	**9.3E+00**	1.0E+01
193-39-5	Indeno(1,2,3-cd)pyrene	2.4E-01	7.2E+00	**2.4E-01**	4.1E-01	2.1E-04	NA	**2.1E-04**	2.2E-04
90-12-0	1-Methylnaphthalene	5.5E+01	1.8E+02	**5.5E+01**	2.8E+02	1.6E+00	NA	**1.6E+00**	4.1E+00
91-57-6	2-Methylnaphthalene	7.9E+01	7.5E+02	**7.9E+01**	1.3E+03	3.8E+00	NA	**3.8E+00**	7.4E+00
95-48-7	2-Methylphenol	1.1E+03	1.0E+04	**1.1E+03**	3.0E+04	8.1E+01	3.0E+04	**8.1E+01**	6.4E+02
108-39-4	3-Methylphenol	1.1E+03	1.0E+04	**1.1E+03**	3.0E+04	8.2E+01	3.0E+04	**8.2E+01**	7.5E+02
106-44-5	4-Methylphenol	2.2E+03	2.1E+04	**2.2E+03**	6.0E+04	1.7E+02	6.1E+04	**1.7E+02**	1.6E+03
34mp	3&4-Methylphenol [e]	1.1E+03	1.0E+04	**1.1E+03**	3.0E+04	8.2E+01	3.0E+04	**8.2E+01**	7.5E+02
91-20-3	Naphthalene	4.4E+00	1.0E+01	**4.4E+00**	3.0E+01	1.7E-01	1.7E+03	**1.7E-01**	3.3E+01
85-01-8	Phenanthrene [d]	NA	NA	NA	NA	NA	NA	NA	NA
108-95-2	Phenol	6.6E+03	6.2E+04	**6.6E+03**	1.9E+05	4.6E+02	3.4E+05	**4.6E+02**	2.4E+03
129-00-0	Pyrene	5.4E+02	5.7E+03	**5.4E+02**	3.7E+03	2.6E+00	NA	**2.6E+00**	2.7E+00
Metals									
7429-90-5	Aluminum [f]	--	--	--	--	--	--	--	--
7440-36-0	Antimony	7.2E+00	1.2E+02	**7.2E+00**	2.1E+01	3.2E-01	5.0E+02	**3.2E-01**	5.5E-01
7440-38-2	Arsenic	1.5E+00	7.5E+00	**1.5E+00**	3.7E+00	1.1E-02	1.5E+02	**1.1E-02**	1.4E-02
7440-39-3	Barium	5.1E+03	5.5E+04	**5.1E+03**	9.5E+04	3.6E+02	1.2E+05	**3.6E+02**	6.9E+03
7440-43-9	Cadmium	1.5E+01	2.5E+02	**1.5E+01**	3.9E+01	3.9E-01	2.1E+02	**3.9E-01**	6.9E-01
7440-47-3	Chromium [d]	NA	NA	NA	NA	NA	NA	NA	NA
16065-83-1	Chromium (III)	3.7E+04	4.4E+05	**3.7E+04**	3.9E+05	2.2E+03	1.6E+05	**2.2E+03**	1.3E+06
18540-29-9	Chromium (VI)	9.3E-01	1.6E+01	**9.3E-01**	6.5E+00	1.2E-02	5.8E+00	**1.2E-02**	1.9E-02
7440-50-8	Copper	9.7E+01	1.2E+04	**9.7E+01**	1.1E+02	2.0E+01	3.3E+05	**2.0E+01**	2.7E+01
7439-92-1	Lead [g]	NA	NA	NA	NA	NA	NA	NA	NA
7439-96-5	Manganese [f]	--	--	--	--	--	--	--	--
7439-97-6	Mercury	1.4E-02	8.8E+01	**1.4E-02**	1.4E-02	2.4E-02	1.7E+02	**2.4E-02**	4.1E-02
7440-02-0	Nickel	2.8E+02	5.6E+03	**2.8E+02**	5.9E+02	1.6E+01	3.3E+04	**1.6E+01**	2.7E+01
7782-49-2	Selenium	7.0E+01	1.5E+03	**7.0E+01**	1.4E+02	2.6E+00	4.1E+04	**2.6E+00**	3.4E+00
7440-22-4	Silver	3.4E+01	1.5E+03	**3.4E+01**	4.4E+01	8.8E+00	2.8E+03	**8.8E+00**	1.4E+02
7440-62-2	Vanadium	1.3E+02	1.4E+03	**1.3E+02**	3.2E+03	8.6E+00	1.1E+03	**8.6E+00**	8.4E+03
7440-66-6	Zinc	3.0E+01	8.8E+04	**3.0E+01**	3.0E+01	3.9E+01	4.1E+06	**3.9E+01**	4.1E+01
Inorganics									
57-12-5	Cyanide	1.6E+01	1.8E+02	**1.6E+01**	5.7E+02	1.5E-01	5.0E+03	**1.5E-01**	3.9E+04

Bold values represent lowest Tier II ALs.

Abbreviations:

CAS #: Chemical Abstract Service registry number
AL: action level
mg/kg: milligrams per kilogram
µg/L: micrograms per liter
s: concentration exceeds Csat
NA: not available
--: not applicable

Footnotes:

[a] Industrial worker action levels were developed using a target hazard quotient of 0.1 and a target cancer risk of 10^{-6}.
Equations and AL calculations are provided in Tables B-8 (soil) and B-9 (water) of Appendix B.
Exposure assumptions are provided in Table B-5; toxicity values and chemical-specific parameters are provided in Table 4.

[b] Future subsistence user action levels were developed using a target hazard quotient of 0.1 and a target cancer risk of 10^{-6}.
Equations and AL calculations are provided in Tables B-10 (soil) and B-11 (water) of Appendix B.
Exposure assumptions are provided in Table B-6; toxicity values and chemical-specific parameters are provided in Table 4.

[c] Current subsistence user action levels were developed using a target hazard quotient of 0.1 and a target cancer risk of 10^{-6}.
Equations and AL calculations are provided in Tables B-12 (soil) and B-13 (water) of Appendix B.
Exposure assumptions are provided in Table B-7; toxicity values and chemical-specific parameters are provided in Table 4.

[d] Toxicity values for acenaphthylene, benzo(g,h,i)perylene, phenanthrene, and chromium are not available from EPA (2015b); in such cases, values for surrogate chemicals are typically used where relevant. Therefore, no action levels were developed for these chemicals.

[e] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[f] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes and no Tier II AL values were developed.

[g] Toxicity values for lead are not available from EPA (2015b); lead is typically evaluated through blood-lead modeling. Therefore, no action levels were developed for lead.

References:

EPA. 2015b. Regional Screening Level Tables. June. http://www2.epa.gov/risk/risk-based-screening-table-generic-tables

Table 26
Tier II Action Level Summary Table
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		**Tier II Action Levels**			
		Soil (mg/kg)		**Water (µg/L)**	
CAS #	**Chemical Name**	**Human Health**	**Ecological**	**Human Health**	**Ecological**
Volatiles					
67-64-1	Acetone	2.0E+04	**6.2E+00**	**1.4E+03**	4.8E+05
107-02-8	Acrolein	**3.9E-02**	1.1E-01	**4.2E-03**	1.1E+01
71-43-2	Benzene	1.8E+00	**6.9E-01**	**4.5E-01**	5.3E+02
78-93-3	2-Butanone	8.1E+03	**1.4E+01**	**5.4E+02**	NA
56-23-5	Carbon tetrachloride	1.5E+00	**3.5E-01**	**4.4E-01**	7.2E+01
108-90-7	Chlorobenzene	**4.1E+01**	1.9E+02	**7.4E+00**	5.3E+02
75-00-3	Chloroethane [a]	**3.0E+03**	NA	**2.1E+03**	NA
67-66-3	Chloroform	**6.2E-01**	1.1E+01	**2.2E-01**	4.9E+00
106-93-4	1,2-Dibromoethane	**6.8E-02**	3.4E-01	**7.2E-03**	2.0E+01
95-50-1	1,2-Dichlorobenzene	2.7E+02	**4.5E+01**	**1.8E+01**	3.6E+02
75-34-3	1,1-Dichloroethane	**7.2E+00**	NA	**2.7E+00**	2.0E+04
107-06-2	1,2-Dichloroethane	**8.7E-01**	1.8E+00	**1.7E-01**	4.2E+02
75-35-4	1,1-Dichloroethene	5.3E+01	**1.0E+01**	**2.7E+01**	NA
156-59-2	cis-1,2-Dichloroethene	5.4E+01	**4.4E+01**	**3.5E+00**	2.0E+04
156-60-5	trans-1,2-Dichloroethene	5.4E+02	**5.9E+01**	**3.2E+01**	2.0E+04
60-29-7	Diethyl ether	5.4E+03	**9.6E+02**	**3.6E+02**	2.6E+05
123-91-1	1,4-Dioxane	1.4E+01	**2.8E+00**	**4.6E-01**	NA
100-41-4	Ethylbenzene	**7.8E+00**	3.6E+02	**1.3E+00**	2.2E+02
50-00-0	Formaldehyde	4.5E+01	**4.7E-01**	**4.3E-01**	1.9E+03
67-56-1	Methanol	3.5E+04	**1.4E+00**	**2.0E+03**	3.3E+05
75-09-2	Methylene chloride	1.0E+02	**1.7E+01**	**8.2E+00**	1.0E+04
108-10-1	4-Methyl-2-pentanone	1.7E+03	**1.2E+01**	**1.2E+02**	3.9E+03
103-65-1	n-Propylbenzene	6.6E+02	**5.2E+02**	**5.3E+01**	1.6E+02
127-18-4	Tetrachloroethene	1.6E+01	**1.0E+01**	**3.2E+00**	NA
108-88-3	Toluene	1.3E+03	**3.8E+00**	**1.0E+02**	7.0E+02
71-55-6	1,1,1-Trichloroethane	1.7E+03	**1.0E+02**	**7.9E+02**	1.3E+03
79-01-6	Trichloroethene	**7.9E-01**	4.5E+00	**2.7E-01**	NA
95-63-6	1,2,4-Trimethylbenzene	**7.1E+00**	4.4E+02	**1.4E+00**	3.6E+02
108-67-8	1,3,5-Trimethylbenzene	**5.1E+00**	1.4E+01	**1.0E+00**	NA
75-01-4	Vinyl chloride	**7.2E-02**	1.5E+01	**1.8E-02**	NA
1330-20-7	Xylenes	**8.5E+01**	6.6E+02	**1.9E+01**	8.6E+02
Semi-Volatiles					
83-32-9	Acenaphthene	1.2E+03	**3.0E+01**	**1.0E+01**	6.0E+01
208-96-8	Acenaphthylene	NA	NA	NA	NA
120-12-7	Anthracene	5.6E+03	**5.6E+01**	2.2E+01	**2.1E+00**
56-55-3	Benzo(a)anthracene	**3.6E-01**	NA	**5.5E-03**	1.0E+00
50-32-8	Benzo(a)pyrene	**3.1E-02**	8.9E-01	**5.0E-05**	5.0E-01
205-99-2	Benzo(b)fluoranthene	**3.6E-01**	NA	**8.5E-04**	1.0E+00
191-24-2	Benzo(g,h,i)perylene	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	**3.2E+00**	NA	**5.2E-03**	NA
218-01-9	Chrysene	**3.5E+01**	NA	**8.1E-02**	4.0E+02
53-70-3	Dibenz(a,h)anthracene	**2.3E-02**	NA	**2.7E-05**	4.6E-01
105-67-9	2,4-Dimethylphenol	4.4E+02	**1.0E+01**	**3.0E+01**	8.1E+02
84-74-2	Di-n-butylphthalate	2.0E+03	**1.0E+00**	4.3E+01	**2.9E+00**
206-44-0	Fluoranthene	6.8E+02	**9.8E+01**	1.5E+00	**1.4E+00**
86-73-7	Fluorene	7.7E+02	**3.3E+00**	**9.3E+00**	2.8E+03
193-39-5	Indeno(1,2,3-cd)pyrene	**2.4E-01**	NA	**2.1E-04**	NA
90-12-0	1-Methylnaphthalene	**5.5E+01**	9.0E+02	**1.6E+00**	1.4E+02
91-57-6	2-Methylnaphthalene	7.9E+01	**6.4E+01**	**3.8E+00**	4.5E+02
95-48-7	2-Methylphenol	1.1E+03	**7.3E+01**	**8.1E+01**	NA
108-39-4	3-Methylphenol	**1.1E+03**	NA	**8.2E+01**	8.9E+02
106-44-5	4-Methylphenol	**2.2E+03**	NA	1.7E+02	**1.4E+02**
34mp	3&4-Methylphenol [b]	**1.1E+03**	NA	**8.2E+01**	1.4E+02
91-20-3	Naphthalene	**4.4E+00**	1.2E+01	**1.7E-01**	2.8E+02
85-01-8	Phenanthrene	NA	**3.8E+02**	NA	**4.8E+01**
108-95-2	Phenol	6.6E+03	**6.8E+00**	**4.6E+02**	5.5E+02
129-00-0	Pyrene	5.4E+02	**2.2E+01**	2.6E+00	**4.6E-01**
Metals					
7429-90-5	Aluminum [c]	--	--	--	--
7440-36-0	Antimony	7.2E+00	**2.3E-01**	**3.2E-01**	6.9E+01
7440-38-2	Arsenic	**1.5E+00**	1.0E+01	**1.1E-02**	3.2E+01
7440-39-3	Barium	5.1E+03	**4.0E+02**	**3.6E+02**	5.8E+03
7440-43-9	Cadmium	1.5E+01	**9.2E-01**	3.9E-01	**3.2E-01**
7440-47-3	Chromium	NA	NA	NA	NA
16065-83-1	Chromium (III)	3.7E+04	**1.0E+01**	**2.2E+03**	NA
18540-29-9	Chromium (VI)	9.3E-01	**4.0E-01**	**1.2E-02**	NA
7440-50-8	Copper	9.7E+01	**3.6E+00**	2.0E+01	**1.1E+00**
7439-92-1	Lead	NA	**5.0E+01**	NA	**2.4E+01**
7439-96-5	Manganese [c]	--	--	--	--
7439-97-6	Mercury	**1.4E-02**	2.6E-01	**2.4E-02**	9.1E-01
7440-02-0	Nickel	2.8E+02	**9.0E+01**	**1.6E+01**	1.0E+02
7782-49-2	Selenium	7.0E+01	**8.5E-01**	2.6E+00	**2.0E+00**
7440-22-4	Silver	3.4E+01	**1.5E+01**	8.8E+00	**2.0E-02**
7440-62-2	Vanadium	1.3E+02	**2.5E+01**	**8.6E+00**	1.7E+03
7440-66-6	Zinc	**3.0E+01**	7.2E+02	**3.9E+01**	7.5E+01
Inorganics					
57-12-5	Cyanide	1.6E+01	**3.6E+00**	**1.5E-01**	5.2E+00

Bold values indicate Tier II action level drivers.

Abbreviations:

CAS #: Chemical Abstract Service registry number
mg/kg: milligrams per kilogram
µg/L: micrograms per liter
NA: not available
--: not applicable

Footnotes:

[a] Human health soil action level exceeds soil saturation limit (Csat; from Table 2). If detected chemical concentrations exceed the Csat concentration, more sophisticated modeling may be necessary on a SWMU/AOC-specific basis.

[b] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[c] Aluminum and manganese are only regulated as water quality constituents by ADEC; therefore only Alaska Water Quality Criteria are relevant for these two target analytes and no Tier II AL values were developed.

APPENDIX A

BACKGROUND INFORMATION ON LOCAL SUBSISTENCE USE PATTERNS NEAR THE PRUDHOE BAY FACILITY

1.0 INTRODUCTION

Several environmental impact statements, reports and environmental assessments were reviewed, along with interviews with local residents and long-time BP personnel to compile subsistence use and harvest data to estimate the degree to which local Native Alaskan communities may use the site for subsistence purposes. Documents reviewed include:

- *Alpine Satellite Development Plan Final Environmental Impact Statement*. (ASDP FEIS),
- *Environmental Assessment. Liberty Development and Production Plan Ultra Extended Reach Drilling From Endicott- Satellite Drilling Island (SDI)* (Liberty FEIS),
- *Environmental Assessment. Shell Offshore Inc. 2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay* (Shell EA),
- *Draft Northstar Environmental Impact Statement*, and
- *Annual Assessment of Subsistence Bowhead Whaling Near Cross Island, 2001-2007, Final Report*.

The majority of information presented in these documents focuses on subsistence use and harvest for residents in the Village of Nuiqsut, as this is the closest subsistence community to the site and has expressed particular interest in the activities being conducted under the Order. Some information for residents in the Village of Kaktovik has also been provided; this community is the next-closest to the site and is located east, rather than west, of the site. Information from the above documents was reviewed, summarized, extracted, and incorporated, as needed and appropriate, in this Appendix. Relevant sections of the above documents are cited, and incorporated by reference, as appropriate. Summary tables of subsistence use for both communities are provided in the main text (Tables 5-6) based on information obtained from the Alaska Department of Fish and Game. Key figures from the above documents are included herein.

2.0 SUBSISTENCE RESOURCES

As provided in the Liberty FEIS and ASDP FEIS, there are two major subsistence-resource categories on the North Slope. The first is the coastal/marine group consisting of resources harvested such as whales, seals, walrus, polar bears, waterfowl, and fish. The second is the terrestrial/aquatic group that includes resources such as caribou, freshwater fish, moose, Dall's sheep, grizzly bears, edible roots and berries, and furbearers (USDOI, MMS 2007). Each of the North Slope Borough (NSB) villages has a characteristic subsistence harvest pattern, although there is substantial year-to-year variability. Although subsistence harvests differ from community to community, the resource combination of caribou, bowhead whales, and fish was identified as the primary grouping of resources harvested across communities (USDOI, MMS, 2007).

Traditional subsistence activities in the Nuiqsut area revolve around caribou, marine mammals, and fish. Moose, waterfowl, and furbearers are secondary but important supplementary resources; moose, however, are not typically found on the coastal plain portion of the North Slope. Nuiqsut's location on the Colville River, 35 miles upstream from the Beaufort Sea, has been a prime area for fish and caribou harvests, but is less advantageous for marine mammal harvests (USDOI, MMS, 2007). Polar bears spend the majority of the year living off the coast on pack ice, but may be present on land in areas near the coast of the Beaufort Sea for short periods of time. The Colville River is one of the largest river systems on the North Slope and supports one of the largest overwintering areas for whitefish (USDOI, BLM, 2004).

The communities of Nuiqsut and Kaktovik maintain a mixed cash and subsistence economy. Subsistence resources provide the staple meat, fish, and fowl in the diet while income earned through employment provides housing, heat, and other basic living expenses and support subsistence activities (BPXA. 1998).

Subsistence uses are central to the customs and traditions of many cultural groups in Alaska, including the North Slope Iñupiat. These customs and traditions encompass sharing and distribution networks, cooperative hunting, fishing, and ceremonial activities. Subsistence fishing and hunting are important sources of non-traditional employment and nutrition in almost all rural communities. The Alaska Department of Fish and Game (ADF&G) estimates that the annual wild food harvest in the arctic area of Alaska is approximately 10,507,255 pounds, or 516 pounds per person per year. Subsistence harvest levels vary widely from one community to the next. Sharing of subsistence foods is common in rural Alaska (UDOI, BLM, 2004).

3.0 SUBSISTENCE HARVEST PARTICIPATION

Nuiqsut

According to the Liberty FEIS, the ADF&G collected subsistence harvest data for Nuiqsut to estimate the total annual subsistence harvests for years 1985, 1992, and 1993 (USDOI, MMS, 2007). The Liberty FEIS describes the importance of subsistence activities to Nuiqsut residents as shown in high household participation rates for 1993 (Table 5 of the main document). Nuiqsut landed no bowheads in 1985 or 1994, but two bowheads were harvested in 1992 and three in 1993. In years when bowhead whale, fish, and terrestrial mammal subsistence harvests are successful, such as 1992 and 1993, each of these resources may provide nearly one-third of the subsistence resource harvest (Liberty, Fuller and George, 1999). In 1992, bowhead whales (32%), caribou (22%), and fish (25%) comprised 79% of Nuiqsut's annual subsistence harvest. In 1993, bowhead whales (29%), whitefish (29%), and caribou (31%) comprised 89% of Nuiqsut's annual subsistence harvest in terms of edible pounds (USDOI, MMS, 2007).

Stephen R. Braund & Associates (SRB&A) conducted 21 interviews with subsistence resource users in Nuiqsut in June and July of 2003. SRB&A interviewed a variety of currently active resource users including persons of both genders and several ages, from young hunters starting out, through increasingly active and productive middle-aged hunters, to the active elders who still harvest subsistence foods and train the younger hunters. Findings from these interviews are presented in the ASDP FEIS and illustrated in Figure A-1 (ASDP FIES Figure 3.4.3.2-2) showing subsistence use areas for all resources over the past ten years. Other findings from these interviews provide additional subsistence use and harvest data incorporated into the ASDP FEIS (USDOI, BLM, 2004).

Kaktovik

Kaktovik's primary harvested resources have been bowhead whales, caribou, Dall's sheep, migratory waterfowl, and freshwater and marine fishes. Secondary resources have been beluga whales, seals, polar bears, moose, furbearers, ptarmigan, and vegetation (BPXA, 1998). Fishing was the most common subsistence harvest activity with 81% of all households participating in fishing and 94% consuming fish. In terms of total pounds of subsistence resources harvested, composition of the overall harvest by major resource category shows marine mammals contributed the largest component (67%) followed by terrestrial mammals (17%), fish (13%), and birds or other resources (2%; BPXA, 1998).

4.0 SUBSISTENCE USE AREAS

4.1 Bowhead Whales

Nuiqsut

Bowhead whaling takes precedence over any other subsistence activity, and occurs only in the fall. The general Nuiqsut harvest use area is located off the coast between the Kuparuk and Canning rivers. Historically, the entire coastal area from Nuiqsut east to Flaxman Island and the Canning River Delta has been used for whaling. However, whaling to the west of Cross Island has not been as productive as hunting closer to the island, and whaling too far to the east requires long tows of the whales back to Cross Island for butchering, creating the potential for meat spoilage (UDOI, MMS, 2007).

Bowhead whaling is usually undertaken between late August and early October, with the exact timing depending on ice and weather conditions. Historically, variable ice conditions have extended the season to two months or contracted it to less than two weeks. Whale strikes occur at an average distance of 10 miles from Cross Island, but hunters now travel farther from the island (USDOI, MMS, 2007). Over the past seven years of reported monitoring (2001-2008), the majority of the bowhead whales have been harvested in the northeast quadrant off Cross Island (USDOI, MMS, 2009).

According to the Shell EA, the 2008 Cross Island bowhead whale hunting season started earlier than any other. The first crew arrived at Cross Island on August 29, and hunting lasted for 14 days. This includes days set aside for traveling, butchering, weather days, and scouting days. The captains agreed to stop whaling on September 9 because the four landed whales were considered enough (USDOI, MMS, 2009).

The Liberty FEIS and ASDP FEIS describe that Pingok and Narwhal islands have also been used as bases in the past. These documents also state that Nuiqsut hunters typically travel out either the Nigliq or the main Colville channel of the Colville River Delta and travel along the coast inside or just outside the barrier islands. If weather conditions allow, whalers usually stop at West Dock for coffee before heading to Cross Island. In the past, work groups may have started fishing and hunting other species to support the whalers after setting up camp, but during the years of 2003, 2004, and 2005, the main subsistence focus was towards whaling (USDOI, BLM, 2004).

Nuiqsut harvest records have ranged from no whales to four per year; nearly one-half of the annual hunts from 1973 through 1995 were unsuccessful in landing whales. According to the Liberty FEIS, Nuiqsut whalers attribute at least part of their lack of success for landed whales in the 1970s and 1980s, and higher rate of “struck and lost” for years 1989 - 1991, to interference from oil and gas exploration, as well as poor weather and ice conditions in some years, and a difficult logistical situation. Once Cross Island was established as a logistical center for Nuiqsut whaling and Nuiqsut whalers gained experience there, harvest success became more regular (USDOI, MMS, 2007).

Figure A-2 (Galginaitis, M. 2009 Figure 6) illustrates Nuiqsut/Cross Island locations and GPS tracks of whaling expeditions with landmarks.

In recent years, the Cross Island whalers have focused exclusively on taking bowhead whales. They do not hunt for belugas. However, because they have only recently stopped hunting belugas, these whales are still considered a potential subsistence resource (USDOI, MMS, 2009).

Kaktovik

Whaling crews use Kaktovik as their home base, leaving the village and returning on a daily basis. The core whaling area is within 12 miles of the village with a periphery ranging about 8 miles farther, if necessary. The extreme limits of the Kaktovik whaling area would be the middle of Camden Bay to the west (USDOI, MMS, 2009). The Northstar EIS describes the prime bowhead whale harvest area extending offshore from the Okilak and Hulahula Rivers in the west to Tapkaurak Point in the east, and 20 miles offshore (BPXA, 1998). The timing of the Kaktovik bowhead whale hunts roughly parallels the Cross Island whale hunt described above for the Nuiqsut community (USDOI, MMS, 2009).

Bowhead harvesting at Kaktovik has been variable, ranging from no whales to five per year. In 1995, the whale strike quota for Kaktovik was three.

The Shell EA describes hunting of beluga whales from Kaktovik. As best as can be ascertained, about one beluga is harvested annually in conjunction with the bowhead whale hunt, but most households obtain beluga through exchanges with other communities (USDOI, MMS, 2009).

4.2 Caribou

The central caribou herd overwinters in the foothills of the Brooks Mountain Range and move to the calving grounds on the open tundra in late April to early June. Bulls, yearlings, and non-pregnant cows join the cows and newborn calves in mid- to late-June. Calving occurs particularly in the Kuparuk and Canning River Deltas with the majority of calving occurring within 24 miles of the coast. Calving does not typically occur within the developed oil fields between the Kuparuk and Sagavanirktok rivers (BPXA, 1998). The Kuparuk calving area is hypothesized to have shifted slightly to the west-southwest in 1987 through 1990 in response to construction of the Milne Point Road (BPXA, 1998).

Nuiqsut

Harvest location data for caribou collected by the NSB, ADF&G and interviews conducted by SRB&A in Nuiqsut indicate that there are several primary harvest areas for caribou. Harvest locations include the Nuiqsut area, the Colville River Delta, the Nigliq Channel, and the Fish and Judy creeks area. To the south of Nuiqsut, the Colville River provides access to areas and sites such as Itkillikpaat, Ocean Point, Itkillik River, Umiat, and the confluences of the Anaktuvuk and Chandler rivers. These areas are usually associated with Traditional Land Use Inventory (TLUI) sites, cabins, camps, and native allotments with harvest locations for other species nearby (USDOI, BLM, 2004). These harvest locations can be used in winter (October through May), summer (June through September), or both, and can be accessed by foot, boat, all-terrain vehicle, and snowmobile. Figure A-3 (ASDP FEIS Figure 3.4.3.2-3) shows the recent harvest areas of interviewed hunters for caribou, and Figure A-4 (ASDP FEIS Figure 3.4.3.2-4) shows the winter and summer caribou hunting areas.

Summer hunting is done by boat after the river ice breaks up, and hunters proceed along the coast from Smith Bay east to the Sagavanirktok River, including Oliktok Point, several barrier islands, and in all channels of the Colville River Delta, Fish Creek, and Judy Creek. Hunters also go south on the Colville River beyond Umiat, passing Itkillikpaat, Ocean Point, Signal Hill, and Umirak en route. These trips upriver are taken by boat in the summer, in the fall when moose and caribou can be harvested well inland, and by snowmobile in the winter in pursuit of caribou and furbearers. Nuiqsut hunters also travel up the Itkillik, Chandler, and Anaktuvuk rivers by boat and snowmobile (USDOI, BLM, 2004).

Cumulative Nuiqsut caribou harvests by month for 1993, 1994 through 1995, 2000, and 2001 are shown on Figure A-5 (ASDP FEIS Figure 3.4.3.2-5). There are monthly and seasonal differences in the proportion of caribou harvested, with summer harvests providing approximately 60 percent of the harvested caribou. Over these four years, July (23 percent) and August (24 percent) are the months with the greatest cumulative caribou harvests (USDOI, BLM, 2004). According to several hunters, October (16 percent) is a preferred month for hunting caribou, because the caribou have by then accumulated a thick layer of fat for the winter. September (8 percent) is normally used for whaling activity, and meat from caribou hunted in August is provided to whaling crews. March (6 percent) represents the beginning of spring, with longer days and warmer weather encouraging hunters to go out on the land again and harvest caribou (USDOI, BLM, 2004).

Winter harvests take place after the rivers and lakes have frozen over and snow covers the tundra, allowing for a greater overland hunting range using snowmobiles. Interviewed hunters have utilized areas ranging from the vicinity of Admiralty Inlet and Teshekpuk Lake in the west, to the Franklin Bluffs area east of the Dalton Highway, south to Anaktuvuk Pass, and along the northern foothills of the Brooks Range (USDOI, BLM, 2004). Caribou are hunted as needed while hunters pursue wolves, wolverines, and foxes southeast of Teshekpuk Lake, in the Brooks Range foothills, the Kuparuk Hills, and east of the Colville River. Subsistence caribou hunting independent of the furbearer harvest continues all winter throughout the Fish and Judy creeks area, along the Nigliq Channel, and south along the Colville and Itkillik rivers. During the coldest months, many hunters stay closer to Nuiqsut, venturing farther out as spring approaches (USDOI, BLM, 2004).

Kaktovik

Caribou is one of the significant resources taken during the summer months by the Kaktovik community. A peak harvest time is in July, when hunters selectively hunt fat bulls along the coast. Over a 4-year period, researchers determined that the summer hunt represented about 40 percent of caribou taken by the community on an annual basis (USDOI, MMS, 2009). The caribou harvest use area is from Tigvariak Island to the Canadian border, inland to the Brooks Range, and approximately 20 miles offshore. Most caribou harvesting is in an area between the Canning River and Griffin Point/Pokok Lagoon (BPXA, 1998).

4.3 Fish

Nuiqsut has the largest documented subsistence fish harvest on the Beaufort Sea coast. According to the Liberty FEIS, subsistence fishing occurs in the Colville River and its tributaries from the Colville River Delta to the confluence with the Ninuluk Creek, the Nigliq Channel, and nearby Fish and Judy creeks and the innumerable lakes in the region. Coastal areas east to the Kuparuk River and areas around several barrier islands, including Thetis and Cross islands, are also used (USDOI, MMS, 2007).

Nets are set in the Nigliq Channel for broad whitefish in June and July. In August and September, fishers set nets and angle in the Nigliq Channel, Nanuq Lake, Fish Creek, and the Colville River Delta, or travel by boat up the Colville River up to and beyond Umiat for grayling, chum salmon, silver salmon, Dolly Varden, and Arctic char. Some people fish in the nearshore waters inside the barrier islands; this fishing is often done by Nuiqsut bowhead whaling crews to support them while they are at Cross Island (USDOI, BLM, 2004).

In the fall and early winter, grayling gather at river mouths, and nets are set under the ice for other fish migrating out of the rivers for the winter, including whitefish and Arctic and Least Cisco. Jigging through the ice continues until the coldest months of winter for burbot, grayling, and rainbow trout (USDOI, BLM, 2004).

The Shell EA reported that during July and August, the people of Nuiqsut harvest whitefish, primarily along channels of the Colville River. They also harvest Arctic char, dog salmon, and pink salmon. In late September into October when Nuiqsut residents complete bowhead whale hunting, they direct some of their subsistence efforts to fish. By this time, the whitefish runs are strong. In a typical year, Nuiqsut residents expend their greatest effort fishing under the ice of the river channels to catch Cisco and small whitefish (USDOI, MMS, 2009).

The NSB subsistence harvest data for 1994 through 1995, 2000, and 2001 show the greatest proportion of fish are harvested in October (54 percent), while November (13 percent), July (11 percent), December (4 percent) and September (4 percent) also comprise substantial harvests. Undated fish harvests (9 percent) are the fourth largest group. The large number of fish harvested reflects the importance of the resource in general, but in particular demonstrates the numerical dominance of Arctic Cisco in the fall and winter harvest (USDOI, BLM, 2004).

Fishing efforts range by area from 19 to 1,407 net-days, and there is no clear correspondence between the harvest and harvest effort. For example, low efforts have brought more fish as in 1993, while high efforts as in 2002 have resulted in few fish harvested, even considering the reduced number of sites sampled. This variability demonstrates the importance of having alternative harvest strategies/species available should poor fish harvests coincide with reduced terrestrial or marine mammal harvests (USDOI, BLM, 2004).

Resource users often fish in conjunction with other subsistence activities, such as caribou and moose hunting and berry picking, especially in harvest areas with camps and cabins. Certain species of fish are only seasonally available, and must be harvested when present in the area. Other fish species are available year-round (USDOI, BLM, 2004). Figure A-6 (ASDP FEIS Figure 3.4.3.2-8) illustrates subsistence use areas for fish from 1993 through 2003.

Kaktovik

The Shell EA addresses fish harvesting exclusively for Kaktovik. During the summer (July and August), the people of Kaktovik engage in a community-based subsistence fishery. Most households gillnet at beach sites on Barter Island near Kaktovik, where the primary fish harvested is either sea run Dolly Varden or char. Some Kaktovik households also fish to the east, where the primary fish harvested is Arctic Cisco. Some households have fished westward in the Canning River, but the main level of effort is on Barter Island. In 2002, one of two years with good census information, 79 percent of the households fished in summer (USDOI, MMS, 2009). In the fall and winter, the residents of Kaktovik fish inland under river ice using nets, mainly catching Dolly Varden, Arctic Cisco, and some lake trout (USDOI, MMS, 2009).

4.4 Seals

Ringed, spotted, and bearded seals are important subsistence resources for Nuiqsut hunters. Seals are harvested along the coast and offshore from Cape Halkett in the west to Foggy Island Bay in the east and in the summer, Nuiqsut hunters harvest ringed and spotted seals in the Colville River as far south as Ocean Point. Hunters usually shoot seals in the water and on the ice edge in the spring (USDOI, BLM, 2004).

In April and May, Nuiqsut hunters ride out to Harrison Bay on snow machines and look for breathing holes, cracks in the ice and open water where seals might surface to breathe. By the second week in June (the most common time of year), open waters on the Colville River and much of Harrison Bay (the most common areas) allow hunters to take boats out on a route following the Nigliq Channel to Harrison Bay, west to Atigaru Point, then along the ice edge out as far as 28 miles from land, then to Thetis Island, east to Oliktok Point, then back south through the main channel of the Colville River (USDOI, BLM, 2004), hunting for seals.

4.5 Polar Bears

Nuiqsut hunters harvest polar bears in mid-September into late winter. Polar bear meat is sometimes eaten, although only limited harvest data are available. The Liberty FEIS references the NE NPR-A Final Amended IAP/EIS as noting “Nuiqsut residents have indicated that polar bears are not an important subsistence resource for the community and if taken would be an incidental harvest” (USDOI, MMS, 2007). The overall harvest of polar bears is lower for Nuiqsut than for Barrow and Kaktovik. The annual polar bear harvest for Nuiqsut from 2004 to 2008 averaged 0.4 bears; lower than the 2 bears per year reported for the period 2000-2004 (USFWS, 2008). The reason for this decline is unknown, but contributing factors could be a difference in data collection techniques, changes in level of effort by harvesters, changes in food preference, or response to other constraints (e.g., environmental conditions, rising fuel costs, proposed listing of polar bears as endangered).

The Shell EA describes Nuiqsut polar bear hunting as follows. During the fall when Nuiqsut whale hunters are out, crew members must ask for permission from the whaling captain to kill a polar bear that might be in the vicinity of the harvested whale carcasses because hunting polar bears would entail hours away from the bowhead whale hunt, which results in scheduling and logistical conflicts. However, it does not mean that the people have abandoned this subsistence resource, and they may resume more active polar bear hunting in the future (USDOI, MMS, 2009). This may be affected by the recent federal proposed listing of polar bears as endangered.

In the Kaktovik community, polar bears are primarily harvested during fall and winter on the pack ice and along open leads. Bears may be pursued seaward of the barrier islands for 10 miles or more (USDOI, MMS, 2003). Compared to other North Slope communities, the overall harvest of polar bears is relatively low. The polar bear harvest by Kaktovik from 2004 to 2008 averaged 1.2 polar bears per year. This is half of the average of 2.4 polar bears for the period 2000 to 2004 (USFWS, 2008). The reason for this decline is unknown, as stated previously.

4.6 Walrus

Nuiqsut hunters occasionally harvest walrus during the open water season from June to early October. Hunts have occurred throughout the entire coastal range, from Cape Halkett to Anderson Point, but walrus are seldom encountered for harvest. However, there is the possibility that walrus are opportunistic harvests during seal hunting. ADF&G subsistence survey data indicate that two walrus were harvested in the 1985/1986 harvest season (USDOI, MMS, 2007). In the period 2000 to 2004, Nuiqsut hunters harvested no walrus, and no tagged walrus were reported from Nuiqsut hunters for the years 2004 to 2008 (USFWS, 2008). During the 2004 whaling season, walrus were seen (and heard) on Cross Island for the first time in anyone's memory (USDOI, MMS, 2007).

Walrus rarely occur near Kaktovik and thus are rarely harvested. However, boat crews hunting for seals in open water (currently July and August) along the coast east and west of the village occasionally harvest walrus. Kaktovik hunters did not harvest any walrus between 2000 and 2008 (USFWS, 2008).

4.7 Moose and Moose Use Areas

According to the ASPD FEIS, Moose are normally harvested in August by boat upriver from Nuiqsut on the Colville, Chandler and Itkillik rivers, but the timing of harvest varies depending on seasonal hunting regulations. Local residents have indicated that the weather is not suited for moose hunting in September due to winds; additionally whaling occupies much of the community during the month of September (USDOI, BLM, 2004).

Moose are hunted from the Colville River Delta area upstream to Ninuluk Creek, up the drainages of the Itkillik River and Fish and Judy creeks, and up some side streams off the Colville River. One hunter mentioned going almost to the Killik River confluence looking for moose, while several others reported Fish and Judy creeks, the Chandler and Anaktuvuk river confluences, several side streams and channels of the Colville River and the Itkillik River area as prime moose hunting areas (USDOI, BLM, 2004). Although relatively small numbers of moose are harvested, they are a valued component of the subsistence harvest in Nuiqsut, and hunters spend considerable effort in their pursuit. Moose offer a large amount of meat per animal harvested because of their relatively large size compared to other terrestrial mammal subsistence resources. Moose, when harvested, are very commonly shared with the rest of the community at large (USDOI, MMS, 2007).

4.8 Waterfowl and Waterfowl Use Areas

The Canada goose, white fronted goose, and brant are the most important species of waterfowl to Nuiqsut. Eiders are also harvested. The only upland bird hunted extensively is the ptarmigan. According to the Liberty FEIS and ASDP FEIS, ducks, geese, and brant molt and nest in the wet tundra to the north of Nuiqsut. Eiders nest on the sandy areas of the Colville River Delta and the barrier islands, molting after their arrival. Both groups of waterfowl raise their young in the area until fall, when they migrate south.

Waterfowl hunting begins in May, and continues throughout the summer during the migration, using snow machines (early in the season when snow is still present) and boats. In the summer and early fall, waterfowl hunting usually occurs as an adjunct to other subsistence activities, such as checking fish nets (USDOI, MMS, 2007). The hunters harvest the migrating birds from snow blinds built to the south, near Sentinel Hill and Ocean Point or at Fish Creek. Once the river breaks up, hunters look for birds by boat, and start to look for eiders in the delta and in Harrison Bay at the ice edge as summer approaches. Hunters end the waterfowl harvest when the birds are on their nests (USDOI, BLM, 2004).

Goose hunting areas include the Fish and Judy creeks area, the Colville River Delta, the area around Nuiqsut extending to the Fish and Judy creeks area, along the Colville River up to Sentinel Hill, the area around Ocean Point, and along the Itkillik River (USDOI, BLM, 2004).

The ASPC FEIS presents data from interviews conducted by SRB&A; 21 Nuiqsut harvesters interviewed in 2003 stated that they no longer gather eggs, and that they do not harvest certain species of waterfowl for various reasons. Some residents indicated that they do not eat certain varieties of ducks (e.g., old squaws, pintails), while many indicated that they chose to avoid harvesting black brant and spectacled eiders because they were considered endangered. While the spectacled eider is listed as a threatened species, the black brant is neither a threatened nor an endangered species; therefore, these species may no longer be commonly avoided as subsistence resources. Nearly all interviewed resource users harvested geese in May, and most harvested some eiders (USDOI, BLM, 2004).

As described in the ASPC EIS, the NSB collected waterfowl harvest data for 1994, 1995, 2000, and 2001 (USDOI, BLM, 2004). These data show that 79 percent of geese, including white fronted and Canada, were harvested in the Fish and Judy creeks area (63 percent) and the Colville River Delta (16 percent). Of the remaining 21 percent, most were harvested up the Colville River from Ocean Point to Umirak. A more specific view of goose harvest locations is shown on Figure A-7 (ASDP FEIS Figure 3.4.3.2-16), with 47 percent of harvested geese coming from Fish Creek alone, and many of the rest harvested in the Colville River Delta and Nuiqsut areas. More than half (53 percent) of the eiders hunted were harvested in the ocean, with Thetis Island, Atigaru Point, and Point Barrow as other maritime harvest locations. The Colville River Delta and its channels were the major freshwater harvest areas for eiders, accounting for 28 percent of the eider harvest, while the Kogru-Kalikpik River area comprised 2 percent of the eider harvest (USDOI, BLM, 2004).

Hunters also harvest waterfowl without investing in fuel and equipment while walking down the Nigliq Channel after work or school. Waterfowl hunting trips also are sometimes the last overland trips made to cabins and camps on Fish and Judy creeks and along the Nigliq Channel before conditions make it impossible to use snowmobiles for the season. The first boat trips of the year are taken to harvest seals and eiders (USDOI, BLM, 2004).

4.9 Furbearers

Wolf, wolverine, and fox are important furbearers for Nuiqsut. Hunting of wolf and wolverine begins in earnest when there is adequate snow in the winter for snow machine travel, generally by November. The harvest area for furbearers extends from the eastern edge of the Colville River Delta along the coast almost to Admiralty Bay and then south along the Ikpikpuk River to the Colville River and eastward to the Toolik River, north and crossing the Dalton Highway to Franklin Bluffs, and west and north back to the Colville River Delta (USDOI, BLM, 2004).

Harvest locations reported for 1994, 1995, 2000, and 2001 are divided between the Colville River Delta and Fish and Judy creeks (48 percent) and other areas (52 percent), as shown on Figure A-8 (ASDP FEIS Figure 3.4.3.2-20). Similarly, 55 percent of wolves harvested during these years were harvested in the Fish and Judy creeks area, with the balance harvested elsewhere [Figure A-9 (ASDP FEIS Figure 3.4.3.2-21)]. In the 2003 interview conducted by SRB&A, one hunter explained, “Wolf, wolverine, and caribou go to the lowest levels, which have the best hiding spots. These are rivers, bluff bases, creeks, frozen ground, and low level places that allow them to hide.” (USDOI, BLM, 2004).

The relatively small numbers of wolves and wolverines harvested belies their importance to the community in several ways. The ASDP FEIS explains that the pursuit of furbearers is a friendly, competitive pursuit both within the village and between villages, and has important functions in teaching younger hunters the landmarks and resources of a very large area. Occasionally furbearer hunters will encounter people from other villages on the tundra also engaged in furbearer hunting, fostering connections between villages in a mostly male social context (USDOI, BLM, 2004).

4.10 Berries and Plants

Numerous varieties of berries including salmonberries and blueberries are harvested in the Fish and Judy creeks area, and along the Colville, Chandler, Anaktuvuk, and Itkillik rivers in August when many families are out moose hunting near the creeks and rivers in the area. Plants, medicinal plants, and greens are harvested in the late summer when families are out at camp hunting and fishing (USDOI, BLM, 2004).

5.0 IMPACT OF PBU DEVELOPMENT ON SUBSISTENCE USE PATTERNS

The following discussion is excerpted and edited from the Alpine satellite Development Plan Final EIS (September, 2004), and focuses specifically on the recent avoidance patterns of subsistence use within and immediately adjacent to the Prudhoe Bay Unit. Combined with the above information, this discussion demonstrates the low degree to which subsistence use may occur on or near the developed or undeveloped areas of the PBU.

Reestablishment of the Village of Nuiqsut in the Colville River Delta occurred in 1973, at which time, community residents began to refamiliarize themselves with the subsistence resources of the area. At that time, oil development was some distance from the community, but its impacts were felt by residents who had ties to the developed area and by residents who wished to use subsistence areas on the east side of the developed area. These issues and concerns were documented in the early 1980s by researchers working under contract to the MMS for the Social and Economic Studies Program (Institute for Social and Economic Research [ISER], 1983). Chapter 6 of the ISER report documented that the Iñupiat subsistence users perceived that there was a high potential for conflicts between industrial and Iñupiat land uses and subsistence access. Figures 7 and 8 of the ISER report showed subsistence use areas overlain on industrial areas closed to subsistence and the vast expanse of land potentially offered for lease. Chapter 7 of the ISER report, *Perceived Threats of Oil Development,* outlines the conflicts and concerns between Iñupiat subsistence uses and industry (ISER, 1983:181-250). No other community in Alaska is as close as Nuiqsut to intensive oil exploration and development, and this proximity is reflected in increased concerns by the residents about reduced subsistence access through increased regulations, competition with outsiders, and the imposition of physically obstructive facilities in traditional use areas (ISER, 1983:223-225).

Through the 1980s, the industrial developed area expanded overland west from Prudhoe Bay, and the possibility of nearshore and offshore development near Nuiqsut was impending (IAI, 1990a). By 1985, development encompassed subsistence and traditional use areas from Oliktok Point south along the Kuparuk River (Pedersen et al., 2000: Figure 4). The harvest of marine resources at specific locations was complicated or prevented by onshore development at traditional camps (e.g., Oliktok Point, Niakuk) and by offshore activity (e.g., drilling, seismic testing, and sealift) (Pedersen et al., 2000).

By 1990, Galginaitis wrote in MMS SESP Special Report 8 that, "Perhaps the most obvious effect of oil development in the Nuiqsut area has been that it has effectively removed certain areas from the Nuiqsut subsistence land uses area." (IAI, 1990a:1-43). Reasons given by subsistence users for avoiding or not avoiding areas in response to oil development in the late 1980s were similar to those noted in the 1983 ISER study and included regulatory constraints (real or perceived), a perception of restriction, lack of cultural privacy, notice or belief that a resource is contaminated, and physical obstacles and barriers such as low pipelines and steep gravel road side slopes (IAI, 1990a: 1-43-44; ISER, 1983).

As shown on Figure A-1 (ASDP FEIS Figure 3.4.3.2-2), Nuiqsut subsistence use areas have retreated from the east as development moved westward from Prudhoe Bay to Oliktok Point, particularly in the area of the Kuparuk field (currently operated by Conoco-Philips). Onshore development displaced subsistence uses east of the Colville River for the majority of Nuiqsut users, and the few who continued to use the area did so primarily for political purposes and did not take many caribou there (IAI, 1990a: 1-44). By 1990, the concern in the community of Nuiqsut was that development would continue to encroach on their shrinking subsistence and traditional use areas on the Itkillik and Colville rivers and the Colville River Delta (IAI, 1990a: 1-46). At that time, some hunters noted that further development in these subsistence use areas would impose a severe hardship on the community of Nuiqsut (IAI, 1990a: 1-46).

In 1993, onshore subsistence harvests and uses east of the Colville River and north of Nuiqsut declined to near zero, and development activity was encroaching on valued traditional use areas (Pedersen et al., 2000). Whaling at Cross Island, the use of onshore camps, and storage of the bowhead harvest at Oliktok Point became deeply entwined with oil company personnel and oversight, as companies sought to minimize the time spent by Iñupiat hunters in the developed areas and to avoid attracting polar bears to Oliktok Point by shipping whale meat and *maktaq* by air to Nuiqsut (Pedersen et al., 2000). This assistance has some advantages in time and convenience for subsistence users; however, this practice reduced the autonomy of the hunters and subjected them to scrutiny and regulation throughout the whaling process, which eliminated the perception of cultural privacy (Pedersen et al., 2000).

The 1993 Nuiqsut caribou harvests within the developed area were at or near zero, four percent were within five miles of developed areas, 17 percent were harvested from six to 15 miles, and 79 percent were harvested more than 16 miles from development (Pedersen et al., 2000:18). The 1994 caribou harvest data were similar (Pedersen et al., 2000) in terms of the percent of caribou harvested in relation to harvest proximity to development. Key informants noted in a 1998 Nuiqsut group session that they no longer used the developed area northeast of Nuiqsut as intensively as they had in the past due to difficulties of access, lack of privacy, loss of cultural landmarks, uncertainty regarding regulations, and oilfield security enforcement (Pedersen et al., 2000:18).

Harvest locations and amounts for caribou for the study years reported in Pedersen et al., 2000 (i.e., 1993 and 1994) are consistent with the published and unpublished harvest location data from the North Slope Borough Division of Wildlife Management for 1994-95, 2000 and 2001 (Brower and Hepa, 1998; North Slope Borough Department of Wildlife Management, 2003). Thus, the NSB data and Pedersen et al. (2000) findings support that Iñupiat subsistence users harvest most of their caribou in locations that are distant from developed areas east of the Colville River. This shift applies to most subsistence resources; these changes are ongoing in response to industrial encroachment, and are similar to those predicted in 1990 (Pedersen et al., 2000; IAI, 1990a). Based on Pederson et al. (2000) and Pedersen and Taalak (2001) data, as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development, with approximately 51 percent of the 1999 and 2000 harvests occurring greater than 16 miles, and 27 percent occurring 6 to 15 miles, from Alpine Field development.

Further development anticipated in Pedersen et al. (2000) has come to pass with the development of the Alpine Field Meltwater, Tarn, Fiord, and other oilfields in the vicinity of Nuiqsut. This ongoing development has contributed to a feeling of being “boxed in” for Nuiqsut subsistence users (Pedersen et al., 2000:4, 19). The Committee on the Environmental Effects of Oil and Gas Activities on Alaska’s North Slope recently concluded in a National Research Council report that,

> “On-land subsistence activities have been affected by the reduction in the harvest area in and around the oilfields. The reductions are greatest in the Prudhoe Bay field, which has been closed to hunting, and in the Kuparuk field, where the high density of roads, drill pads, and pipelines inhibits travel by snow machine.
>
> The reduction in area used for subsistence is most significant for Nuiqsut, the village closest to the oilfield complex. Even where access is possible, hunters are often reluctant to enter oilfields for personal, aesthetic, or safety reasons. There is thus a net reduction in the available area, and this reduction continues as the oilfields spread.” (National Research Council 2003:156).

6.0 SUMMARY

Historically the subsistence use range for the Nuiqsut community included a wide area from the Chipp River west of Smith Bay to just east of the Sagavanirktok River valley, and extending south of Umiak (Figure A-1). Development of the oilfield at Prudhoe Bay has modified this historical area to exclude the site, with substantive increase in the use of areas west and south of the site. Whale hunting areas have been little affected by development, but caribou hunting has mostly been done in areas removed from the oilfield for at least the past 15 years. As long as the field continues to operate, this recent pattern is likely to continue. As a result, little subsistence use is anticipated within the site over the time period relevant to risk assessments conducted under the RCRA Order. The only anticipated use is opportunistic hunting of caribou and waterfowl along the narrow strip of coastline contiguous with the site.

FIGURES

REFERENCES:

British Petroleum Exploration, Alaska Inc (BPXA). 1998. *Draft Northstar Environmental Impact Statement*. June 1998.

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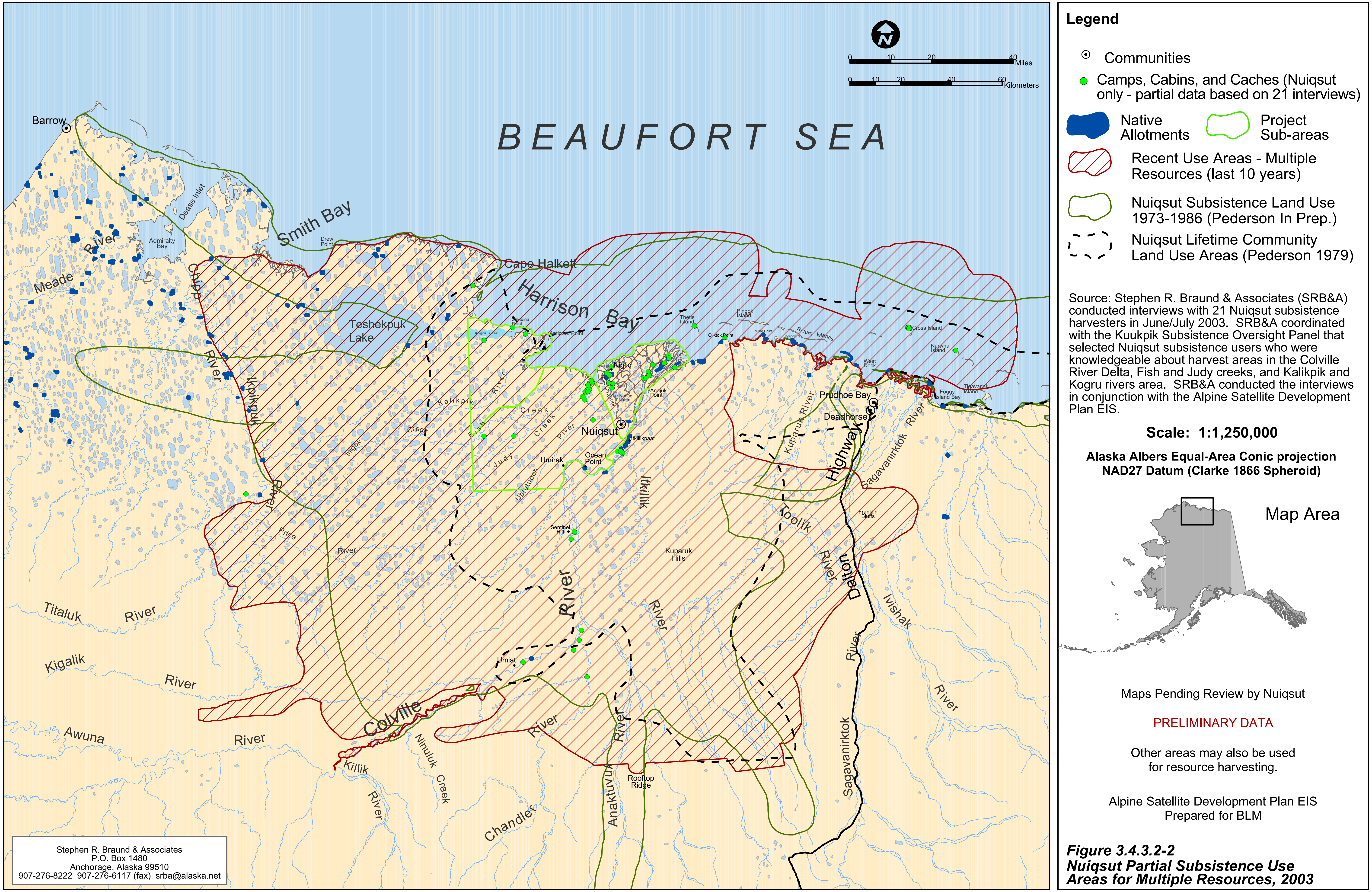
USDOI MMS. 2009. Office of Leasing and Environmental, Alaska OCS Region. *Environmental Assessment. Shell Offshore Inc. 2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay*. October 2009.

FIGURE 1



Source: Stephen R. Braund & Associates (SRB&A) conducted interviews with 21 Nuiqsut subsistence harvesters in June/July 2003. SRB&A coordinated with the Kuukpik Subsistence Oversight Panel that selected Nuiqsut subsistence users who were knowledgeable about harvest areas in the Colville River Delta, Fish and Judy creeks, and Kalikpik and Kogru rivers area. SRB&A conducted the interviews in conjunction with the Alpine Satellite Development Plan EIS.

Scale: 1:1,250,000

Alaska Albers Equal-Area Conic projection
NAD27 Datum (Clarke 1866 Spheroid)

Maps Pending Review by Nuiqsut

PRELIMINARY DATA

Other areas may also be used
for resource harvesting.

Alpine Satellite Development Plan EIS
Prepared for BLM

Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

Figure 3.4.3.2-2
Nuiqsut Partial Subsistence Use Areas for Multiple Resources, 2003

c:/gis/ALP03/maps/DEIS/nui_Multiple_Resources.mxd

Figure 14: Cross Island GPS Boat Tracks, All Boats and All Days, by Year (2001-2007)

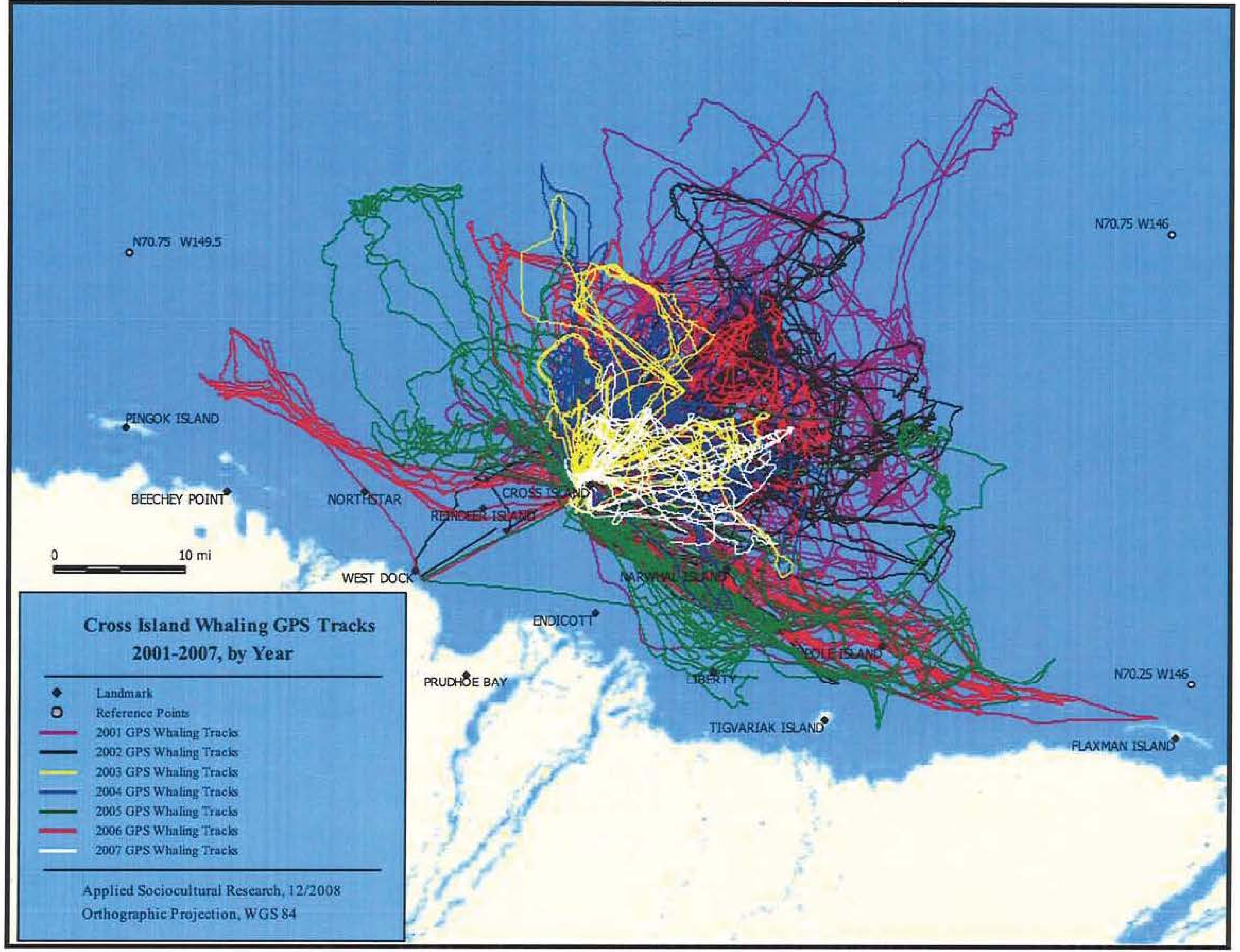
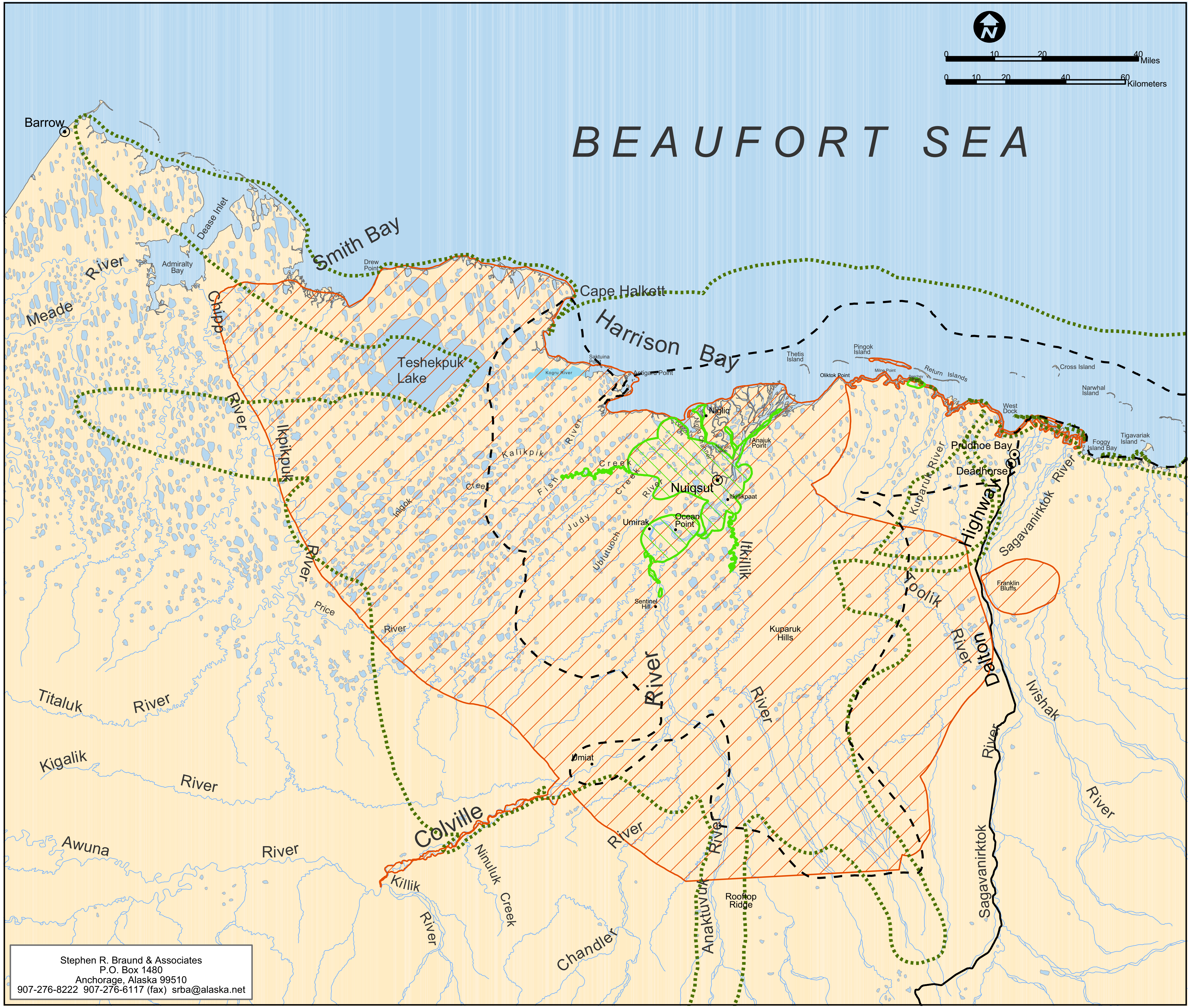


FIGURE 2

FIGURE 3



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

Legend

- ⊙ Communities
- ▨ Recent Use Areas - Geese (last 10 years)
- ▨ Recent Use Areas - Caribou (last 10 years)
- ⋯ Nuiqsut Subsistence Land Use 1973-1986 (Pederson In Prep.)
- - - Nuiqsut Lifetime Community Land Use Areas (Pederson 1979)

Source: Stephen R. Braund & Associates (SRB&A) conducted interviews with 21 Nuiqsut subsistence harvesters in June/July 2003. SRB&A coordinated with the Kuukpik Subsistence Oversight Panel that selected Nuiqsut subsistence users who were knowledgeable about harvest areas in the Colville River Delta, Fish and Judy creeks, and Kalikpik and Kogru rivers area. SRB&A conducted the interviews in conjunction with the Alpine Satellite Development Plan EIS.

Scale: 1:1,250,000

Alaska Albers Equal-Area Conic projection
NAD27 Datum (Clarke 1866 Spheroid)

Map Area

Maps Pending Review by Nuiqsut

PRELIMINARY DATA

Other areas may also be used for resource harvesting.

Alpine Satellite Development Plan EIS
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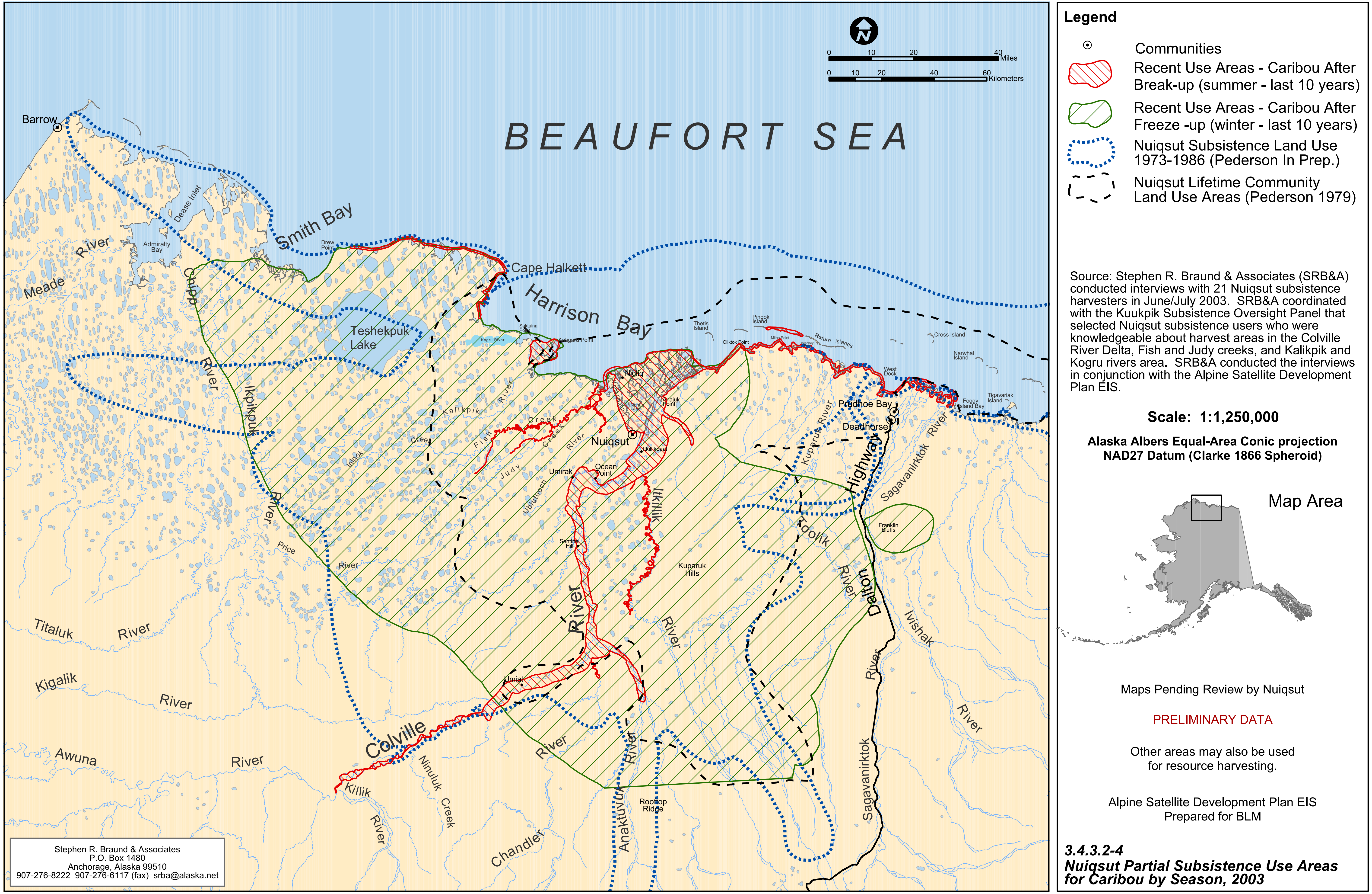
Figure 3.4.3.2-3
Nuiqsut Partial Subsistence Use Areas for Caribou (All seasons) and Geese, 2003

c:/gis/ALP03/maps/DEIS/nui_Caribou_Geese.mxd

FIGURE 4



Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

Source: Stephen R. Braund & Associates (SRB&A) conducted interviews with 21 Nuiqsut subsistence harvesters in June/July 2003. SRB&A coordinated with the Kuukpik Subsistence Oversight Panel that selected Nuiqsut subsistence users who were knowledgeable about harvest areas in the Colville River Delta, Fish and Judy creeks, and Kalikpik and Kogru rivers area. SRB&A conducted the interviews in conjunction with the Alpine Satellite Development Plan EIS.

Scale: 1:1,250,000

Alaska Albers Equal-Area Conic projection
NAD27 Datum (Clarke 1866 Spheroid)

Maps Pending Review by Nuiqsut

PRELIMINARY DATA

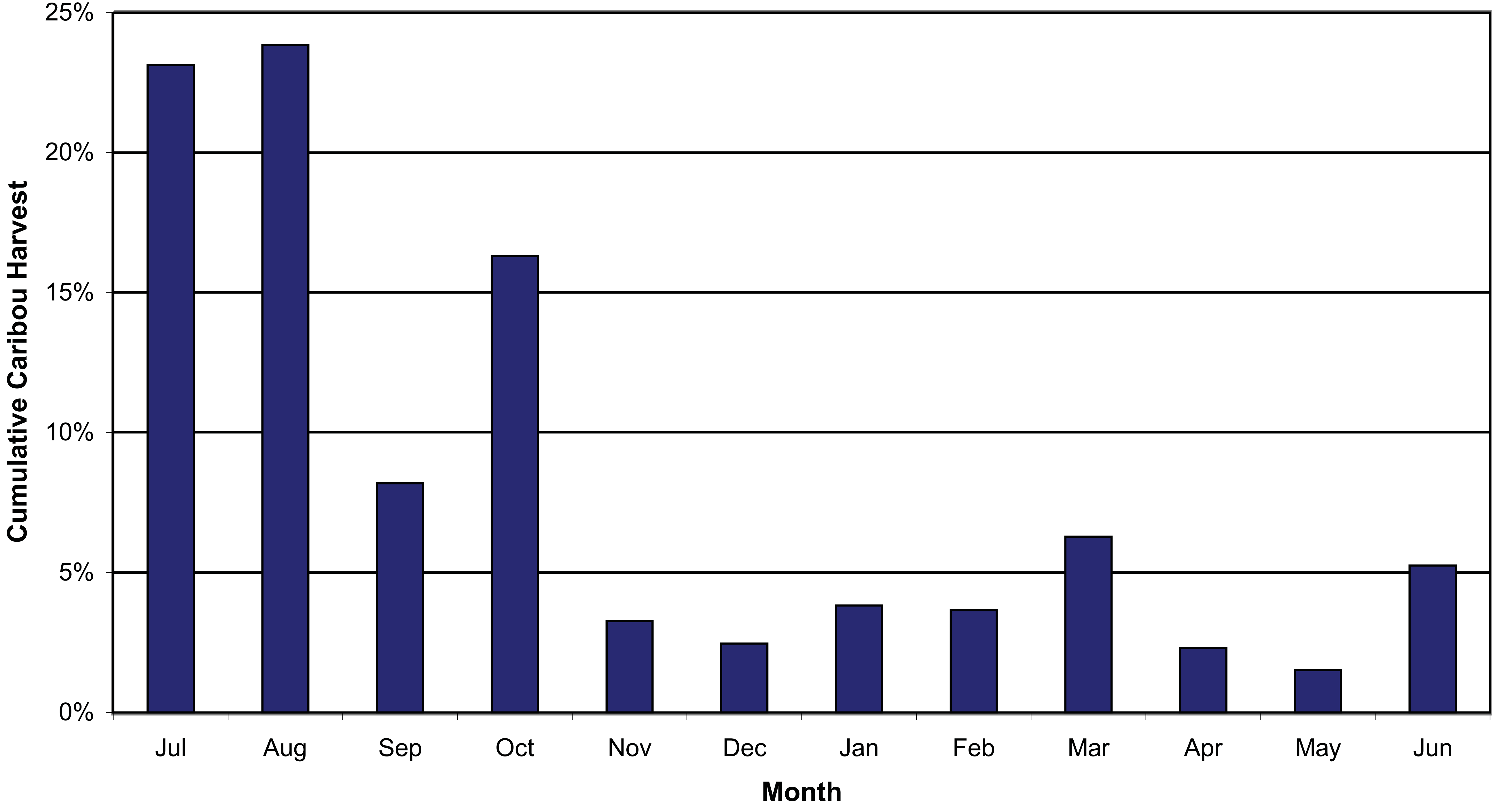
Other areas may also be used
for resource harvesting.

Alpine Satellite Development Plan EIS
Prepared for BLM

3.4.3.2-4
Nuiqsut Partial Subsistence Use Areas for Caribou by Season, 2003

c:/gis/ALP03/maps/DEIS/nui_Caribou_Seasons.mxd

FIGURE 5



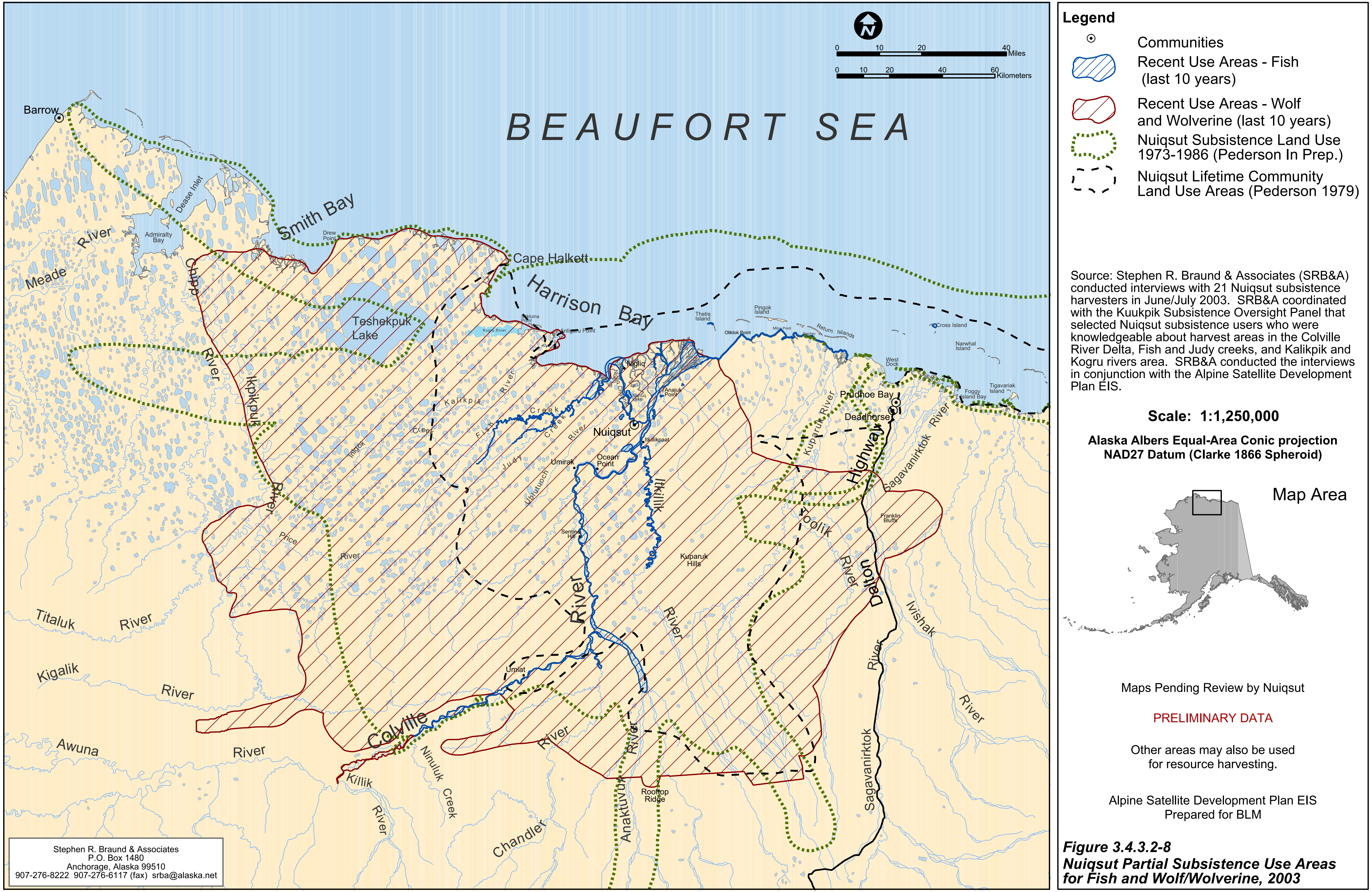
Note: Data for the study years of 1994-1995, 2000 and 2001 is raw, uncorrected data, and the figure does not represent total harvest numbers

Source: Alaska Department of Fish and Game, Division of Subsistence, 2003 (unpublished Nuiqsut data, 1993)
North Slope Borough Department of Wildlife Management, 2003 (unpublished Nuiqsut data, 1994-1995, 2000, 2001)

Stephen R. Braund & Associates, 2003

Figure 3.4.3.2-5
Nuiqsut Cumulative Caribou Harvest by Month,
1993, 1994-1995, 2000, and 2001

FIGURE 6



Legend

- ⊙ Communities
- ▨ Recent Use Areas - Fish (last 10 years)
- ▨ Recent Use Areas - Wolf and Wolverine (last 10 years)
- Nuiqsut Subsistence Land Use 1973-1986 (Pederson In Prep.)
- Nuiqsut Lifetime Community Land Use Areas (Pederson 1979)

Source: Stephen R. Braund & Associates (SRB&A) conducted interviews with 21 Nuiqsut subsistence harvesters in June/July 2003. SRB&A coordinated with the Kuukpik Subsistence Oversight Panel that selected Nuiqsut subsistence users who were knowledgeable about harvest areas in the Colville River Delta, Fish and Judy creeks, and Kalikpik and Kogru rivers area. SRB&A conducted the interviews in conjunction with the Alpine Satellite Development Plan EIS.

Scale: 1:1,250,000

Alaska Albers Equal-Area Conic projection
NAD27 Datum (Clarke 1866 Spheroid)

Maps Pending Review by Nuiqsut

PRELIMINARY DATA

Other areas may also be used for resource harvesting.

Alpine Satellite Development Plan EIS
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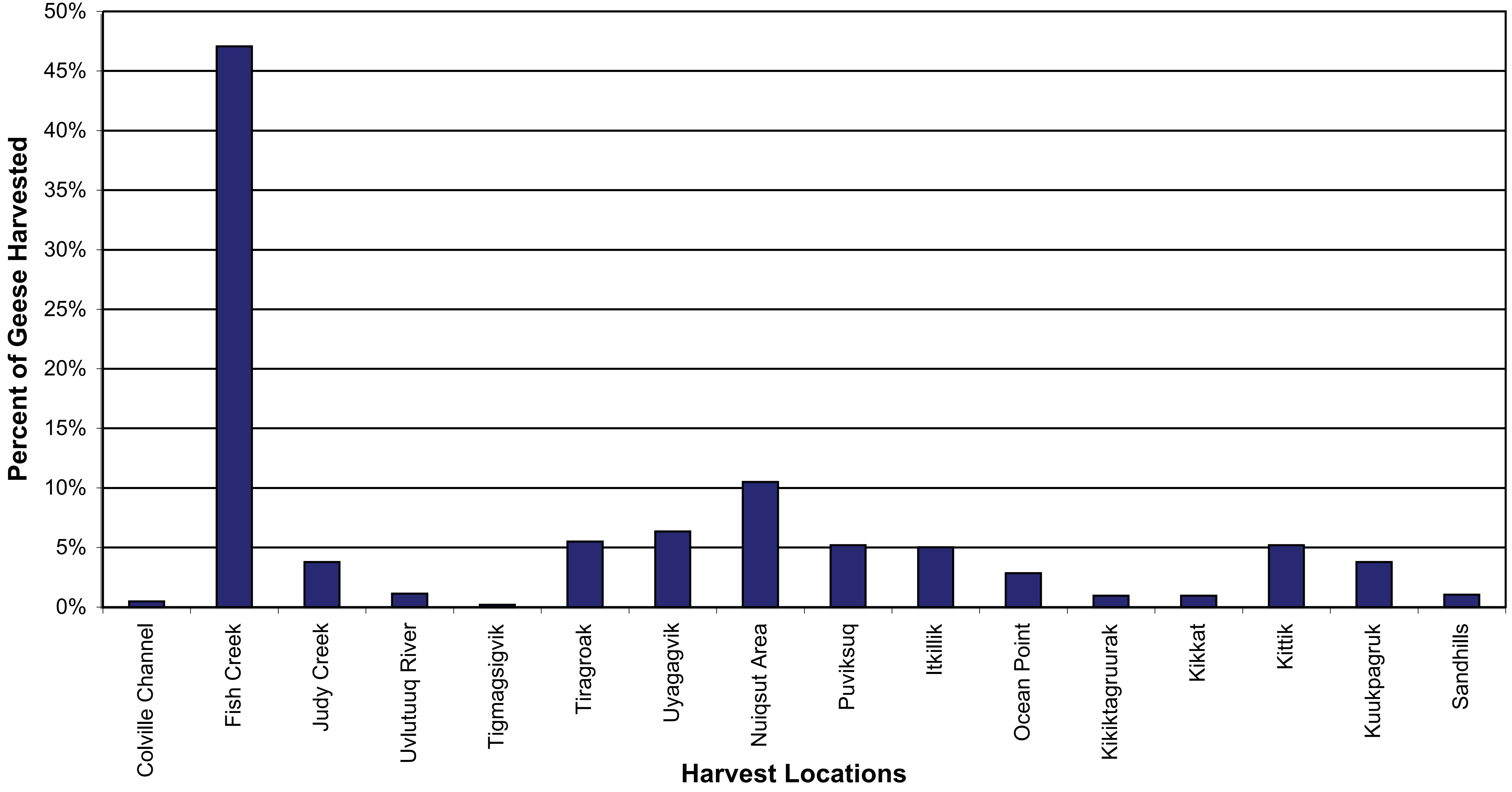
Figure 3.4.3.2-8
Nuiqsut Partial Subsistence Use Areas for Fish and Wolf/Wolverine, 2003

Stephen R. Braund & Associates
P.O. Box 1480
Anchorage, Alaska 99510
907-276-8222 907-276-6117 (fax) srba@alaska.net

c:/gis/ALP03/maps/DEIS/nui_W&W_Fish.mxd

FIGURE 7

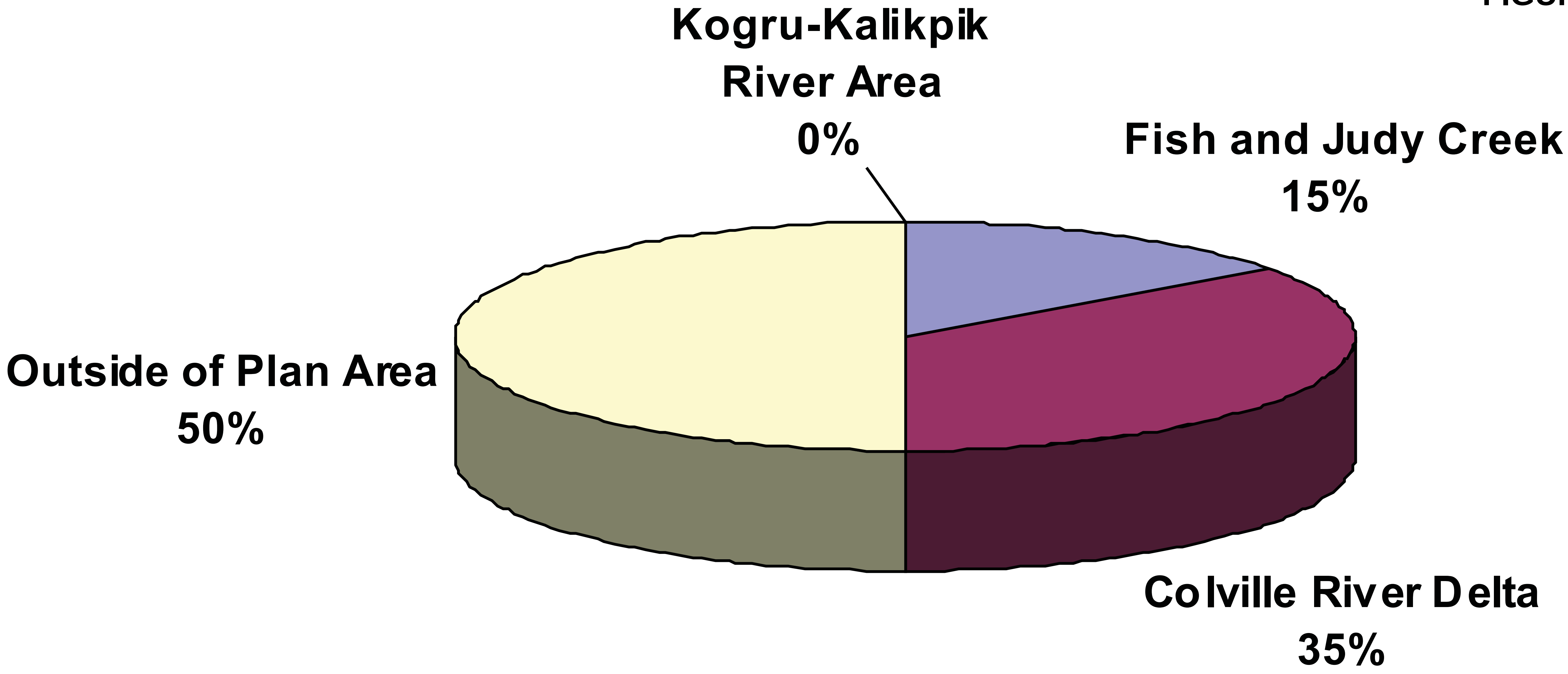


Note: This figure is based on raw, uncorrected data and does not represent total harvest numbers

Source: North Slope Burough Department of Wildlife Management, 2003 (Unpublished Nuiqsut Harvest Data 1994-1995, 2000 and 2001)

Stephen R. Braund & Associates, 2003

Figure 3.4.3.2-16
Nuiqsut Harvest Locations for all Species
of Geese,1994-1995, 2000, and 2001

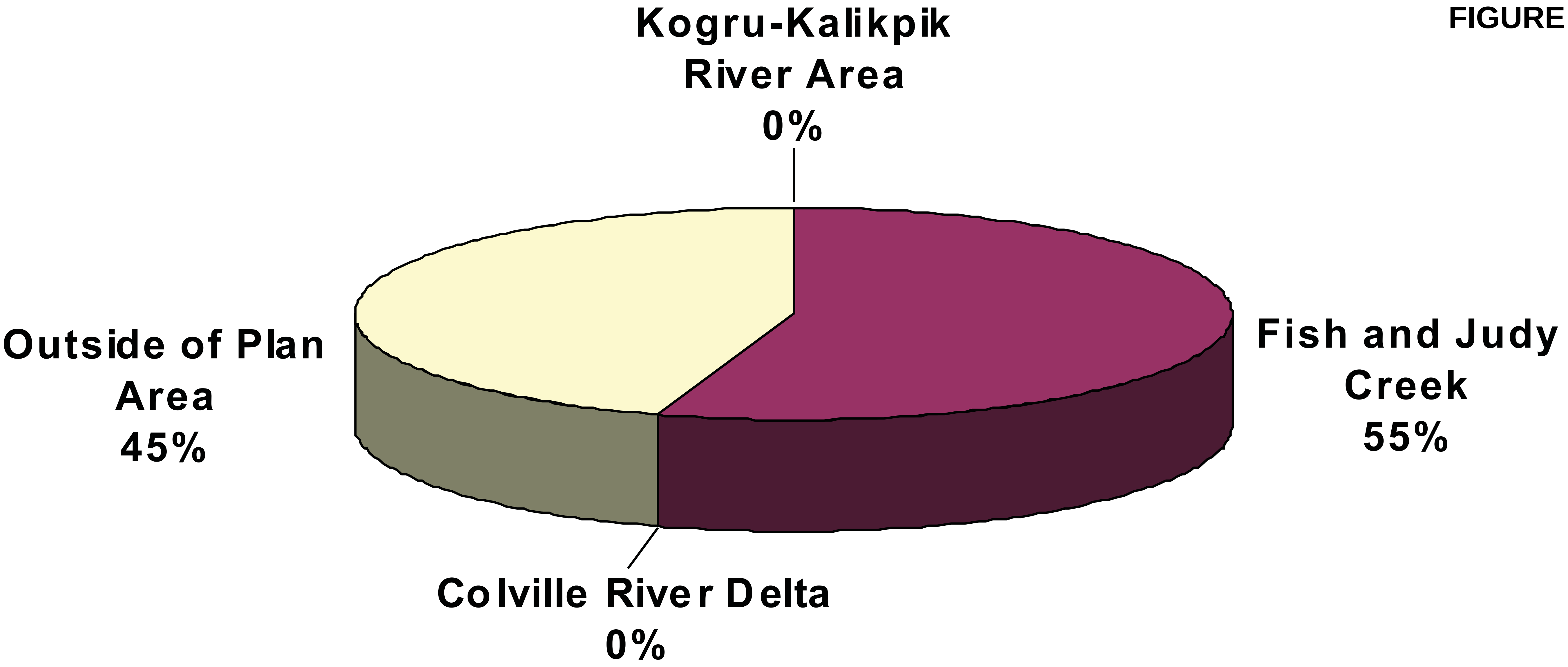


Note: This figure is based on raw, uncorrected data and does not represent total harvest numbers

Source: North Slope Borough Department of Wildlife Management, 2003 (Unpublished Nuiqsut Harvest Data 1994-1995, 2000 and 2001)

Stephen R. Braund & Associates, 2003

Figure 3.4.3.2-20
Nuiqsut Wolverine Harvest Locations
for 1994-1995, 2000, and 2001



Note: This figure is based on raw, uncorrected data and does not represent total harvest numbers.

Source: North Slope Borough Department of Wildlife Management, 2003 (Unpublished Nuiqsut Harvest Data 1994-1995, 2000 and 2001)

Stephen R. Braund & Associates, 2003

Figure 3.4.3.2-21
Nuiqsut Wolves Harvested in Fish and
Judy Creeks in 1994-1995, 2000, and 2001

APPENDIX B

TIER I AND TIER II HUMAN HEALTH SCREENING AND ACTION LEVEL CALCULATION TABLES

Table B-1
Volatilization Factor for Soil
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes				Soil Properties [a]					Chemical Properties [b]									
CAS #	Chemical Name	Q/C [a] (g/m^2-s)/(kg/m^3)	T [a] (s)	ρ_b (g/cm^3)	n (unitless)	θ_w (unitless)	θ_a (unitless)	f_{oc} (unitless)	K_d (L/kg)	Koc (L/kg)	Di (cm^2/s)	Dw (cm^2/s)	H' (unitless)	HLC (atm-m^3/mol)	VP (mm Hg)	VOC? [c]	D_A [d] (cm^2/s)	VF / PEF [d,e] (m^3/kg)
Volatiles																		
67-64-1	Acetone	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.4E-03	2.4E+00	1.1E-01	1.2E-05	1.4E-03	3.5E-05	2.3E+02	Yes	7.9E-05	2.0E+04
107-02-8	Acrolein	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.0E-03	1.0E+00	1.1E-01	1.2E-05	5.0E-03	1.2E-04	2.7E+02	Yes	2.9E-04	1.1E+04
71-43-2	Benzene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.5E-01	1.5E+02	9.0E-02	1.0E-05	2.3E-01	5.5E-03	9.5E+01	Yes	3.7E-03	3.0E+03
78-93-3	2-Butanone	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.5E-03	4.5E+00	9.1E-02	1.0E-05	2.3E-03	5.7E-05	9.1E+01	Yes	1.1E-04	1.7E+04
56-23-5	Carbon tetrachloride	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.4E-02	4.4E+01	5.7E-02	9.8E-06	1.1E+00	2.8E-02	1.2E+02	Yes	9.6E-03	1.9E+03
108-90-7	Chlorobenzene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.3E-01	2.3E+02	7.2E-02	9.5E-06	1.3E-01	3.1E-03	1.2E+01	Yes	1.4E-03	4.9E+03
75-00-3	Chloroethane	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.2E-02	2.2E+01	1.0E-01	1.2E-05	4.5E-01	1.1E-02	1.0E+03	Yes	1.2E-02	1.7E+03
67-66-3	Chloroform	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	3.2E-02	3.2E+01	7.7E-02	1.1E-05	1.5E-01	3.7E-03	2.0E+02	Yes	3.8E-03	2.9E+03
106-93-4	1,2-Dibromoethane	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.0E-02	4.0E+01	4.3E-02	1.0E-05	2.7E-02	6.5E-04	1.1E+01	Yes	4.2E-04	8.9E+03
95-50-1	1,2-Dichlorobenzene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	3.8E-01	3.8E+02	5.6E-02	8.9E-06	7.8E-02	1.9E-03	1.4E+00	Yes	4.7E-04	8.4E+03
75-34-3	1,1-Dichloroethane	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	3.2E-02	3.2E+01	8.4E-02	1.1E-05	2.3E-01	5.6E-03	2.3E+02	Yes	5.8E-03	2.4E+03
107-06-2	1,2-Dichloroethane	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.0E-02	4.0E+01	8.6E-02	1.1E-05	4.8E-02	1.2E-03	7.9E+01	Yes	1.5E-03	4.7E+03
75-35-4	1,1-Dichloroethene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	3.2E-02	3.2E+01	8.6E-02	1.1E-05	1.1E+00	2.6E-02	6.0E+02	Yes	1.5E-02	1.5E+03
156-59-2	cis-1,2-Dichloroethene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.0E-02	4.0E+01	8.8E-02	1.1E-05	1.7E-01	4.1E-03	2.0E+02	Yes	4.6E-03	2.7E+03
156-60-5	trans-1,2-Dichloroethene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.0E-02	4.0E+01	8.8E-02	1.1E-05	3.9E-01	9.4E-03	3.3E+02	Yes	8.5E-03	2.0E+03
60-29-7	Diethyl ether	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	9.7E-03	9.7E+00	8.5E-02	9.4E-06	5.0E-02	1.2E-03	5.4E+02	Yes	1.9E-03	4.2E+03
123-91-1	1,4-Dioxane	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.6E-03	2.6E+00	8.7E-02	1.1E-05	2.0E-04	4.8E-06	3.8E+01	Yes	9.5E-06	5.9E+04
100-41-4	Ethylbenzene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.5E-01	4.5E+02	6.8E-02	8.5E-06	3.2E-01	7.9E-03	9.6E+00	Yes	1.9E-03	4.1E+03
50-00-0	Formaldehyde	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.0E-03	1.0E+00	1.7E-01	1.7E-05	1.4E-05	3.4E-07	3.9E+03	Yes	2.3E-06	1.2E+05
67-56-1	Methanol	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.0E-03	1.0E+00	1.6E-01	1.7E-05	1.9E-04	4.5E-06	1.3E+02	Yes	1.7E-05	4.5E+04
75-09-2	Methylene chloride	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.2E-02	2.2E+01	1.0E-01	1.3E-05	1.3E-01	3.2E-03	4.4E+02	Yes	4.8E-03	2.6E+03
108-10-1	4-Methyl-2-pentanone	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.3E-02	1.3E+01	7.0E-02	8.3E-06	5.6E-03	1.4E-04	2.0E+01	Yes	1.9E-04	1.3E+04
103-65-1	n-Propylbenzene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	8.1E-01	8.1E+02	6.0E-02	7.8E-06	4.3E-01	1.0E-02	3.4E+00	Yes	1.4E-03	4.9E+03
127-18-4	Tetrachloroethene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	9.5E-02	9.5E+01	5.0E-02	9.5E-06	7.2E-01	1.8E-02	1.9E+01	Yes	5.9E-03	2.4E+03
108-88-3	Toluene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.3E-01	2.3E+02	7.8E-02	9.2E-06	2.7E-01	6.6E-03	2.8E+01	Yes	2.9E-03	3.4E+03
71-55-6	1,1,1-Trichloroethane	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.4E-02	4.4E+01	6.5E-02	9.6E-06	7.0E-01	1.7E-02	1.2E+02	Yes	8.8E-03	1.9E+03
79-01-6	Trichloroethene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	6.1E-02	6.1E+01	6.9E-02	1.0E-05	4.0E-01	9.8E-03	6.9E+01	Yes	6.2E-03	2.3E+03
95-63-6	1,2,4-Trimethylbenzene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	6.1E-01	6.1E+02	6.1E-02	7.9E-06	2.5E-01	6.1E-03	2.1E+00	Yes	1.1E-03	5.6E+03
108-67-8	1,3,5-Trimethylbenzene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	6.0E-01	6.0E+02	6.0E-02	7.8E-06	3.6E-01	8.7E-03	2.1E+00	Yes	1.5E-03	4.7E+03
75-01-4	Vinyl chloride	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.2E-02	2.2E+01	1.1E-01	1.2E-05	1.1E+00	2.8E-02	3.0E+03	Yes	1.9E-02	1.3E+03
1330-20-7	Xylenes	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	3.8E-01	3.8E+02	6.9E-02	8.5E-06	2.1E-01	5.2E-03	8.0E+00	Yes	1.5E-03	4.7E+03
Semi-Volatiles																		
83-32-9	Acenaphthene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	5.0E+00	5.0E+03	5.1E-02	8.3E-06	7.5E-03	1.8E-04	2.2E-03	Yes	4.0E-06	9.2E+04
208-96-8	Acenaphthylene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	5.0E+00	5.0E+03	4.5E-02	7.0E-06	4.7E-03	1.1E-04	6.7E-03	Yes	2.2E-06	1.2E+05
120-12-7	Anthracene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.6E+01	1.6E+04	3.9E-02	7.9E-06	2.3E-03	5.5E-05	6.5E-06	Yes	2.9E-07	3.4E+05
56-55-3	Benzo(a)anthracene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.8E+02	1.8E+05	2.6E-02	6.7E-06	4.9E-04	1.2E-05	2.1E-07	Yes	4.1E-09	2.8E+06
50-32-8	Benzo(a)pyrene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	5.9E+02	5.9E+05	4.8E-02	5.6E-06	1.9E-05	4.6E-07	5.5E-09	No	--	4.6E+09
205-99-2	Benzo(b)fluoranthene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	6.0E+02	6.0E+05	4.8E-02	5.6E-06	2.7E-05	6.6E-07	5.0E-07	No	--	4.6E+09
191-24-2	Benzo(g,h,i)perylene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.0E+03	2.0E+06	4.5E-02	5.2E-06	1.4E-05	3.3E-07	1.0E-10	No	--	4.6E+09
207-08-9	Benzo(k)fluoranthene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	5.9E+02	5.9E+05	4.8E-02	5.6E-06	2.4E-05	5.8E-07	9.7E-10	No	--	4.6E+09
218-01-9	Chrysene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.8E+02	1.8E+05	2.6E-02	6.7E-06	2.1E-04	5.2E-06	6.2E-09	No	--	4.6E+09
53-70-3	Dibenz(a,h)anthracene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.9E+03	1.9E+06	4.5E-02	5.2E-06	5.8E-06	1.4E-07	9.6E-10	No	--	4.6E+09
105-67-9	2,4-Dimethylphenol	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	4.9E-01	4.9E+02	6.2E-02	8.3E-06	3.9E-05	9.5E-07	1.0E-01	No	--	4.6E+09
84-74-2	Di-n-butylphthalate	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.2E+00	1.2E+03	2.1E-02	5.3E-06	7.4E-05	1.8E-06	2.0E-05	No	--	4.6E+09
206-44-0	Fluoranthene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	5.5E+01	5.5E+04	2.8E-02	7.2E-06	3.6E-04	8.8E-06	9.2E-06	No	--	4.6E+09
86-73-7	Fluorene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	9.2E+00	9.2E+03	4.4E-02	7.9E-06	3.9E-03	9.6E-05	6.0E-04	Yes	1.0E-06	1.8E+05
193-39-5	Indeno(1,2,3-cd)pyrene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.0E+03	2.0E+06	4.5E-02	5.2E-06	1.4E-05	3.5E-07	1.3E-10	No	--	4.6E+09
90-12-0	1-Methylnaphthalene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.5E+00	2.5E+03	5.3E-02	7.8E-06	2.1E-02	5.1E-04	6.7E-02	Yes	2.2E-05	3.8E+04
91-57-6	2-Methylnaphthalene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	2.5E+00	2.5E+03	5.2E-02	7.8E-06	2.1E-02	5.2E-04	5.5E-02	Yes	2.3E-05	3.8E+04
95-48-7	2-Methylphenol	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	3.1E-01	3.1E+02	7.3E-02	9.3E-06	4.9E-05	1.2E-06	3.0E-01	No	--	4.6E+09
108-39-4	3-Methylphenol	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	3.0E-01	3.0E+02	7.3E-02	9.3E-06	3.5E-05	8.5E-07	1.1E-01	No	--	4.6E+09
106-44-5	4-Methylphenol	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	3.0E-01	3.0E+02	7.2E-02	9.2E-06	4.1E-05	1.0E-06	1.1E-01	No	--	4.6E+09
34mp	3&4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
91-20-3	Naphthalene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.5E+00	1.5E+03	6.0E-02	8.4E-06	1.8E-02	4.4E-04	8.5E-02	Yes	3.5E-05	3.1E+04
85-01-8	Phenanthrene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.7E+01	1.7E+04	3.5E-02	6.7E-06	1.7E-03	4.2E-05	1.2E-04	Yes	1.9E-07	4.2E+05
108-95-2	Phenol	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	1.9E-01	1.9E+02	8.3E-02	1.0E-05	1.4E-05	3.3E-07	3.5E-01	No	--	4.6E+09
129-00-0	Pyrene	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	5.4E+01	5.4E+04	2.8E-02	7.2E-06	4.9E-04	1.2E-05	4.5E-06	Yes	1.4E-08	1.5E+06

Table B-1
Volatilization Factor for Soil
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes				Soil Properties [a]					Chemical Properties [b]									
CAS #	Chemical Name	Q/C [a] $(g/m^2\text{-}s)/(kg/m^3)$	T [a] (s)	ρ_b (g/cm^3)	n (unitless)	θ_w (unitless)	θ_a (unitless)	f_{oc} (unitless)	K_d (L/kg)	Koc (L/kg)	Di (cm^2/s)	Dw (cm^2/s)	H' (unitless)	HLC $(atm\text{-}m^3/mol)$	VP (mm Hg)	VOC? [c]	D_A [d] (cm^2/s)	VF / PEF [d,e] (m^3/kg)
Metals																		
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	0.0E+00	No	--	4.6E+09
7440-38-2	Arsenic	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	NA	No	--	4.6E+09
7440-39-3	Barium	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	NA	No	--	4.6E+09
7440-43-9	Cadmium (food)	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	0.0E+00	No	--	4.6E+09
7440-43-9	Cadmium (water)	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0E+00	No	--	--
7440-47-3	Chromium	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	NA	No	--	4.6E+09
16065-83-1	Chromium (III)	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	NA	No	--	4.6E+09
18540-29-9	Chromium (VI)	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	NA	No	--	4.6E+09
7440-50-8	Copper	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	0.0E+00	No	--	4.6E+09
7439-92-1	Lead	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	0.0E+00	No	--	4.6E+09
7439-96-5	Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7487-94-7	Mercury (inorganic salts)	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	NA	No	--	4.6E+09
7439-97-6	Mercury (elemental)	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	3.1E-02	6.3E-06	4.7E-01	1.1E-02	2.0E-03	Yes	--	--
7440-02-0	Nickel	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	0.0E+00	No	--	4.6E+09
7782-49-2	Selenium	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	1.4E-10	No	--	4.6E+09
7440-22-4	Silver	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	0.0E+00	No	--	4.6E+09
7440-62-2	Vanadium	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	NA	No	--	4.6E+09
7440-66-6	Zinc	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	NA	NA	NA	--	NA	No	--	4.6E+09
Inorganics																		
57-12-5	Cyanide	1.0E+02	9.5E+08	1.5E+00	4.3E-01	1.5E-01	2.8E-01	1.0E-03	--	NA	2.1E-01	2.5E-05	9.9E-01	2.4E-02	3.1E+02	Yes	--	--

Abbreviations:

CAS #: Chemical Abstract Service registry number
Q/C: inverse of mean concentration at center of source
T: exposure interval
ρ_b: dry soil bulk density
n: total soil porosity
θ_w: water-filled porosity
θ_a: air-filled porosity
f_{oc}: fraction organic carbon
K_d: soil-water partition coefficient
Koc: organic carbon partition coefficient
Di: diffusivity in air
Dw: diffusivity in water
H': dimensionless Henry's law constant
HLC: Henry's law constant ($atm\text{-}m^3/mol$)
VP: vapor pressure
VOC: volatile organic chemical
D_A: apparent diffusivity
VF: volatilization factor
PEF: particulate emission factor
$(g/m^2\text{-}s)/(kg/m^3)$: grams per square meter-second per kilogram per cubic meter
s: second
g/cm^3: grams per cubic centimeter
L/kg: liters per kilogram
cm^2/s: square centimeters per second
$atm\text{-}m^3/mol$: atmosphere-cubic meters/mol
m^3/kg: cubic meters/kilogram
mm Hg: millimeters of mercury
NA: not available
--: not applicable

References:

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Footnotes:

[a] Soil properties (ρ_b, n, θ_w, θ_a, and f_{oc}), Q/C, and T are from ADEC (2008b). Q/C is the default value for the Arctic zone.

[b] Chemical properties (Koc, Di, Dw, H', VP) are from EPA (2015b). Values for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene are not available from EPA (2015b) and are from ORNL (2015). Kd = Koc*foc. HLC = H'/41 (EPA, 1996b).

[c] Chemicals were identified as volatile if HLC > 10^{-5} $atm\text{-}m^3/mol$ or VP > 1 mm Hg (EPA, 2015d).

[d] $D_A=[(\theta_a^{10/3}*Di*H'+\theta_w^{10/3}*Dw)/n^2]/(\rho_b*K_d+\theta_w+\theta_a*H')$

$VF = [Q/C * (3.14*D_A*T)^{1/2} * 10^{-4}\ m^2/cm^2] / (2*\rho_b*D_A)$

Values calculated using Equation 9 in ADEC (2008b).

[e] The soil-to-air transfer factor was the VF for VOCs, and the PEF for all other chemicals. The PEF is the default value from EPA (1991).

Table B-2
Tier I Water Screening Levels
Industrial Worker Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Values [a]		Dermal Factors [a]						Industrial Worker (IW) SLs [c]		
CAS #	Chemical Name	SFd $(mg/kg\text{-}d)^{-1}$	RfDd (mg/kg-d)	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA_{event} [b] cm/event	IW Dermal (NC) [d] (µg/L)	IW Dermal (C) [e] (µg/L)	Lowest IW SL [f] (µg/L)
Volatiles												
67-64-1	Acetone	NA	9.0E-01	5.1E-04	2.2E-01	5.3E-01	NA	1.5E-03	NA	NA	NA	NA
107-02-8	Acrolein	NA	5.0E-04	7.5E-04	2.2E-01	5.2E-01	1.0E+00	2.2E-03	1.1E-03	1.9E+03	NA	1.9E+03
71-43-2	Benzene	5.5E-02	4.0E-03	1.5E-02	2.9E-01	6.9E-01	1.0E+00	5.1E-02	2.3E-02	7.1E+02	9.1E+01	9.1E+01
78-93-3	2-Butanone	NA	6.0E-01	9.6E-04	2.7E-01	6.4E-01	1.0E+00	3.1E-03	1.5E-03	1.7E+06	NA	1.7E+06
56-23-5	Carbon tetrachloride	7.0E-02	4.0E-03	1.6E-02	7.6E-01	1.8E+00	1.0E+00	7.8E-02	3.9E-02	4.2E+02	4.2E+01	4.2E+01
108-90-7	Chlorobenzene	NA	2.0E-02	2.8E-02	4.5E-01	1.1E+00	1.0E+00	1.2E-01	5.2E-02	1.6E+03	NA	1.6E+03
75-00-3	Chloroethane	NA	NA	6.1E-03	2.4E-01	5.8E-01	1.0E+00	1.9E-02	8.9E-03	NA	NA	NA
67-66-3	Chloroform	3.1E-02	1.0E-02	6.8E-03	4.9E-01	1.2E+00	1.0E+00	2.9E-02	1.3E-02	3.1E+03	2.8E+02	2.8E+02
106-93-4	1,2-Dibromoethane	2.0E+00	9.0E-03	2.8E-03	1.2E+00	2.8E+00	1.0E+00	1.5E-02	8.4E-03	4.5E+03	6.9E+00	6.9E+00
95-50-1	1,2-Dichlorobenzene	NA	9.0E-02	4.5E-02	7.0E-01	1.7E+00	1.0E+00	2.1E-01	1.0E-01	3.6E+03	NA	3.6E+03
75-34-3	1,1-Dichloroethane	5.7E-03	2.0E-01	6.8E-03	3.8E-01	9.0E-01	1.0E+00	2.6E-02	1.2E-02	7.0E+04	1.7E+03	1.7E+03
107-06-2	1,2-Dichloroethane	9.1E-02	6.0E-03	4.2E-03	3.8E-01	9.0E-01	1.0E+00	1.6E-02	7.3E-03	3.4E+03	1.7E+02	1.7E+02
75-35-4	1,1-Dichloroethene	NA	5.0E-02	1.2E-02	3.7E-01	8.8E-01	1.0E+00	4.4E-02	2.0E-02	1.0E+04	NA	1.0E+04
156-59-2	cis-1,2-Dichloroethene	NA	2.0E-03	1.1E-02	3.7E-01	8.8E-01	NA	4.2E-02	NA	NA	NA	NA
156-60-5	trans-1,2-Dichloroethene	NA	2.0E-02	1.1E-02	3.7E-01	8.8E-01	1.0E+00	4.2E-02	1.9E-02	4.4E+03	NA	4.4E+03
60-29-7	Diethyl ether	NA	2.0E-01	2.4E-03	2.7E-01	6.6E-01	1.0E+00	7.8E-03	3.6E-03	2.3E+05	NA	2.3E+05
123-91-1	1,4-Dioxane	1.0E-01	3.0E-02	3.3E-04	3.3E-01	7.9E-01	1.0E+00	1.2E-03	5.5E-04	2.3E+05	2.1E+03	2.1E+03
100-41-4	Ethylbenzene	1.1E-02	1.0E-01	4.9E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	9.0E-02	4.6E+03	1.2E+02	1.2E+02
50-00-0	Formaldehyde	NA	2.0E-01	1.8E-03	1.5E-01	3.7E-01	1.0E+00	3.8E-03	2.4E-03	3.5E+05	NA	3.5E+05
67-56-1	Methanol	NA	2.0E+00	3.2E-04	1.6E-01	3.8E-01	1.0E+00	6.9E-04	4.2E-04	2.0E+07	NA	2.0E+07
75-09-2	Methylene chloride	2.0E-03	6.0E-03	3.5E-03	3.1E-01	7.5E-01	1.0E+00	1.3E-02	5.7E-03	4.3E+03	1.0E+04	4.3E+03
108-10-1	4-Methyl-2-pentanone	NA	8.0E-02	3.2E-03	3.8E-01	9.2E-01	1.0E+00	1.2E-02	5.6E-03	5.9E+04	NA	5.9E+04
103-65-1	n-Propylbenzene	NA	1.0E-01	9.4E-02	5.0E-01	1.2E+00	NA	4.0E-01	NA	NA	NA	NA
127-18-4	Tetrachloroethene	2.1E-03	6.0E-03	3.3E-02	8.9E-01	2.1E+00	1.0E+00	1.7E-01	8.7E-02	2.8E+02	6.3E+02	2.8E+02
108-88-3	Toluene	NA	8.0E-02	3.1E-02	3.5E-01	8.3E-01	1.0E+00	1.1E-01	5.2E-02	6.4E+03	NA	6.4E+03
71-55-6	1,1,1-Trichloroethane	NA	2.0E+00	1.3E-02	5.9E-01	1.4E+00	1.0E+00	5.6E-02	2.7E-02	3.1E+05	NA	3.1E+05
79-01-6	Trichloroethene	4.6E-02	5.0E-04	1.2E-02	5.7E-01	1.4E+00	1.0E+00	5.1E-02	2.4E-02	8.5E+01	1.0E+02	8.5E+01
95-63-6	1,2,4-Trimethylbenzene	NA	5.0E-02	8.6E-02	5.0E-01	1.2E+00	NA	3.6E-01	NA	NA	NA	NA
108-67-8	1,3,5-Trimethylbenzene	NA	1.0E-02	6.2E-02	5.0E-01	1.2E+00	NA	2.6E-01	NA	NA	NA	NA
75-01-4	Vinyl chloride	7.2E-01	3.0E-03	8.4E-03	2.4E-01	5.7E-01	1.0E+00	2.5E-02	1.2E-02	1.0E+03	1.3E+01	1.3E+01
1330-20-7	Xylenes	NA	2.0E-01	5.0E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	9.1E-02	9.1E+03	NA	9.1E+03
Semi-Volatiles												
83-32-9	Acenaphthene	NA	6.0E-02	8.6E-02	7.7E-01	1.8E+00	NA	4.1E-01	NA	NA	NA	NA
208-96-8	Acenaphthylene	NA	NA	9.1E-02	NA	NA	NA	NA	NA	NA	NA	NA
120-12-7	Anthracene	NA	3.0E-01	1.4E-01	1.0E+00	2.5E+00	NA	7.3E-01	NA	NA	NA	NA
56-55-3	Benzo(a)anthracene	7.3E-01	NA	--	2.0E+00	4.8E+00	1.0E+00	3.2E+00	--	NA	NA	NA
50-32-8	Benzo(a)pyrene	7.3E+00	NA	--	2.7E+00	6.5E+00	1.0E+00	4.4E+00	--	NA	NA	NA
205-99-2	Benzo(b)fluoranthene	7.3E-01	NA	--	2.7E+00	6.5E+00	1.0E+00	2.5E+00	--	NA	NA	NA
191-24-2	Benzo(g,h,i)perylene	NA	NA	1.1E+00	NA	NA	NA	NA	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	7.3E-02	NA	--	2.7E+00	6.5E+00	NA	4.2E+00	NA	NA	NA	NA
218-01-9	Chrysene	7.3E-03	NA	--	2.0E+00	4.8E+00	1.0E+00	3.5E+00	--	NA	NA	NA
53-70-3	Dibenz(a,h)anthracene	7.3E+00	NA	--	3.8E+00	9.1E+00	6.0E-01	6.1E+00	--	NA	NA	NA
105-67-9	2,4-Dimethylphenol	NA	2.0E-02	1.1E-02	5.1E-01	1.2E+00	1.0E+00	4.6E-02	2.1E-02	3.9E+03	NA	3.9E+03
84-74-2	Di-n-butylphthalate	NA	1.0E-01	4.2E-02	3.8E+00	9.1E+00	9.0E-01	2.7E-01	2.0E-01	2.0E+03	NA	2.0E+03
206-44-0	Fluoranthene	NA	4.0E-02	--	1.4E+00	3.4E+00	1.0E+00	1.7E+00	--	NA	NA	NA
86-73-7	Fluorene	NA	4.0E-02	1.1E-01	9.0E-01	2.2E+00	NA	5.5E-01	NA	NA	NA	NA
193-39-5	Indeno(1,2,3-cd)pyrene	7.3E-01	NA	--	3.7E+00	8.9E+00	6.0E-01	7.9E+00	--	NA	NA	NA
90-12-0	1-Methylnaphthalene	2.9E-02	7.0E-02	9.3E-02	6.6E-01	1.6E+00	NA	4.3E-01	NA	NA	NA	NA
91-57-6	2-Methylnaphthalene	NA	4.0E-03	9.2E-02	6.6E-01	1.6E+00	NA	4.2E-01	NA	NA	NA	NA
95-48-7	2-Methylphenol	NA	5.0E-02	7.7E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	1.4E-02	1.5E+04	NA	1.5E+04
108-39-4	3-Methylphenol	NA	5.0E-02	7.8E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	1.4E-02	1.5E+04	NA	1.5E+04
106-44-5	4-Methylphenol	NA	1.0E-01	7.5E-03	4.2E-01	1.0E+00	1.0E+00	3.0E-02	1.4E-02	3.1E+04	NA	3.1E+04
34mp	3&4-Methylphenol [g]	--	--	--	--	--	--	--	--	1.5E+04	NA	1.5E+04
91-20-3	Naphthalene	NA	2.0E-02	4.7E-02	5.5E-01	1.3E+00	1.0E+00	2.0E-01	9.5E-02	8.7E+02	NA	8.7E+02
85-01-8	Phenanthrene	NA	NA	--	1.1E+00	2.5E+00	1.0E+00	7.0E-01	--	NA	NA	NA
108-95-2	Phenol	NA	3.0E-01	4.3E-03	3.5E-01	8.5E-01	1.0E+00	1.6E-02	7.4E-03	1.7E+05	NA	1.7E+05
129-00-0	Pyrene	NA	3.0E-02	2.0E-01	1.4E+00	3.4E+00	NA	1.1E+00	NA	NA	NA	NA

Table B-2
Tier I Water Screening Levels
Industrial Worker Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Values [a]		Dermal Factors [a]						Industrial Worker (IW) SLs [c]		
CAS #	Chemical Name	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA_{event} [b] cm/event	IW Dermal (NC) [d] (µg/L)	IW Dermal (C) [e] (µg/L)	Lowest IW SL [f] (µg/L)
Metals												
7429-90-5	Aluminum	--	--	--	--	--	--	2.0E-03	--	--	--	--
7440-36-0	Antimony	NA	6.0E-05	1.0E-03	5.1E-01	1.2E+00	--	4.2E-03	1.0E-03	2.5E+02	NA	2.5E+02
7440-38-2	Arsenic	1.5E+00	3.0E-04	1.0E-03	2.8E-01	6.6E-01	--	3.3E-03	1.0E-03	1.2E+03	7.7E+01	7.7E+01
7440-39-3	Barium	NA	1.4E-02	1.0E-03	6.2E-01	1.5E+00	--	4.5E-03	1.0E-03	5.8E+04	NA	5.8E+04
7440-43-9	Cadmium (food)	NA	2.5E-05	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	--	--	--	--
7440-43-9	Cadmium (water)	NA	2.5E-05	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	1.0E-03	1.0E+02	NA	1.0E+02
7440-47-3	Chromium	NA	NA	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	1.0E-03	NA	NA	NA
16065-83-1	Chromium (III)	NA	2.0E-02	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	1.0E-03	8.1E+04	NA	8.1E+04
18540-29-9	Chromium (VI)	2.0E+01	7.5E-05	2.0E-03	2.1E-01	4.9E-01	--	5.5E-03	2.0E-03	1.6E+02	2.9E+00	2.9E+00
7440-50-8	Copper	NA	4.0E-02	1.0E-03	2.4E-01	5.7E-01	--	3.1E-03	1.0E-03	1.7E+05	NA	1.7E+05
7439-92-1	Lead	NA	NA	1.0E-04	1.5E+00	3.7E+00	--	5.5E-04	1.0E-04	NA	NA	NA
7439-96-5	Manganese	--	--	1.0E-03	2.1E-01	5.1E-01	--	2.9E-03	--	--	--	--
7487-94-7	Mercury (inorganic salts) [h]	NA	2.1E-05	1.0E-03	3.5E+00	8.4E+00	--	6.3E-03	1.0E-03	8.7E+01	NA	8.7E+01
7439-97-6	Mercury (elemental) [h]	NA	NA	1.0E-03	1.4E+00	3.4E+00	--	5.4E-03	1.0E-03	NA	NA	NA
7440-02-0	Nickel	NA	8.0E-04	2.0E-04	2.2E-01	5.4E-01	--	5.9E-04	2.0E-04	1.7E+04	NA	1.7E+04
7782-49-2	Selenium	NA	5.0E-03	1.0E-03	2.9E-01	7.0E-01	--	3.4E-03	1.0E-03	2.1E+04	NA	2.1E+04
7440-22-4	Silver	NA	2.0E-04	6.0E-04	4.2E-01	1.0E+00	--	2.4E-03	6.0E-04	1.4E+03	NA	1.4E+03
7440-62-2	Vanadium	NA	1.3E-04	1.0E-03	2.0E-01	4.9E-01	--	2.7E-03	1.0E-03	5.4E+02	NA	5.4E+02
7440-66-6	Zinc	NA	3.0E-01	6.0E-04	2.4E-01	5.9E-01	--	1.9E-03	6.0E-04	2.1E+06	NA	2.1E+06
Inorganics												
57-12-5	Cyanide	NA	6.0E-04	1.0E-03	1.5E-01	3.5E-01	NA	2.0E-03	1.0E-03	2.5E+03	NA	2.5E+03

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFd: dermal slope factor
RfDd: dermal reference dose
Kp: dermal permeability coefficient of compound in water
τ: lag time per event
t*: time to reach steady state
FA: fraction absorbed water
B: ratio of the permeability coefficient of a compound through the

stratum corneum relative to its permeability coefficient across the viable epidermis
DA_{event}: dermally absorbed dose per exposure event
SL: screening level
NC: noncarcinogen
C: carcinogen
mg/kg-d: milligrams per kilogram body weight per day
cm/hr: centimeters per hour
hr/event: hours per event
cm/event: centimeters per event
µg/L: micrograms per liter
NA: not available
--: not applicable

Footnotes:

[a] Toxicity values and dermal factors (Kp, τ, FA, and B) from Table 4. t* = 2.4*τ (EPA 2004).

[b] For organics, where $t_{event} \leq t^*$, $DA_{event} = 2*FA*Kp*(6*\tau*t_{event}/\pi)^{0.5}$
For organics, where $t_{event} > t^*$, $DA_{event} = FA*Kp*((t_{event}/1+B) + (2*\tau*(1+3*B+3*B^2/(1+B)^2)$
For inorganics, $DA_{event} = Kp*t_{event}$
DA_{event} equations are from EPA (2004).

[c] Exposure factors are provided in Table 5. Equations provided below modified from EPA (2004).

[d] IW Dermal (NC) SL = $(THQ*BW*ATnc*365\ d/yr*CF_3) / (EF*ED*EV*(1/RfDd)*SAw*DA_{event}*CF_2)$

[e] IW Dermal (C) SL = $(TR*BW*ATc*365\ d/yr*CF_3) / (EF*ED*EV*SFd*SAw*DA_{event}*CF_2)$

[f] Value is the lower of noncarcinogen and carcinogen values.

[g] Screening levels for the more toxic of the coeluting compounds used to represent this mixture.

[h] Values for elemental mercury were used, where available, to calculate water SLs for mercury; otherwise, values for inorganic salts were used.

References:

U.S. Environmental Protection Agency (EPA). 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005. July.

Table B-3
Tier I Soil Screening Levels
Future Resident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]				Subsistence User SLs												
			Oral		Dermal		Inhalation						Noncarcinogen [b]					Carcinogen [b]							
CAS #	Chemical Name	Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	VF / PEF (m^3/kg)	ABSd (Unitless)	BV (Unitless)	BTF (d/kg)	SU - Soil Ingestion (NC) [c] (mg/kg)	SU - Dermal (NC) [d] (mg/kg)	SU - Inhalation (NC) [e] (mg/kg)	SU - Diet (NC) [f] (mg/kg)	SU - Total (NC) [g] (mg/kg)	SU - Soil Ingestion (C) [h] (mg/kg)	SU - Dermal (C) [i] (mg/kg)	SU - Inhalation (C) [j] (mg/kg)	SU - Diet (C) [k] (mg/kg)	SU - Total (C) [g] (mg/kg)	Csat [l] (mg/kg)	Lowest Total SL [m] (mg/kg)	
Volatiles																									
67-64-1	Acetone	No	NA	9.0E-01	NA	9.0E-01	3.1E+01	NA	2.0E+04	0.0E+00	1.1E+01	1.4E-08	1.2E+04	NA	1.2E+05	3.9E+06	1.1E+04	NA	NA	NA	NA	NA	1.1E+05	1.1E+04	
107-02-8	Acrolein	No	NA	5.0E-04	NA	5.0E-04	2.0E-05	NA	1.1E+04	0.0E+00	7.8E+00	2.4E-08	6.8E+00	NA	3.9E-02	1.8E+03	3.9E-02	NA	NA	NA	NA	NA	2.3E+04	3.9E-02	
71-43-2	Benzene	No	5.5E-02	4.0E-03	5.5E-02	4.0E-03	3.0E-02	7.8E-03	3.0E+03	0.0E+00	4.5E-01	3.4E-06	5.5E+01	NA	1.6E+01	1.8E+03	1.2E+01	2.2E+01	NA	1.9E+00	3.9E+02	1.7E+00	1.8E+03	1.7E+00	
78-93-3	2-Butanone	No	NA	6.0E-01	NA	6.0E-01	5.0E+00	NA	1.7E+04	0.0E+00	5.2E+00	4.9E-08	8.2E+03	NA	1.6E+04	1.6E+06	5.4E+03	NA	NA	NA	NA	NA	2.8E+04	5.4E+03	
56-23-5	Carbon tetrachloride	No	7.0E-02	4.0E-03	7.0E-02	4.0E-03	1.0E-01	6.0E-03	1.9E+03	0.0E+00	1.8E-01	1.7E-05	5.5E+01	NA	3.4E+01	9.0E+02	2.0E+01	1.7E+01	NA	1.5E+00	1.6E+02	1.4E+00	4.6E+02	1.4E+00	
108-90-7	Chlorobenzene	No	NA	2.0E-02	NA	2.0E-02	5.0E-02	NA	4.9E+03	0.0E+00	1.7E-01	1.7E-05	2.7E+02	NA	4.5E+01	4.5E+03	3.8E+01	NA	NA	NA	NA	NA	7.6E+02	3.8E+01	
75-00-3	Chloroethane	No	NA	NA	NA	NA	1.0E+01	NA	1.7E+03	0.0E+00	1.1E+00	6.7E-07	NA	NA	3.0E+03	NA	3.0E+03	NA	NA	NA	NA	NA	2.1E+03	3.0E+03	s
67-66-3	Chloroform	No	3.1E-02	1.0E-02	3.1E-02	1.0E-02	9.8E-02	2.3E-02	2.9E+03	0.0E+00	5.5E-01	2.3E-06	1.4E+02	NA	5.3E+01	5.2E+03	3.8E+01	3.9E+01	NA	6.3E-01	8.1E+02	6.2E-01	2.5E+03	6.2E-01	
106-93-4	1,2-Dibromoethane	No	2.0E+00	9.0E-03	2.0E+00	9.0E-03	9.0E-03	6.0E-01	8.9E+03	0.0E+00	5.6E-01	2.3E-06	1.2E+02	NA	1.5E+01	4.7E+03	1.3E+01	6.1E-01	NA	7.3E-02	1.3E+01	6.5E-02	1.3E+03	6.5E-02	
95-50-1	1,2-Dichlorobenzene	No	NA	9.0E-02	NA	9.0E-02	2.0E-01	NA	8.4E+03	0.0E+00	7.9E-02	6.7E-05	1.2E+03	NA	3.1E+02	1.1E+04	2.4E+02	NA	NA	NA	NA	NA	3.8E+02	2.4E+02	
75-34-3	1,1-Dichloroethane	No	5.7E-03	2.0E-01	5.7E-03	2.0E-01	NA	1.6E-03	2.4E+03	0.0E+00	7.1E-01	1.5E-06	2.7E+03	NA	NA	1.2E+05	2.7E+03	2.1E+02	NA	7.3E+00	5.3E+03	7.1E+00	1.7E+03	7.1E+00	
107-06-2	1,2-Dichloroethane	No	9.1E-02	6.0E-03	9.1E-02	6.0E-03	7.0E-03	2.6E-02	4.7E+03	0.0E+00	1.1E+00	7.6E-07	8.2E+01	NA	6.0E+00	5.0E+03	5.6E+00	1.3E+01	NA	8.9E-01	4.4E+02	8.4E-01	3.0E+03	8.4E-01	
75-35-4	1,1-Dichloroethene	No	NA	5.0E-02	NA	5.0E-02	2.0E-01	NA	1.5E+03	0.0E+00	4.5E-01	3.4E-06	6.8E+02	NA	5.5E+01	2.2E+04	5.1E+01	NA	NA	NA	NA	NA	1.2E+03	5.1E+01	
156-59-2	cis-1,2-Dichloroethene	No	NA	2.0E-03	NA	2.0E-03	NA	NA	2.7E+03	0.0E+00	6.4E-01	1.8E-06	2.7E+01	NA	NA	1.1E+03	2.7E+01	NA	NA	NA	NA	NA	2.4E+03	2.7E+01	
156-60-5	trans-1,2-Dichloroethene	No	NA	2.0E-02	NA	2.0E-02	NA	NA	2.0E+03	0.0E+00	4.7E-01	3.1E-06	2.7E+02	NA	NA	9.2E+03	2.7E+02	NA	NA	NA	NA	NA	1.9E+03	2.7E+02	
60-29-7	Diethyl ether	No	NA	2.0E-01	NA	2.0E-01	NA	NA	4.2E+03	0.0E+00	2.4E+00	1.9E-07	2.7E+03	NA	NA	2.9E+05	2.7E+03	NA	NA	NA	NA	NA	1.0E+04	2.7E+03	
123-91-1	1,4-Dioxane	No	1.0E-01	3.0E-02	1.0E-01	3.0E-02	3.0E-02	5.0E-03	5.9E+04	1.0E-01	1.1E+01	1.3E-08	4.1E+02	1.7E+03	3.2E+02	1.4E+05	1.6E+02	1.2E+01	4.3E+01	5.8E+01	2.2E+03	8.1E+00	1.2E+05	8.1E+00	
100-41-4	Ethylbenzene	No	1.1E-02	1.0E-01	1.1E-02	1.0E-01	1.0E+00	2.5E-03	4.1E+03	0.0E+00	1.2E-01	3.5E-05	1.4E+03	NA	7.6E+02	1.6E+04	4.7E+02	1.1E+02	NA	8.1E+00	7.3E+02	7.5E+00	4.8E+02	7.5E+00	
50-00-0	Formaldehyde	No	NA	2.0E-01	NA	2.0E-01	9.8E-03	1.3E-02	1.2E+05	1.0E-01	4.8E+00	5.6E-08	2.7E+03	1.2E+04	2.1E+02	4.9E+05	2.0E+02	NA	NA	4.5E+01	NA	4.5E+01	4.2E+04	4.5E+01	
67-56-1	Methanol	No	NA	2.0E+00	NA	2.0E+00	2.0E+01	NA	4.5E+04	1.0E-01	2.2E+01	4.3E-09	2.7E+04	1.2E+05	1.6E+05	1.5E+07	1.9E+04	NA	NA	NA	NA	NA	1.1E+05	1.9E+04	
75-09-2	Methylene chloride	Yes	2.0E-03	6.0E-03	2.0E-03	6.0E-03	6.0E-01	1.0E-05	2.6E+03	0.0E+00	1.5E+00	4.5E-07	8.2E+01	NA	2.9E+02	6.2E+03	6.3E+01	1.3E+02	NA	4.7E+02	7.4E+03	1.0E+02	3.3E+03	6.3E+01	
108-10-1	4-Methyl-2-pentanone	No	NA	8.0E-02	NA	8.0E-02	3.0E+00	NA	1.3E+04	0.0E+00	1.3E+00	5.1E-07	1.1E+03	NA	7.3E+03	7.8E+04	9.4E+02	NA	NA	NA	NA	NA	3.4E+03	9.4E+02	
103-65-1	n-Propylbenzene	No	NA	1.0E-01	NA	1.0E-01	1.0E+00	NA	4.9E+03	0.0E+00	5.6E-02	1.2E-04	1.4E+03	NA	8.9E+02	9.8E+03	5.1E+02	NA	NA	NA	NA	NA	2.6E+02	5.1E+02	s
127-18-4	Tetrachloroethene	No	2.1E-03	6.0E-03	2.1E-03	6.0E-03	4.0E-02	2.6E-04	2.4E+03	0.0E+00	8.2E-02	6.3E-05	8.2E+01	NA	1.7E+01	7.8E+02	1.4E+01	5.8E+02	NA	4.5E+01	3.0E+03	4.1E+01	1.7E+02	1.4E+01	
108-88-3	Toluene	No	NA	8.0E-02	NA	8.0E-02	5.0E+00	NA	3.4E+03	0.0E+00	2.0E-01	1.3E-05	1.1E+03	NA	3.1E+03	2.0E+04	7.8E+02	NA	NA	NA	NA	NA	8.2E+02	7.8E+02	
71-55-6	1,1,1-Trichloroethane	No	NA	2.0E+00	NA	2.0E+00	5.0E+00	NA	1.9E+03	0.0E+00	2.8E-01	7.7E-06	2.7E+04	NA	1.8E+03	6.2E+05	1.7E+03	NA	NA	NA	NA	NA	6.4E+02	1.7E+03	s
79-01-6	Trichloroethene	Yes	4.6E-02	5.0E-04	4.6E-02	5.0E-04	2.0E-03	4.1E-03	2.3E+03	0.0E+00	3.0E-01	6.6E-06	6.8E+00	NA	8.4E-01	1.7E+02	7.5E-01	1.5E+01	NA	1.9E+00	2.4E+02	1.7E+00	6.9E+02	7.5E-01	
95-63-6	1,2,4-Trimethylbenzene	No	NA	5.0E-02	NA	5.0E-02	7.0E-03	NA	5.6E+03	0.0E+00	6.0E-02	1.1E-04	6.8E+02	NA	7.1E+00	5.2E+03	7.0E+00	NA	NA	NA	NA	NA	2.2E+02	7.0E+00	
108-67-8	1,3,5-Trimethylbenzene	No	NA	1.0E-02	NA	1.0E-02	6.0E-03	NA	4.7E+03	0.0E+00	8.0E-02	6.6E-05	1.4E+02	NA	5.2E+00	1.3E+03	5.0E+00	NA	NA	NA	NA	NA	1.8E+02	5.0E+00	
75-01-4	Vinyl chloride	Yes	7.2E-01	3.0E-03	7.2E-01	3.0E-03	1.0E-01	4.4E-03	1.3E+03	0.0E+00	8.9E-01	1.0E-06	4.1E+01	NA	2.4E+01	2.2E+03	1.5E+01	9.8E-02	NA	2.5E-01	8.4E+00	7.0E-02	3.9E+03	7.0E-02	
1330-20-7	Xylenes	No	NA	2.0E-01	NA	2.0E-01	1.0E-01	NA	4.7E+03	0.0E+00	1.1E-01	3.6E-05	2.7E+03	NA	8.7E+01	3.3E+04	8.4E+01	NA	NA	NA	NA	NA	2.6E+02	8.4E+01	
Semi-Volatiles																									
83-32-9	Acenaphthene	No	NA	6.0E-02	NA	6.0E-02	NA	NA	9.2E+04	1.3E-01	4.1E-02	2.1E-04	8.2E+02	2.7E+03	NA	4.7E+03	5.5E+02	NA	NA	NA	NA	NA	NA	5.5E+02	
208-96-8	Acenaphthylene	No	NA	NA	NA	NA	NA	NA	1.2E+05	1.3E-01	4.0E-02	2.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
120-12-7	Anthracene	No	NA	3.0E-01	NA	3.0E-01	NA	NA	3.4E+05	1.3E-01	2.0E-02	7.1E-04	4.1E+03	1.3E+04	NA	1.4E+04	2.6E+03	NA	NA	NA	NA	NA	NA	2.6E+03	
56-55-3	Benzo(a)anthracene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	2.8E+06	1.3E-01	3.5E-03	1.4E-02	NA	NA	NA	NA	NA	3.7E-01	1.1E+00	4.6E+01	2.6E-01	1.3E-01	NA	1.3E-01	
50-32-8	Benzo(a)pyrene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.1E+00	4.6E+09	1.3E-01	2.1E-03	3.4E-02	NA	NA	NA	NA	NA	3.7E-02	1.1E-01	7.5E+03	1.8E-02	1.1E-02	NA	1.1E-02	
205-99-2	Benzo(b)fluoranthene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	4.6E+09	1.3E-01	3.4E-03	1.5E-02	NA	NA	NA	NA	NA	3.7E-01	1.1E+00	7.5E+04	2.5E-01	1.3E-01	NA	1.3E-01	
191-24-2	Benzo(g,h,i)perylene	No	NA	NA	NA	NA	NA	NA	4.6E+09	1.3E-01	1.1E-03	1.1E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
207-08-9	Benzo(k)fluoranthene	Yes	7.3E-02	NA	7.3E-02	NA	NA	1.1E-01	4.6E+09	1.3E-01	2.2E-03	3.2E-02	NA	NA	NA	NA	NA	3.7E+00	1.1E+01	7.5E+04	1.9E+00	1.1E+00	NA	1.1E+00	
218-01-9	Chrysene	Yes	7.3E-03	NA	7.3E-03	NA	NA	1.1E-02	4.6E+09	1.3E-01	3.3E-03	1.6E-02	NA	NA	NA	NA	NA	3.7E+01	1.1E+02	7.5E+05	2.5E+01	1.3E+01	NA	1.3E+01	
53-70-3	Dibenz(a,h)anthracene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.2E+00	4.6E+09	1.3E-01	9.4E-04	1.4E-01	NA	NA	NA	NA	NA	3.7E-02	1.1E-01	6.8E+03	1.0E-02	7.3E-03	NA	7.3E-03	
105-67-9	2,4-Dimethylphenol	No	NA	2.0E-02	NA	2.0E-02	NA	NA	4.6E+09	1.0E-01	3.6E-01	5.0E-06	2.7E+02	1.2E+03	NA	7.5E+03	2.1E+02	NA	NA	NA	NA	NA	NA	2.1E+02	
84-74-2	Di-n-butylphthalate	No	NA	1.0E-01	NA	1.0E-01	NA	NA	4.6E+09	1.0E-01	1.9E-02	7.9E-04	1.4E+03	5.8E+03	NA	4.5E+03	8.9E+02	NA	NA	NA	NA	NA	NA	8.9E+02	
206-44-0	Fluoranthene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	4.6E+09	1.3E-01	7.8E-03	3.6E-03	5.5E+02	1.8E+03	NA	9.4E+02	2.9E+02	NA	NA	NA	NA	NA	NA	2.9E+02	
86-73-7	Fluorene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.8E+05	1.3E-01	2.9E-02	3.8E-04	5.5E+02	1.8E+03	NA	2.4E+03	3.6E+02	NA	NA	NA	NA	NA	NA	3.6E+02	
193-39-5	Indeno(1,2,3-cd)pyrene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	4.6E+09	1.3E-01	1.0E-03	1.3E-01	NA	NA	NA	NA	NA	3.7E-01	1.1E+00	7.5E+04	1.1E-01	7.6E-02	NA	7.6E-02	
90-12-0	1-Methylnaphthalene	No	2.9E-02	7.0E-02	2.9E-02	7.0E-02	NA	NA	3.8E+04	1.3E-01	4.4E-02	1.9E-04	9.6E+02	3.1E+03	NA	5.8E+03	6.5E+02	4.2E+01	1.1E+02	NA	1.4E+02	2.5E+01	NA	2.5E+01	
91-57-6	2-Methylnaphthalene	No	NA	4.0E-03	NA	4.0E-03	NA	NA	3.8E+04	1.3E-01	4.4E-02	1.8E-04	5.5E+01	1.8E+02	NA	3.3E+02	3.7E+01	NA	NA	NA	NA	NA	NA	3.7E+01	
95-48-7	2-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	4.6E+09	1.0E-01	5.7E-01	2.2E-06	6.8E+02	2.9E+03	5.1E+08	2.6E+04	5.4E+02	NA	NA	NA	NA	NA	NA	5.4E+02	
108-39-4	3-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	4.6E+09	1.0E-01	5.6E-01	2.3E-06	6.8E+02	2.9E+03	5.1E+08	2.6E+04	5.4E+02	NA	NA	NA	NA	NA	NA	5.4E+02	
106-44-5	4-Methylphenol	No	NA	1.0E-01	NA	1.0E-01	6.0E-01	NA	4.6E+09	1.0E-01	5.8E-01	2.2E-06	1.4E+03	5.8E+03	5.1E+08	5.3E+04	1.1E+03	NA	NA	NA	NA	NA	NA	1.1E+03	
34mp	3&4-Methylphenol [n]	--	--	--	--	--	--	--	--	--	--	--	6.8E+02	2.9E+03	5.1E+08	2.6E+04	5.4E+02	NA	NA	NA	NA	NA	--	5.4E+02	
91-20-3	Naphthalene	No	NA	2.0E-02	NA	2.0E-02	3.0E-03	3.4E-02	3.1E+04	1.3E-01	9.4E-02	5.0E-05	2.7E+02	8.9E+02	1.7E+01	2.8E+03	1.5E+01	NA	NA	4.4E+00	NA	4.4E+00	NA	4.4E+00	
85-01-8	Phenanthrene	No	NA	NA	NA	NA	NA	NA	4.2E+05	1.3E-01	2.0E-02	7.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
108-95-2	Phenol	No	NA	3.0E-01	NA	3.0E-01	2.0E-01	NA	4.6E+09	1.0E-01	1.1E+00	7.2E-07	4.1E+03	1.7E+04	1.7E+08	2.5E+05	3.3E+03	NA	NA	NA	NA	NA	NA	3.3E+03	
129-00-0	Pyrene	No	NA	3.0E-02	NA	3.0E-02	NA	NA	1.5E+06	1.3E-01	1.1E-02	1.9E-03	4.1E+02	1.3E+03	NA	9.2E+02	2.3E+02	NA	NA	NA	NA	NA	NA	2.3E+02	

Table B-3
Tier I Soil Screening Levels
Future Resident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]				Subsistence User SLs											
			Oral		Dermal		Inhalation						Noncarcinogen [b]					Carcinogen [b]						
CAS #	Chemical Name	Mutagen? [a]	SFo $(mg/kg\text{-}d)^{-1}$	RfDo (mg/kg-d)	SFd $(mg/kg\text{-}d)^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi $(mg/m^3)^{-1}$	VF / PEF (m^3/kg)	ABSd (Unitless)	BV (Unitless)	BTF (d/kg)	SU - Soil Ingestion (NC) [c] (mg/kg)	SU - Dermal (NC) [d] (mg/kg)	SU - Inhalation (NC) [e] (mg/kg)	SU - Diet (NC) [f] (mg/kg)	SU - Total (NC) [g] (mg/kg)	SU - Soil Ingestion (C) [h] (mg/kg)	SU - Dermal (C) [i] (mg/kg)	SU - Inhalation (C) [j] (mg/kg)	SU - Diet (C) [k] (mg/kg)	SU - Total (C) [g] (mg/kg)	Csat [l] (mg/kg)	Lowest Total SL [m] (mg/kg)
Metals																								
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	No	NA	4.0E-04	NA	6.0E-05	NA	NA	4.6E+09	0.0E+00	5.0E-02	1.0E-03	5.5E+00	NA	NA	5.3E+00	2.7E+00	NA	NA	NA	NA	NA	NA	2.7E+00
7440-38-2	Arsenic	No	1.5E+00	3.0E-04	1.5E+00	3.0E-04	1.5E-05	4.3E+00	4.6E+09	3.0E-02	1.0E-02	2.0E-03	4.1E+00	5.8E+01	1.3E+04	1.0E+01	2.8E+00	8.1E-01	9.6E+00	5.3E+03	1.1E+00	4.4E-01	NA	4.4E-01
7440-39-3	Barium	No	NA	2.0E-01	NA	1.4E-02	5.0E-04	NA	4.6E+09	0.0E+00	3.8E-02	1.5E-04	2.7E+03	NA	4.2E+05	2.4E+04	2.4E+03	NA	NA	NA	NA	NA	NA	2.4E+03
7440-43-9	Cadmium (food)	No	NA	1.0E-03	NA	2.5E-05	1.0E-05	1.8E+00	4.6E+09	1.0E-03	1.3E-01	5.5E-04	1.4E+01	1.4E+02	8.4E+03	9.7E+00	5.5E+00	NA	NA	1.3E+04	NA	1.3E+04	NA	5.5E+00
7440-43-9	Cadmium (water)	No	NA	5.0E-04	NA	2.5E-05	1.0E-05	1.8E+00	--	1.0E-03	1.4E-01	5.5E-04	--	--	--	--	--	--	--	--	--	--	--	--
7440-47-3	Chromium	No	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.9E-03	5.5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
16065-83-1	Chromium (III)	No	NA	1.5E+00	NA	2.0E-02	NA	NA	4.6E+09	0.0E+00	1.9E-03	5.5E-03	2.1E+04	NA	NA	9.7E+04	1.7E+04	NA	NA	NA	NA	NA	NA	1.7E+04
18540-29-9	Chromium (VI)	Yes	5.0E-01	3.0E-03	2.0E+01	7.5E-05	1.0E-04	8.4E+01	4.6E+09	0.0E+00	1.9E-03	5.5E-03	4.1E+01	NA	8.4E+04	1.9E+02	3.4E+01	5.4E-01	NA	9.8E+01	1.9E+00	4.1E-01	NA	4.1E-01
7440-50-8	Copper	No	NA	4.0E-02	NA	4.0E-02	NA	NA	4.6E+09	0.0E+00	1.0E-01	1.0E-02	5.5E+02	NA	NA	2.7E+01	2.5E+01	NA	NA	NA	NA	NA	NA	2.5E+01
7439-92-1	Lead	No	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.1E-02	4.0E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7439-96-5	Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7487-94-7	Mercury (inorganic salts) [o]	No	NA	3.0E-04	NA	2.1E-05	3.0E-04	NA	4.6E+09	0.0E+00	2.3E-01	2.5E-01	4.1E+00	NA	2.5E+05	3.6E-03	3.6E-03	NA	NA	NA	NA	NA	NA	3.6E-03
7439-97-6	Mercury (elemental) [o]	No	NA	NA	NA	NA	3.0E-04	NA	--	0.0E+00	2.3E-01	2.5E-01	--	--	--	--	--	--	--	--	--	--	--	--
7440-02-0	Nickel	No	NA	2.0E-02	NA	8.0E-04	9.0E-05	2.6E-01	4.6E+09	0.0E+00	1.5E-02	6.0E-03	2.7E+02	NA	7.6E+04	1.5E+02	9.6E+01	NA	NA	8.7E+04	NA	8.7E+04	NA	9.6E+01
7782-49-2	Selenium	No	NA	5.0E-03	NA	5.0E-03	2.0E-02	NA	4.6E+09	0.0E+00	6.3E-03	1.5E-02	6.8E+01	NA	1.7E+07	3.6E+01	2.3E+01	NA	NA	NA	NA	NA	NA	2.3E+01
7440-22-4	Silver	No	NA	5.0E-03	NA	2.0E-04	NA	NA	4.6E+09	0.0E+00	1.0E-01	3.0E-03	6.8E+01	NA	NA	1.1E+01	9.6E+00	NA	NA	NA	NA	NA	NA	9.6E+00
7440-62-2	Vanadium	No	NA	5.0E-03	NA	1.3E-04	1.0E-04	NA	4.6E+09	0.0E+00	1.4E-03	2.5E-03	6.8E+01	NA	8.4E+04	9.7E+02	6.4E+01	NA	NA	NA	NA	NA	NA	6.4E+01
7440-66-6	Zinc	No	NA	3.0E-01	NA	3.0E-01	NA	NA	4.6E+09	0.0E+00	2.6E-01	1.0E-01	4.1E+03	NA	NA	7.6E+00	7.6E+00	NA	NA	NA	NA	NA	NA	7.6E+00
Inorganics																								
57-12-5	Cyanide	No	NA	6.0E-04	NA	6.0E-04	8.0E-04	NA	--	0.0E+00	1.1E+01	1.4E-08	8.2E+00	NA	NA	2.6E+03	8.2E+00	NA	NA	NA	NA	NA	9.7E+05	8.2E+00

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFo: oral slope factor
RfDo: oral reference dose
SFd: dermal slope factor
RfDd: dermal reference dose
RfCi: inhalation reference concentration
URFi: inhalation unit risk factor
VF: volatilization factor
PEF: particulate emission factor
ABSd: dermal absorption factor
BV: soil-to-wet-plant uptake factor
BTF: beef transfer coefficient
SL: screening level
SU: subsistence user
NC: noncarcinogen
C: carcinogen
Csat: soil saturation concentration
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
m^3/kg: cubic meters per kilogram
NA: not available
--: not applicable
TCE: trichloroethene
s: concentration exceeds Csat

Footnotes:

[a] Values and mutagen identification from Table 4.

[b] Exposure factors are provided in Table 6. Equations provided below modified from ADEC (2008b) and EPA (2015c).

[c] SU Soil Ingestion (NC) SL = (THQ*ATnc,c*BWc*365 d/yr) / (EFs*EDc*(1/RfDo)*CF*IRs,c)

[d] SU Dermal (NC) SL = (THQ*ATnc,c*BWc*365 d/yr) / (EFs*EDc*(1/RfDd)*SAc*AFc*ABSd*CF)

[e] SU Inhalation (NC) SL = (THQ*ATnc,c*365 d/yr) / (EFs*EDc*(1/RfCi)*[1/VF or 1/PEF])

[f] SU Diet (NC) SL = (THQ*ATnc,c*BWc*365 d/yr) / (EFd*EDc*(1/RfDo)*CF*IRd,c*CRp*BV*BTF)

[g] SU Total SL = 1/((1/soil ingestion SL)+(1/dermal SL)+(1/inhalation SL)+(1/diet SL))

[h] SU Soil Ingestion (C) SL = (TR*ATc*365 d/yr) / (EFs*SFo*IFSadj*CF)
SU Soil Ingestion (Mutagen) SL =(TR*ATc*365 d/yr) / (EFs*SFo*IFSMadj*CF)
SU Soil Ingestion (Vinyl Chloride) SL = TR / (((EFs*SFo*CF*IFSadj)/(ATc*365 d/yr)) + ((SFo*IRs,c*CF)/BWc))
SU Soil Ingestion (TCE) SL =(TR*ATc*365 d/yr) / (EFs*SFo*((CAFo*IFSadj)+(MAFo*IFSMadj))*CF)

[i] SU Dermal (C) SL = (TR*ATc*365 d/yr) / (EFs*SFd*ABSd*DFSadj*CF)
SU Dermal (Mutagen) SL = (TR*ATc*365 d/yr) / (EFs*SFd*ABSd*DFSMadj*CF)
SU Dermal (Vinyl Chloride) SL = TR / (((EFs*DFSadj*SFd*ABSd*CF)/(ATc*365 d/yr)) + ((SFd*SAs,c*AFc*ABSd*CF)/BWc))
SU Dermal (TCE) SL = (TR*ATc*365 d/yr) / (EFs*SFd*ABSd*((CAFo*DFSadj)+(MAFo*DFSMadj))*CF)

[j] SU Inhalation (C) SL = (TR*ATc*365 d/yr) / (EFs*ED*URFi*[1/VF or 1/PEF])
SU Inhalation (Mutagen) SL = (TR*ATc*365 d/yr) / (EFs*((ED_{0-2}*URFi*10)+(ED_{2-6}*URFi*3)+ (ED_{6-16}*URFi*3)+(ED_{16-26}*URFi*1))*[1/VF or 1/PEF])
SU Inhalation (Vinyl Chloride) SL = TR / (((EFs*ED*URFi)/(ATc*365 d/yr*VF)) + (URFi/VF))
SU Inhalation (TCE) SL = (TR*ATc*365 d/yr) / (URFi*EFs*[(CAFi*ED)+((ED_{0-2}*MAFi*10)+(ED_{2-6}*MAFi*3)+ (ED_{6-16}*MAFi*3)+(ED_{16-26}*MAFi*1))]*[1/VF or 1/PEF])

[k] SU Diet (C) SL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*IFDadj*CRp*BV*BTF)
SU Diet (Mutagen) SL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*IFDMadj*CRp*BV*BTF)
SU Diet (Vinyl Chloride) SL = TR / (((EFd*SFo*CF*IFDadj*CRp*BV*BTF)/(ATc*365 d/yr)) + ((SFo*CF*IRd,c*CRp*BTF*BV)/BWc))
SU Diet (TCE) SL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*((CAFo*IFDadj)+(MAFo*IFDMadj))*CRp*BV*BTF)

[l] Values from Table 2.

[m] Lowest of SU - Total (NC) and SU - Total (C). For target analytes that include the inhalation exposure route and have overall SLs that exceed the saturation limit (Csat), the SLs may be overly protective (see EPA, 2015c).
If detected chemical concentrations exceed the Csat concentration, more sophisticated modeling may be necessary on a SWMU/AOC-specific basis.

[n] Screening levels for the more toxic of the coeluting compounds used to represent this mixture.

[o] Values for inorganic mercury salts were used to calculate soil SLs for mercury.

References:

Alaska Department of Environmental Conservation (ADEC). 2008b. Cleanup Levels Guidance.
Division of Spill Prevention and Response, Contaminated Sites Program. June 9.
U.S. Environmental Protection Agency (EPA). 2015c. Regional Screening Level User's Guide. June.
http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Table B-4
Tier I Water Screening Levels
Future Resident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]								Subsistence User SLs										
			Oral		Dermal		Inhalation		Dermal Factors								Noncarcinogen [c]					Carcinogen [c]					
CAS #	Chemical Name	Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA$_{event}$ (NC) [b] cm/event	DA$_{event}$ (C) [b] cm/event	Fish BCF (L/kg)	SU - Water Ingestion (NC) [d] (µg/L)	SU - Dermal (NC) [e] (µg/L)	SU - Inhalation (NC) [f] (µg/L)	SU - Diet (NC) [g] (µg/L)	SU - Total (NC) [h] (µg/L)	SU - Water Ingestion (C) [i] (µg/L)	SU - Dermal (C) [j] (µg/L)	SU - Inhalation (C) [k] (µg/L)	SU - Diet (C) [l] (µg/L)	SU - Total (C) [h] (µg/L)	Lowest Total SL [m] (µg/L)
Volatiles																											
67-64-1	Acetone	No	NA	9.0E-01	NA	9.0E-01	3.1E+01	NA	5.1E-04	2.2E-01	5.3E-01	NA	1.5E-03	NA	NA	3.2E+00	1.8E+03	NA	6.5E+03	3.9E+03	1.0E+03	NA	NA	NA	NA	NA	1.0E+03
107-02-8	Acrolein	No	NA	5.0E-04	NA	5.0E-04	2.0E-05	NA	7.5E-04	2.2E-01	5.2E-01	1.0E+00	2.2E-03	7.3E-04	--	3.2E+00	1.0E+00	1.7E+02	4.2E-03	2.2E+00	4.1E-03	NA	NA	NA	NA	NA	4.1E-03
71-43-2	Benzene	No	5.5E-02	4.0E-03	5.5E-02	4.0E-03	3.0E-02	7.8E-03	1.5E-02	2.9E-01	6.9E-01	1.0E+00	5.1E-02	1.6E-02	1.8E-02	4.3E+00	8.0E+00	6.0E+01	6.3E+00	1.3E+01	2.6E+00	1.4E+00	9.4E+00	7.2E-01	2.7E+00	3.9E-01	3.9E-01
78-93-3	2-Butanone	No	NA	6.0E-01	NA	6.0E-01	5.0E+00	NA	9.6E-04	2.7E-01	6.4E-01	1.0E+00	3.1E-03	1.0E-03	--	3.2E+00	1.2E+03	1.5E+05	1.0E+03	2.6E+03	4.6E+02	NA	NA	NA	NA	NA	4.6E+02
56-23-5	Carbon tetrachloride	No	7.0E-02	4.0E-03	7.0E-02	4.0E-03	1.0E-01	6.0E-03	1.6E-02	7.6E-01	1.8E+00	1.0E+00	7.8E-02	2.9E-02	3.2E-02	7.4E+00	8.0E+00	3.4E+01	2.1E+01	7.4E+00	3.0E+00	1.1E+00	4.2E+00	9.4E-01	1.2E+00	3.3E-01	3.3E-01
108-90-7	Chlorobenzene	No	NA	2.0E-02	NA	2.0E-02	5.0E-02	NA	2.8E-02	4.5E-01	1.1E+00	1.0E+00	1.2E-01	3.8E-02	--	1.8E+01	4.0E+01	1.3E+02	1.0E+01	1.5E+01	5.2E+00	NA	NA	NA	NA	NA	5.2E+00
75-00-3	Chloroethane	No	NA	NA	NA	NA	1.0E+01	NA	6.1E-03	2.4E-01	5.8E-01	1.0E+00	1.9E-02	6.1E-03	--	4.1E+00	NA	NA	2.1E+03	NA	2.1E+03	NA	NA	NA	NA	NA	2.1E+03
67-66-3	Chloroform	No	3.1E-02	1.0E-02	3.1E-02	1.0E-02	9.8E-02	2.3E-02	6.8E-03	4.9E-01	1.2E+00	1.0E+00	2.9E-02	9.7E-03	1.1E-02	1.3E+01	2.0E+01	2.5E+02	2.0E+01	1.1E+01	5.1E+00	2.5E+00	2.8E+01	2.4E-01	1.6E+00	1.9E-01	1.9E-01
106-93-4	1,2-Dibromoethane	No	2.0E+00	9.0E-03	2.0E+00	9.0E-03	9.0E-03	6.0E-01	2.8E-03	1.2E+00	2.8E+00	1.0E+00	1.5E-02	6.1E-03	6.9E-03	1.5E+01	1.8E+01	3.6E+02	1.9E+00	8.2E+00	1.4E+00	3.9E-02	6.9E-01	9.4E-03	2.1E-02	5.5E-03	5.5E-03
95-50-1	1,2-Dichlorobenzene	No	NA	9.0E-02	NA	9.0E-02	2.0E-01	NA	4.5E-02	7.0E-01	1.7E+00	1.0E+00	2.1E-01	7.6E-02	--	2.7E+02	1.8E+02	2.9E+02	4.2E+01	4.6E+00	4.0E+00	NA	NA	NA	NA	NA	4.0E+00
75-34-3	1,1-Dichloroethane	No	5.7E-03	2.0E-01	5.7E-03	2.0E-01	NA	1.6E-03	6.8E-03	3.8E-01	9.0E-01	1.0E+00	2.6E-02	8.4E-03	9.4E-03	7.1E+00	4.0E+02	5.8E+03	NA	3.9E+02	1.9E+02	1.4E+01	1.8E+02	3.5E+00	1.6E+01	2.3E+00	2.3E+00
107-06-2	1,2-Dichloroethane	No	9.1E-02	6.0E-03	9.1E-02	6.0E-03	7.0E-03	2.6E-02	4.2E-03	3.8E-01	9.0E-01	1.0E+00	1.6E-02	5.2E-03	5.8E-03	4.4E+00	1.2E+01	2.8E+02	1.5E+00	1.9E+01	1.2E+00	8.6E-01	1.8E+01	2.2E-01	1.6E+00	1.5E-01	1.5E-01
75-35-4	1,1-Dichloroethene	No	NA	5.0E-02	NA	5.0E-02	2.0E-01	NA	1.2E-02	3.7E-01	8.8E-01	1.0E+00	4.4E-02	1.4E-02	--	1.3E+01	1.0E+02	8.5E+02	4.2E+01	5.3E+01	1.9E+01	NA	NA	NA	NA	NA	1.9E+01
156-59-2	cis-1,2-Dichloroethene	No	NA	2.0E-03	NA	2.0E-03	NA	NA	1.1E-02	3.7E-01	8.8E-01	NA	4.2E-02	NA	NA	1.1E+01	4.0E+00	NA	NA	2.5E+00	1.5E+00	NA	NA	NA	NA	NA	1.5E+00
156-60-5	trans-1,2-Dichloroethene	No	NA	2.0E-02	NA	2.0E-02	NA	NA	1.1E-02	3.7E-01	8.8E-01	1.0E+00	4.2E-02	1.4E-02	--	1.1E+01	4.0E+01	3.6E+02	NA	2.5E+01	1.5E+01	NA	NA	NA	NA	NA	1.5E+01
60-29-7	Diethyl ether	No	NA	2.0E-01	NA	2.0E-01	NA	NA	2.4E-03	2.7E-01	6.6E-01	1.0E+00	7.8E-03	2.5E-03	--	5.4E+00	4.0E+02	2.0E+04	NA	5.1E+02	2.2E+02	NA	NA	NA	NA	NA	2.2E+02
123-91-1	1,4-Dioxane	No	1.0E-01	3.0E-02	1.0E-01	3.0E-02	3.0E-02	5.0E-03	3.3E-04	3.3E-01	7.9E-01	1.0E+00	1.2E-03	3.9E-04	4.3E-04	5.0E-01	6.0E+01	1.9E+04	6.3E+00	8.2E+02	5.6E+00	7.8E-01	2.2E+02	1.1E+00	1.3E+01	4.4E-01	4.4E-01
100-41-4	Ethylbenzene	No	1.1E-02	1.0E-01	1.1E-02	1.0E-01	1.0E+00	2.5E-03	4.9E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	6.4E-02	7.2E-02	5.6E+01	2.0E+02	3.8E+02	2.1E+02	2.5E+01	1.9E+01	7.1E+00	1.2E+01	2.2E+00	1.0E+00	6.1E-01	6.1E-01
50-00-0	Formaldehyde	No	NA	2.0E-01	NA	2.0E-01	9.8E-03	1.3E-02	1.8E-03	1.5E-01	3.7E-01	1.0E+00	3.8E-03	1.5E-03	--	3.2E+00	4.0E+02	3.2E+04	2.0E+00	8.7E+02	2.0E+00	NA	NA	4.3E-01	NA	4.3E-01	4.3E-01
67-56-1	Methanol	No	NA	2.0E+00	NA	2.0E+00	2.0E+01	NA	3.2E-04	1.6E-01	3.8E-01	1.0E+00	6.9E-04	2.7E-04	--	3.2E+00	4.0E+03	1.8E+06	4.2E+03	8.7E+03	1.7E+03	NA	NA	NA	NA	NA	1.7E+03
75-09-2	Methylene chloride	Yes	2.0E-03	6.0E-03	2.0E-03	6.0E-03	6.0E-01	1.0E-05	3.5E-03	3.1E-01	7.5E-01	1.0E+00	1.3E-02	4.0E-03	4.5E-03	2.3E+01	1.2E+01	3.7E+02	1.3E+02	3.6E+00	2.7E+00	1.3E+01	3.4E+02	2.0E+02	4.1E+00	3.0E+00	2.7E+00
108-10-1	4-Methyl-2-pentanone	No	NA	8.0E-02	NA	8.0E-02	3.0E+00	NA	3.2E-03	3.8E-01	9.2E-01	1.0E+00	1.2E-02	4.0E-03	--	3.4E+00	1.6E+02	4.9E+03	6.3E+02	3.2E+02	9.0E+01	NA	NA	NA	NA	NA	9.0E+01
103-65-1	n-Propylbenzene	No	NA	1.0E-01	NA	1.0E-01	1.0E+00	NA	9.4E-02	5.0E-01	1.2E+00	NA	4.0E-01	NA	NA	1.3E+02	2.0E+02	NA	2.1E+02	1.1E+01	9.9E+00	NA	NA	NA	NA	NA	9.9E+00
127-18-4	Tetrachloroethene	No	2.1E-03	6.0E-03	2.1E-03	6.0E-03	4.0E-02	2.6E-04	3.3E-02	8.9E-01	2.1E+00	1.0E+00	1.7E-01	6.4E-02	7.1E-02	5.2E+01	1.2E+01	2.3E+01	8.3E+00	1.6E+00	1.1E+00	3.7E+01	6.3E+01	2.2E+01	5.8E+00	3.8E+00	1.1E+00
108-88-3	Toluene	No	NA	8.0E-02	NA	8.0E-02	5.0E+00	NA	3.1E-02	3.5E-01	8.3E-01	1.0E+00	1.1E-01	3.7E-02	--	8.3E+00	1.6E+02	5.3E+02	1.0E+03	1.3E+02	6.0E+01	NA	NA	NA	NA	NA	6.0E+01
71-55-6	1,1,1-Trichloroethane	No	NA	2.0E+00	NA	2.0E+00	5.0E+00	NA	1.3E-02	5.9E-01	1.4E+00	1.0E+00	5.6E-02	2.0E-02	--	5.0E+00	4.0E+03	2.5E+04	1.0E+03	5.5E+03	7.0E+02	NA	NA	NA	NA	NA	7.0E+02
79-01-6	Trichloroethene	Yes	4.6E-02	5.0E-04	4.6E-02	5.0E-04	2.0E-03	4.1E-03	1.2E-02	5.7E-01	1.4E+00	1.0E+00	5.1E-02	1.8E-02	2.0E-02	1.6E+01	1.0E+00	6.9E+00	4.2E-01	4.3E-01	1.7E-01	1.2E+00	7.2E+00	9.6E-01	5.9E-01	2.7E-01	1.7E-01
95-63-6	1,2,4-Trimethylbenzene	No	NA	5.0E-02	NA	5.0E-02	7.0E-03	NA	8.6E-02	5.0E-01	1.2E+00	NA	3.6E-01	NA	NA	1.2E+02	1.0E+02	NA	1.5E+00	5.7E+00	1.1E+00	NA	NA	NA	NA	NA	1.1E+00
108-67-8	1,3,5-Trimethylbenzene	No	NA	1.0E-02	NA	1.0E-02	6.0E-03	NA	6.2E-02	5.0E-01	1.2E+00	NA	2.6E-01	NA	NA	1.9E+02	2.0E+01	NA	1.3E+00	7.4E-01	4.5E-01	NA	NA	NA	NA	NA	4.5E-01
75-01-4	Vinyl chloride	Yes	7.2E-01	3.0E-03	7.2E-01	3.0E-03	1.0E-01	4.4E-03	8.4E-03	2.4E-01	5.7E-01	1.0E+00	2.5E-02	8.3E-03	9.5E-03	5.5E+00	6.0E+00	8.9E+01	2.1E+01	7.5E+00	2.8E+00	2.1E-02	2.7E-01	3.4E-01	2.9E-02	1.1E-02	1.1E-02
1330-20-7	Xylenes	No	NA	2.0E-01	NA	2.0E-01	1.0E-01	NA	5.0E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	6.5E-02	--	1.5E+01	4.0E+02	7.5E+02	2.1E+01	1.9E+02	1.7E+01	NA	NA	NA	NA	NA	1.7E+01
Semi-Volatiles																											
83-32-9	Acenaphthene	No	NA	6.0E-02	NA	6.0E-02	NA	NA	8.6E-02	7.7E-01	1.8E+00	NA	4.1E-01	NA	NA	7.6E+02	1.2E+02	NA	NA	1.1E+00	1.1E+00	NA	NA	NA	NA	NA	1.1E+00
208-96-8	Acenaphthylene	No	NA	NA	NA	NA	NA	NA	9.1E-02	NA	NA	NA	NA	NA	NA	2.7E+02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
120-12-7	Anthracene	No	NA	3.0E-01	NA	3.0E-01	NA	NA	1.4E-01	1.0E+00	2.5E+00	NA	7.3E-01	NA	NA	1.8E+03	6.0E+02	NA	NA	2.3E+00	2.3E+00	NA	NA	NA	NA	NA	2.3E+00
56-55-3	Benzo(a)anthracene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	2.0E+00	4.8E+00	1.0E+00	3.2E+00	--	--	2.6E+02	NA	NA	NA	NA	NA	3.4E-02	NA	1.8E-02	1.0E-03	9.3E-04	9.3E-04
50-32-8	Benzo(a)pyrene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.1E+00	--	2.7E+00	6.5E+00	1.0E+00	4.4E+00	--	--	5.2E+03	NA	NA	--	NA	NA	3.4E-03	NA	--	5.1E-06	5.1E-06	5.1E-06
205-99-2	Benzo(b)fluoranthene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	2.7E+00	6.5E+00	1.0E+00	2.5E+00	--	--	3.0E+03	NA	NA	--	NA	NA	3.4E-02	NA	--	8.7E-05	8.7E-05	8.7E-05
191-24-2	Benzo(g,h,i)perylene	No	NA	NA	NA	NA	NA	NA	1.1E+00	NA	NA	NA	NA	NA	NA	1.1E+04	NA	NA	--	NA	NA	NA	NA	--	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	Yes	7.3E-02	NA	7.3E-02	NA	NA	1.1E-01	--	2.7E+00	6.5E+00	NA	4.2E+00	NA	NA	5.0E+03	NA	NA	--	NA	NA	3.4E-01	NA	--	5.3E-04	5.3E-04	5.3E-04
218-01-9	Chrysene	Yes	7.3E-03	NA	7.3E-03	NA	NA	1.1E-02	--	2.0E+00	4.8E+00	1.0E+00	3.5E+00	--	--	3.2E+03	NA	NA	--	NA	NA	3.4E+00	NA	--	8.3E-03	8.3E-03	8.3E-03
53-70-3	Dibenz(a,h)anthracene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.2E+00	--	3.8E+00	9.1E+00	6.0E-01	6.1E+00	--	--	9.6E+03	NA	NA	--	NA	NA	3.4E-03	NA	--	2.7E-06	2.7E-06	2.7E-06
105-67-9	2,4-Dimethylphenol	No	NA	2.0E-02	NA	2.0E-02	NA	NA	1.1E-02	5.1E-01	1.2E+00	1.0E+00	4.6E-02	1.6E-02	--	1.5E+01	4.0E+01	3.1E+02	--	1.8E+01	1.2E+01	NA	NA	--	NA	NA	1.2E+01
84-74-2	Di-n-butylphthalate	No	NA	1.0E-01	NA	1.0E-01	NA	NA	4.2E-02	3.8E+00	9.1E+00	9.0E-01	2.7E-01	1.5E-01	--	1.7E+02	2.0E+02	1.6E+02	--	8.2E+00	7.5E+00	NA	NA	--	NA	NA	7.5E+00
206-44-0	Fluoranthene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	--	1.4E+00	3.4E+00	1.0E+00	1.7E+00	--	--	3.6E+03	8.0E+01	NA	--	1.5E-01	1.5E-01	NA	NA	--	NA	NA	1.5E-01
86-73-7	Fluorene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.1E-01	9.0E-01	2.2E+00	NA	5.5E-01	NA	NA	5.3E+02	8.0E+01	NA	NA	1.0E+00	1.0E+00	NA	NA	NA	NA	NA	1.0E+00
193-39-5	Indeno(1,2,3-cd)pyrene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	3.7E+00	8.9E+00	6.0E-01	7.9E+00	--	--	1.2E+04	NA	NA	--	NA	NA	3.4E-02	NA	--	2.2E-05	2.1E-05	2.1E-05
90-12-0	1-Methylnaphthalene	No	2.9E-02	7.0E-02	2.9E-02	7.0E-02	NA	NA	9.3E-02	6.6E-01	1.6E+00	NA	4.3E-01	NA	NA	5.3E+01	1.4E+02	NA	NA	1.8E+01	1.6E+01	2.7E+00	NA	NA	4.1E-01	3.6E-01	3.6E-01
91-57-6	2-Methylnaphthalene	No	NA	4.0E-03	NA	4.0E-03	NA	NA	9.2E-02	6.6E-01	1.6E+00	NA	4.2E-01	NA	NA	7.5E+01	8.0E+00	NA	NA	7.4E-01	6.7E-01	NA	NA	NA	NA	NA	6.7E-01
95-48-7	2-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	7.7E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	1.0E-02	--	1.1E+01	1.0E+02	1.2E+03	--	6.4E+01	3.8E+01	NA	NA	--	NA	NA	3.8E+01
108-39-4	3-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	7.8E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	1.0E-02	--	9.1E+00	1.0E+02	1.2E+03	--	7.5E+01	4.2E+01	NA	NA	--	NA	NA	4.2E+01
106-44-5	4-Methylphenol	No	NA	1.0E-01	NA	1.0E-01	6.0E-01	NA	7.5E-03	4.2E-01	1.0E+00	1.0E+00	3.0E-02	1.0E-02	--	8.9E+00	2.0E+02	2.5E+03	--	1.6E+02	8.4E+01	NA	NA	--	NA	NA	8.4E+01
34mp	3&4-Methylphenol [n]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0E+02	1.2E+03	--	7.5E+01	4.2E+01	NA	NA	--	NA	NA	4.2E+01
91-20-3	Naphthalene	No	NA	2.0E-02	NA	2.0E-02	3.0E-03	3.4E-02	4.7E-02	5.5E-01	1.3E+00	1.0E+00	2.0E-01	7.0E-02	--	8.5E+01	4.0E+01	7.0E+01	6.3E-01	3.3E+00	5.1E-01	NA	NA	1.7E-01	NA	1.7E-01	1.7E-01
85-01-8	Phenanthrene	No	NA	NA	NA	NA	NA	NA	--	1.1E+00	2.5E+00	1.0E+00	7.0E-01	--	--	2.5E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
108-95-2	Phenol	No	NA	3.0E-01	NA	3.0E-01	2.0E-01	NA	4.3E-03	3.5E-01	8.5E-01	1.0E+00	1.6E-02	5.2E-03	--	1.7E+01	6.0E+02	1.4E+04	--	2.4E+02	1.7E+02	NA	NA	--	NA	NA	1.7E+02
129-00-0	Pyrene	No	NA	3.0E-02	NA	3.0E-02	NA	NA	2.0E-01	1.4E+00	3.4E+00	NA	1.1E+00	NA	NA	1.5E+03	6.0E+01	NA	NA	2.7E-01	2.7E-01	NA	NA	NA	NA	NA	2.7E-01

Table B-4
Tier I Water Screening Levels
Future Resident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]								Subsistence User SLs										
			Oral		Dermal		Inhalation		Dermal Factors								Noncarcinogen [c]					Carcinogen [c]					
CAS #	Chemical Name	Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA$_{event}$ (NC) [b] cm/event	DA$_{event}$ (C) [b] cm/event	Fish BCF (L/kg)	SU - Water Ingestion (NC) [d] (µg/L)	SU - Dermal (NC) [e] (µg/L)	SU - Inhalation (NC) [f] (µg/L)	SU - Diet (NC) [g] (µg/L)	SU - Total (NC) [h] (µg/L)	SU - Water Ingestion (C) [i] (µg/L)	SU - Dermal (C) [j] (µg/L)	SU - Inhalation (C) [k] (µg/L)	SU - Diet (C) [l] (µg/L)	SU - Total (C) [h] (µg/L)	Lowest Total SL [m] (µg/L)
Metals																											
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	2.0E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	No	NA	4.0E-04	NA	6.0E-05	NA	NA	1.0E-03	5.1E-01	1.2E+00	--	4.2E-03	5.4E-04	--	1.0E+02	8.0E-01	2.7E+01	--	5.5E-02	5.1E-02	NA	NA	--	NA	NA	5.1E-02
7440-38-2	Arsenic	No	1.5E+00	3.0E-04	1.5E+00	3.0E-04	1.5E-05	4.3E+00	1.0E-03	2.8E-01	6.6E-01	--	3.3E-03	5.4E-04	6.7E-04	3.0E+02	6.0E-01	1.4E+02	--	1.4E-02	1.3E-02	5.2E-02	9.3E+00	--	1.4E-03	1.4E-03	1.4E-03
7440-39-3	Barium	No	NA	2.0E-01	NA	1.4E-02	5.0E-04	NA	1.0E-03	6.2E-01	1.5E+00	--	4.5E-03	5.4E-04	--	4.0E+00	4.0E+02	6.4E+03	--	6.9E+02	2.4E+02	NA	NA	--	NA	NA	2.4E+02
7440-43-9	Cadmium (food)	No	NA	1.0E-03	NA	2.5E-05	1.0E-05	1.8E+00	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	--	--	2.0E+02	--	--	--	6.9E-02	--	--	--	--	NA	--	--
7440-43-9	Cadmium (water)	No	NA	5.0E-04	NA	2.5E-05	1.0E-05	1.8E+00	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	5.4E-04	--	2.0E+02	1.0E+00	1.1E+01	--	--	6.4E-02	NA	NA	--	--	NA	6.4E-02
7440-47-3	Chromium	No	NA	NA	NA	NA	NA	NA	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	5.4E-04	--	2.0E+02	NA	NA	--	NA	NA	NA	NA	--	NA	NA	NA
16065-83-1	Chromium (III)	No	NA	1.5E+00	NA	2.0E-02	NA	NA	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	5.4E-04	--	NA	3.0E+03	8.9E+03	--	NA	2.2E+03	NA	NA	--	NA	NA	2.2E+03
18540-29-9	Chromium (VI)	Yes	5.0E-01	3.0E-03	2.0E+01	7.5E-05	1.0E-04	8.4E+01	2.0E-03	2.1E-01	4.9E-01	--	5.5E-03	1.1E-03	1.3E-03	2.0E+02	6.0E+00	1.7E+01	--	2.1E-01	2.0E-01	5.0E-02	1.1E-01	--	1.9E-03	1.8E-03	1.8E-03
7440-50-8	Copper	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.0E-03	2.4E-01	5.7E-01	--	3.1E-03	5.4E-04	--	2.0E+02	8.0E+01	1.8E+04	--	2.7E+00	2.7E+00	NA	NA	--	NA	NA	2.7E+00
7439-92-1	Lead	No	NA	NA	NA	NA	NA	NA	1.0E-04	1.5E+00	3.7E+00	--	5.5E-04	5.4E-05	--	3.0E+02	NA	NA	--	NA	NA	NA	NA	--	NA	NA	NA
7439-96-5	Manganese	--	--	--	--	--	--	--	1.0E-03	2.1E-01	5.1E-01	--	2.9E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7487-94-7	Mercury (inorganic salts) [o]	No	NA	3.0E-04	NA	2.1E-05	3.0E-04	NA	1.0E-03	3.5E+00	8.4E+00	--	6.3E-03	5.4E-04	--	1.0E+03	6.0E-01	9.5E+00	--	4.1E-03	3.8E-03	NA	NA	--	NA	NA	3.8E-03
7439-97-6	Mercury (elemental) [o]	No	NA	NA	NA	NA	3.0E-04	NA	1.0E-03	1.4E+00	3.4E+00	--	5.4E-03	5.4E-04	--	NA	NA	NA	6.3E-02	NA	3.8E-03	NA	NA	NA	NA	NA	3.8E-03
7440-02-0	Nickel	No	NA	2.0E-02	NA	8.0E-04	9.0E-05	2.6E-01	2.0E-04	2.2E-01	5.4E-01	--	5.9E-04	1.1E-04	--	1.0E+02	4.0E+01	1.8E+03	--	2.7E+00	2.6E+00	NA	NA	--	NA	NA	2.6E+00
7782-49-2	Selenium	No	NA	5.0E-03	NA	5.0E-03	2.0E-02	NA	1.0E-03	2.9E-01	7.0E-01	--	3.4E-03	5.4E-04	--	2.0E+02	1.0E+01	2.3E+03	--	3.4E-01	3.3E-01	NA	NA	--	NA	NA	3.3E-01
7440-22-4	Silver	No	NA	5.0E-03	NA	2.0E-04	NA	NA	6.0E-04	4.2E-01	1.0E+00	--	2.4E-03	3.2E-04	--	5.0E+00	1.0E+01	1.5E+02	--	1.4E+01	5.6E+00	NA	NA	--	NA	NA	5.6E+00
7440-62-2	Vanadium	No	NA	5.0E-03	NA	1.3E-04	1.0E-04	NA	1.0E-03	2.0E-01	4.9E-01	--	2.7E-03	5.4E-04	--	NA	1.0E+01	5.9E+01	--	NA	8.6E+00	NA	NA	--	NA	NA	8.6E+00
7440-66-6	Zinc	No	NA	3.0E-01	NA	3.0E-01	NA	NA	6.0E-04	2.4E-01	5.9E-01	--	1.9E-03	3.2E-04	--	1.0E+03	6.0E+02	2.3E+05	--	4.1E+00	4.1E+00	NA	NA	--	NA	NA	4.1E+00
Inorganics																											
57-12-5	Cyanide	No	NA	6.0E-04	NA	6.0E-04	8.0E-04	NA	1.0E-03	1.5E-01	3.5E-01	NA	2.0E-03	5.4E-04	--	NA	1.2E+00	2.7E+02	1.7E-01	NA	1.5E-01	NA	NA	NA	NA	NA	1.5E-01

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFo: oral slope factor
RfDo: oral reference dose
SFd: dermal slope factor
RfDd: dermal reference dose
RfCi: inhalation reference concentration
URFi: inhalation unit risk factor
Kp: dermal permeability coefficient of compound in water
τ: lag time per event
t*: time to reach steady state
FA: fraction absorbed water
B: ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis
DA$_{event}$: dermally absorbed dose per exposure event
BCF: fish bioaccumulation factor
SL: screening level
SU: subsistence user
NC: noncarcinogen
C: carcinogen
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
cm/hr: centimeters per hour
hr/event: hours per event
cm/event: centimeters per event
L/kg: liters per kilogram
µg/L: micrograms per liter
NA: not available
--: not applicable
TCE: trichloroethene

Footnotes:

[a] Toxicity values, dermal factors (Kp, τ, FA, and B), BCFs, and mutagen identification from Table 4. t* = 2.4*τ (EPA 2004).

[b] For organics, where $t_{event} \leq t^*$, $DA_{event} = 2*FA*Kp*(6*\tau*t_{event}/\pi)^{0.5}$

For organics, where $t_{event} > t^*$, $DA_{event} = FA*Kp*((t_{event}/1+B) + (2*\tau*(1+3*B+3*B^2/(1+B)^2)$

For inorganics, $DA_{event} = Kp*t_{event}$

DA_{event} equations are from EPA (2004). t_{event} values are shown in Table 6.

$t_{event, c}$ used to calculate DA_{event} (NC); $t_{event, adj}$ and $t_{event, madj}$ used to calculate DA_{event} (C) for carcinogens and mutagens, respectively.

[c] Exposure factors are provided in Table 6. Equations provided below modified from ADEC (2008b) and EPA (2004, 2015c).

[d] SU Water Ingestion (NC) SL = (THQ*ATnc,c*BWc*365 d/yr) / (EFw*EDc*(1/RfDo)*IRw,c*CF_4)

[e] SU Dermal (NC) SL = (THQ*ATnc,c*BWc*365 d/yr) / (EFw*EDc*EV*(1/RfDd)*SAw,c*DA_{event}*CF_2*CF_4)

[f] SU Inhalation (NC) SL = (THQ*ATnc,c*365 d/yr) / (EFw*EDc*(1/RfCi)*K*CF_4)

[g] SU Diet (NC) SL = (THQ*ATnc,c*BWc*365 d/yr) / (EFf*EDc*IRf,c*(1/RfDo)*BCF*CF_4)

[h] SU Total SL = 1/((1/water ingestion SL)+(1/dermal SL)+(1/inhalation SL)+(1/diet SL))

[i] SU Water Ingestion (C) SL = (TR*ATc*365 d/yr) / (EFw*SFo*IFWadj*CF_4)

SU Water Ingestion (Mutagen) SL = (TR*ATc*365 d/yr) / (EFw*SFo*IFWMadj*CF_4)

SU Water Ingestion (Vinyl Chloride) SL = TR / (((EFw*SFo*IFWadj*CF_4)/(ATc*365 d/yr)) + ((SFo*IRw,c*CF_4)/BWc))

SU Water Ingestion (TCE) SL = (TR*ATc*365 d/yr) / (EFw*SFo*((CAFo*IFWadj)+(MAFo*IFWMadj))*CF_4)

[j] SU Dermal (C) SL = (TR*ATc*365 d/yr) / (EFw*EV*SFd*DFWadj*DA_{event}*CF_2*CF_4)

SU Dermal (Mutagen) SL = (TR*ATc*365 d/yr) / (EFw*EV*SFd*DFWMadj*DA_{event}*CF_2*CF_4)

SU Dermal (Vinyl Chloride) SL = TR / (((EFw*EV*DFWadj*SFd*DA_{event}*CF_2*CF_4)/(ATc*365 d/yr)) + ((EV*SAw,c*SFd*DA_{event}*CF_2*CF_4)/BWc))

SU Dermal (TCE) SL = (TR*ATc*365 d/yr) / (EFw*EV*SFd*((CAFo*DFWadj)+(MAFo*DFWMadj))*DA_{event}*CF_2*CF_4)

[k] SU Inhalation (C) SL = (TR*ATc*365 d/yr) / (EFw*ED*URFi*K*CF_4)

SU Inhalation (Mutagen) SL = (TR*ATc*365 d/yr) / (EFw*K*((ED_{0-2}*URFi*10)+(ED_{2-6}*URFi*3)+ (ED_{6-16}*URFi*3)+(ED_{16-26}*URFi*1))*CF_4)

SU Inhalation (Vinyl Chloride) SL = TR / (((EFw*ED*URFi*CF_4*K)/(ATc*365 d/yr)) + (URFi*CF_4*K))

SU Inhalation (TCE) SL = (TR*ATc*365 d/yr) / (EFw*K*URFi*((ED*CAFi)+((ED_{0-2}*MAFi*10)+(ED_{2-6}*MAFi*3)+ (ED_{6-16}*MAFi*3)+(ED_{16-26}*MAFi*1)))*CF_4)

[l] SU Diet (C) SL = (TR*ATc*365 d/yr) / (EFf*SFo*IFFadj*BCF*CF_4)

SU Diet (Mutagen) SL = (TR*ATc*365 d/yr) / (EFf*SFo*IFFMadj*BCF*CF_4)

SU Diet (Vinyl Chloride) SL = TR / (((EFf*SFo*BCF*IFFadj*CF_4)/(ATc*365 d/yr)) + ((SFo*BCF*IRf,c*CF_4)/BWc))

SU Diet (TCE) SL = (TR*ATc*365 d/yr) / (EFf*SFo*((CAFo*IFFadj)+(MAFo*IFFMadj))*BCF*CF_4)

[m] Value is the lower of SU - Total (NC) and SU - Total (C).

[n] Screening levels for the more toxic of the coeluting compounds used to represent this mixture.

[o] Values for elemental mercury were used, where available, to calculate water SLs for mercury; otherwise, values for inorganic salts were used.

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Table B-5
Industrial Worker Action Level Calculation Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Abbreviation	Definition	Units	Value	Source
TR	Target Lifetime Excess Cancer Risk	--	1.0E-06	EPA, 2015c
THQ	Target Hazard Quotient	--	0.1	EPA, 2015c
BW	Body Weight	kg	80	EPA, 2015c
ATc	Averaging Time, Carcinogen	years	70	EPA, 2015c
ATnc	Averaging Time, Non-carcinogen	years	25	EPA, 2015c
--	Days in One Year	days	365	--
SFo	Slope Factor, Oral	$(mg/kg\text{-}day)^{-1}$	Chemical-specific	See Table 4
SFd	Slope Factor, Dermal	$(mg/kg\text{-}day)^{-1}$	Chemical-specific	See Table 4
URFi	Inhalation Unit Risk Factor	$(mg/m^3)^{-1}$	Chemical-specific	See Table 4
RfDo	Reference Dose, Oral	mg/kg-day	Chemical-specific	See Table 4
RfDd	Reference Dose, Dermal	mg/kg-day	Chemical-specific	See Table 4
RfCi	Inhalation Reference Concentration	mg/m^3	Chemical-specific	See Table 4
ED	Exposure Duration	years	25	EPA, 2015c
EF	Exposure Frequency	days/year	100	Wendler et al., 2010
EFs,i	Exposure Frequency, Soil Inhalation	days/year	185	Workdays at Facility for BP employees
CF	Conversion Factor	kg/mg	0.000001	--
CF_2	Conversion Factor	L/cm^3	0.001	--
CF_3	Conversion Factor	µg/mg	1,000	--
CF_4	Conversion Factor	days/hour	1/24	--
IRs	Ingestion Rate, Soil	mg/day	100	EPA, 2015c
ABS	Absorption Factor	--	Chemical-specific	See Table 4
SAs	Skin Surface Area, Soil Contact	cm^2/day	3,527	EPA, 2015c
AF	Soil Adherence Factor	mg/cm^2	0.12	EPA, 2015c
VF	Volatilization Factor from Soil	m^3/kg	Chemical-specific	See Table 4
PEF	Particulate Emission Factor from Soil	m^3/kg	4.63E+09	EPA, 1991
ET	Exposure Time, Soil Inhalation	hours/day	12	Standard work shift for BP employees
EV	Event Frequency	events/day	1	EPA, 2004
SAw	Skin Surface Area, Water Contact	cm^2	3,527	EPA, 2015c
FA	Fraction Absorbed Water	--	Chemical-specific	See Table 4
Kp	Dermal Permeability Coefficient of Compound in Water	cm/hour	Chemical-specific	See Table 4
τ	Lag Time per Event	hours/event	Chemical-specific	See Table 4
t_{event}	Event Duration	hours/event	1	Best professional judgement
B	Ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis	--	Chemical-specific	See Table 4

Units Abbreviations:

mg: milligram
kg: kilogram
µg: microgram
L: liter
cm: centimeter
cm^2: square centimeter
cm^3: cubic centimeter
m^3: cubic meter
--: not applicable

References:

U.S. Environmental Protection Agency (EPA). 1991. Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals). Interim. EPA/540/R-92/003. December.

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Table B-6
Future Resident Subsistence User Action Level Calculation Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Abbreviation	Definition	Units	Value	Source
General				
TR	Target Lifetime Excess Cancer Risk	--	1.0E-06	EPA, 2015c
THQ	Target Hazard Quotient	--	0.1	EPA, 2015c
BWa	Body Weight, Adult	kg	80	EPA, 2015c
BWc	Body Weight, Child	kg	15	EPA, 2015c
ATc	Averaging Time, Carcinogen	years	70	EPA, 2015c
ATnc	Averaging Time, Non-carcinogen	years	26	EPA, 2015c
ATnc,a	Averaging Time, Non-carcinogen, Adult only	years	20	EPA, 2015c
ATnc,c	Averaging Time, Non-carcinogen, Child only	years	6	EPA, 2015c
--	Days in One Year	days/year	365	--
SFo	Slope Factor, Oral	(mg/kg-day)$^{-1}$	Chemical-specific	See Table 4
SFd	Slope Factor, Dermal	(mg/kg-day)$^{-1}$	Chemical-specific	See Table 4
URFi	Inhalation Unit Risk Factor	(mg/m^3)$^{-1}$	Chemical-specific	See Table 4
RfDo	Reference Dose, Oral	mg/kg-day	Chemical-specific	See Table 4
RfDd	Reference Dose, Dermal	mg/kg-day	Chemical-specific	See Table 4
RfCi	Inhalation Reference Concentration	mg/m^3	Chemical-specific	See Table 4
ED	Exposure Duration	years	26	EPA, 2015c
EDa	Exposure Duration, Adult only	years	20	EPA, 2015c
EDc	Exposure Duration, Child only	years	6	EPA, 2015c
ED_{0-2}	Exposure Duration, Ages 0-2 years	years	2	EPA, 2015c
ED_{2-6}	Exposure Duration, Ages 2-6 years	years	4	EPA, 2015c
ED_{6-16}	Exposure Duration, Ages 6-16 years	years	10	EPA, 2015c
ED_{16-26}	Exposure Duration, Ages 16-26 years	years	10	EPA, 2015c
CAFo	TCE Cancer Adjustment Factor, oral	--	0.804	EPA, 2015c
MAFo	TCE Mutagen Adjustment Factor, oral	--	0.202	EPA, 2015c
CAFi	TCE Cancer Adjustment Factor, inhalation	--	0.756	EPA, 2015c
MAFi	TCE Mutagen Adjustment Factor, inhalation	--	0.244	EPA, 2015c
CF	Conversion Factor	kg/mg	0.000001	--
CF_2	Conversion Factor	L/cm^3	0.001	--
CF_3	Conversion Factor	µg/mg	1,000	--
CF_4	Conversion Factor	mg/µg	0.001	--
Soil Specific				
EFs	Exposure Frequency, Soil Ingestion and Dermal Contact	days/year	100	Wendler et al., 2010
EFs,i	Exposure Frequency, Soil Inhalation	days/year	200	ADEC, 2015
EFd	Exposure Frequency, Diet	days/year	365	ADEC, 2015
IRs,a	Ingestion Rate, Soil, Adult	mg/day	100	EPA, 2015c
IRs,c	Ingestion Rate, Soil, Child	mg/day	200	EPA, 2015c
IFSMadj	Mutagenic Soil Ingestion Rate, Age-adjusted	mg-year/kg-day	476.7	Calculated based on EPA, 2015c ((ED0-2*IRs,c*10/BWc) + (ED2-6*IRs,c*3/BWc) + (ED6-16*IRs,a*3/BWa) + (ED16-26*IRs,a*1/BWa))
IFSadj	Age-adjusted Soil Ingestion Rate	mg-year/kg-day	105	Calculated based on EPA, 2015c ((EDc*IRs,c/BWc) + (EDa*IRs,a/BWa))
AFa	Soil Adherence Factor, Adult	mg/cm^2	0.07	EPA, 2015c
AFc	Soil Adherence Factor, Child	mg/cm^2	0.2	EPA, 2015c
SAs,a	Skin Surface Area, Soil Exposure, Adult	cm^2/day	6,032	EPA, 2015c
SAs,c	Skin Surface Area, Soil Exposure, Child	cm^2/day	2,373	EPA, 2015c
ABSd	Dermal Absorption Factor	--	Chemical-specific	See Table 4
DFSMadj	Mutagenic Soil Dermal Contact Factor, Age-adjusted	mg-year/kg-day	1,224	Calculated based on EPA, 2015c ((ED0-2*AFc*SAs,c*10/BWc) + (ED2-6*AFc*SAs,c*3/BWc) + (ED6-16*AFa*SAs,a*3/BWa) + (ED16-26*AFa*SAs,a*1/BWa))
DFSadj	Age-adjusted Soil Dermal Contact Factor	mg-year/kg-day	295	Calculated based on EPA, 2015c ((EDc*AFc*SAs,c/BWc) + (EDa*AFa*SAs,a/BWa))
IRd,a	Ingestion Rate, Diet, Adult	mg/day	250,000	ADF&G, 2002
IRd,c	Ingestion Rate, Diet, Child	mg/day	112,500	ADF&G, 2002 modified for child based on EPA, 2011b
IFDMadj	Mutagenic Dietary Ingestion Rate, Age-adjusted	mg-year/kg-day	365,000	Calculated based on EPA, 2015c ((ED0-2*IRd,c*10/BWc) + (ED2-6*IRd,c*3/BWc) + (ED6-16*IRd,a*3/BWa) + (ED16-26*IRd,a*1/BWa))
IFDadj	Age-adjusted Dietary Ingestion Rate	mg-year/kg-day	107,500	Calculated based on EPA, 2015c ((EDc*IRd,c/BWc) + (EDa*IRd,a/BWa))
AUFs	Area Use Factor, Soil	--	0.25	Percentage of caribou that may be exposed to Site chemicals
BTF	Beef Transfer Coefficient	day/kg	Chemical-specific	See Table 4
CRp	Plant Ingestion Rate by Caribou	kg/day (wet weight)	20	Holleman et al., 1979
BV	Soil-to-Plant Uptake	unitless	Chemical-specific	See Table 4
VF	Volatilization Factor from Soil	m^3/kg	Chemical-specific	See Table 4
PEF	Particulate Emission Factor from Soil	m^3/kg	4.63E+09	EPA, 1991

Table B-6
Future Resident Subsistence User Action Level Calculation Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Abbreviation	Definition	Units	Value	Source
Surface Water Specific				
EFw	Exposure Frequency, Water	days/year	350	ADEC, 2015
EFf	Exposure Frequency, Fish	days/year	365	ADEC, 2015
IRw,a	Ingestion Rate, Water, Adult	L/day	2.5	EPA, 2015c
IRw,c	Ingestion Rate, Water, Child	L/day	0.78	EPA, 2015c
IFWMadj	Mutagenic Water Ingestion Rate, Age-adjusted	L-year/kg-day	2.91	Calculated based on EPA, 2015c ((ED0-2*IRw,c*10/BWc) + (ED2-6*IRw,c*3/BWc) + (ED6-16*IRw,a*3/BWa) + (ED16-26*IRw,a*1/BWa))
IFWadj	Age-adjusted Water Ingestion Rate	L-year/kg-day	0.937	Calculated based on EPA, 2015c ((EDc*IRw,c/BWc) + (EDa*IRw,a/BWa))
IRf,a	Ingestion Rate, Fish, Adult	kg/day	0.265	ADF&G, 2002
IRf,c	Ingestion Rate, Fish, Child	kg/day	0.109	ADF&G, 2002 modified for child based on EPA, 2011b
IFFMadj	Mutagenic Fish Ingestion Rate, Age-adjusted	year/day	0.365	Calculated based on EPA, 2015c ((ED0-2*IRf,c*10/BWc) + (ED2-6*IRf,c*3/BWc) + (ED6-16*IRf,a*3/BWa) + (ED16-26*IRf,a*1/BWa))
IFFadj	Age-adjusted Fish Ingestion Rate	year/day	0.11	Calculated based on EPA, 2015c ((EDc*IRf,c/BWc) + (EDa*IRf,a/BWa))
AUFw	Area Use Factor, Water	--	0.10	Percentage of fish conservatively assumed to come from Site lakes
BCF	Fish Bioaccumulation Factor	L/kg	Chemical-specific	See Table 4
K	Volatilization Factor from Water	L/m^3	0.5	EPA, 2015c
EV	Event Frequency	events/day	1	EPA, 2004
FA	Fraction Absorbed Water	--	Chemical-specific	See Table 4
Kp	Dermal Permeability Coefficient of Compound in Water	cm/hour	Chemical-specific	See Table 4
τ	Lag Time per Event	hours/event	Chemical-specific	See Table 4
$t_{event, c}$	Event Duration, Child	hours/event	0.54	EPA, 2015c
$t_{event, a}$	Event Duration, Adult	hours/event	0.71	EPA, 2015c
$t_{event, adj}$	Age-Adjusted Event Duration	hours/event	0.6708	Calculated based on EPA, 2015c (((EDc*$t_{event, c}$) + (EDa*$t_{event,a}$)) / ED)
$t_{event, madj}$	Mutagenic Event Duration, Age-adjusted	hours/event	0.6708	Calculated based on EPA, 2015c (((ED0-2*$t_{event, c}$) + (ED2-6*$t_{event, c}$) + (ED6-16*$t_{event, a}$) + (ED16-26*$t_{event,a}$)) / (ED0-2 + ED2-6 + ED6-16 + ED16-26))
SAw,a	Skin Surface Area, Showering, Adult	cm^2	20,900	EPA, 2015c
SAw,c	Skin Surface Area, Showering, Child	cm^2	6,378	EPA, 2015c
DFWMadj	Mutagenic Dermal Water Contact Factor, Age-adjusted	cm^2-years/kg	24,056	Calculated based on EPA, 2015c ((ED0-2*SAw,c*10/BWc) + (ED2-6*SAw,c*3/BWc) + (ED6-16*SAw,a*3/BWa) + (ED16-26*SAw,a*1/BWa))
DFWadj	Age-adjusted Dermal Water Contact Factor	cm^2-years/kg	7,776	Calculated based on EPA, 2015c ((EDc*SAw,c/BWc) + (EDa*SAw,a/BWa))

Units Abbreviations:
mg: milligram
kg: kilogram
µg: microgram
L: liter
cm: centimeter
cm^2: square centimeter
cm^3: cubic centimeter
m^3: cubic meter
--: not applicable
TCE: trichloroethene

References:

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Table B-7
Current Nonresident Subsistence User Action Level Calculation Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Abbreviation	Definition	Units	Value	Source
General				
TR	Target Lifetime Excess Cancer Risk	--	1.0E-06	EPA, 2015c
THQ	Target Hazard Quotient	--	0.1	EPA, 2015c
BWa	Body Weight, Adult	kg	80	EPA, 2015c
BWc	Body Weight, Child	kg	15	EPA, 2015c
ATc	Averaging Time, Carcinogen	years	70	EPA, 2015c
ATnc	Averaging Time, Non-carcinogen	years	26	EPA, 2015c
ATnc,a	Averaging Time, Non-carcinogen, Adult only	years	20	EPA, 2015c
ATnc,c	Averaging Time, Non-carcinogen, Child only	years	6	EPA, 2015c
--	Days in One Year	days/year	365	--
SFo	Slope Factor, Oral	$(mg/kg\text{-}day)^{-1}$	Chemical-specific	See Table 4
SFd	Slope Factor, Dermal	$(mg/kg\text{-}day)^{-1}$	Chemical-specific	See Table 4
URFi	Inhalation Unit Risk Factor	$(mg/m^3)^{-1}$	Chemical-specific	See Table 4
RfDo	Reference Dose, Oral	mg/kg-day	Chemical-specific	See Table 4
RfDd	Reference Dose, Dermal	mg/kg-day	Chemical-specific	See Table 4
RfCi	Inhalation Reference Concentration	mg/m^3	Chemical-specific	See Table 4
ED	Exposure Duration	years	26	EPA, 2015c
EDa	Exposure Duration, Adult only	years	20	EPA, 2015c
EDc	Exposure Duration, Child only	years	6	EPA, 2015c
ED_{0-2}	Exposure Duration, Ages 0-2 years	years	2	EPA, 2015c
ED_{2-6}	Exposure Duration, Ages 2-6 years	years	4	EPA, 2015c
ED_{6-16}	Exposure Duration, Ages 6-16 years	years	10	EPA, 2015c
ED_{16-26}	Exposure Duration, Ages 16-26 years	years	10	EPA, 2015c
CAFo	TCE Cancer Adjustment Factor, oral	--	0.804	EPA, 2015c
MAFo	TCE Mutagen Adjustment Factor, oral	--	0.202	EPA, 2015c
CF	Conversion Factor	kg/mg	0.000001	--
CF_2	Conversion Factor	L/cm^3	0.001	--
CF_3	Conversion Factor	µg/mg	1,000	--
CF_4	Conversion Factor	mg/µg	0.001	--
Soil Specific				
EFs	Exposure Frequency, Soil Ingestion, Dermal Contact, and Inhalation	days/year	30	Number of days spent on whaling trips; MMS, 2009
EFd	Exposure Frequency, Diet	days/year	365	ADEC, 2015
IRs,a	Ingestion Rate, Soil, Adult	mg/day	100	EPA, 2015c
IFSa	Adult Soil Ingestion Factor	mg-year/kg-day	33	Calculated based on EPA, 2015c (ED*IRs,a/BWa)
AFa	Soil Adherence Factor, Adult	mg/cm^2	0.07	EPA, 2015c
SAs,a	Skin Surface Area, Soil Exposure, Adult	cm^2/day	6,032	EPA, 2015c
ABSd	Dermal Absorption Factor	--	Chemical-specific	See Table 4
DFSa	Adult Soil Dermal Contact Factor	mg-year/kg-day	137	Calculated based on EPA, 2015c (ED*AFa*SAs,a/BWa)
IRd,a	Ingestion Rate, Diet, Adult	mg/day	250,000	ADF&G, 2002
IRd,c	Ingestion Rate, Diet, Child	mg/day	112,500	ADF&G, 2002 modified for child based on EPA, 2011b
IFDMadj	Mutagenic Dietary Ingestion Rate, Age-adjusted	mg-year/kg-day	365,000	Calculated based on EPA, 2015c ((ED0-2*IRd,c*10/BWc) + (ED2-6*IRd,c*3/BWc) + (ED6-16*IRd,a*3/BWa) + (ED16-26*IRd,a*1/BWa))
IFDadj	Age-adjusted Dietary Ingestion Rate	mg-year/kg-day	107,500	Calculated based on EPA, 2015c ((EDc*IRd,c/BWc) + (EDa*IRd,a/BWa))
AUFs	Area Use Factor, Soil	--	0.25	Percentage of caribou that may be exposed to Site chemicals
BTF	Beef Transfer Coefficient	day/kg	Chemical-specific	See Table 4
CRp	Plant Ingestion Rate by Caribou	kg/day (wet weight)	20	Holleman et al., 1979
BV	Soil-to-Plant Uptake	unitless	Chemical-specific	See Table 4
VF	Volatilization Factor from Soil	m^3/kg	Chemical-specific	See Table 4
PEF	Particulate Emission Factor from Soil	m^3/kg	4.63E+09	EPA, 1991

Table B-7
Current Nonresident Subsistence User Action Level Calculation Input Parameters
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Abbreviation	Definition	Units	Value	Source
Surface Water Specific				
EFw	Exposure Frequency, Water	days/year	30	Number of days spent on whaling trips; MMS, 2009
EFf	Exposure Frequency, Fish	days/year	365	ADEC, 2015
IRf,a	Ingestion Rate, Fish, Adult	kg/day	0.265	ADF&G, 2002
IRf,c	Ingestion Rate, Fish, Child	kg/day	0.109	Adult value modified for child based on EPA, 2011b
IFFMadj	Mutagenic Fish Ingestion Rate, Age-adjusted	year/day	0.365	Calculated based on EPA, 2015c ((ED0-2*IRf,c*10/BWc) + (ED2-6*IRf,c*3/BWc) + (ED6-16*IRf,a*3/BWa) + (ED16-26*IRf,a*1/BWa))
IFFadj	Age-adjusted Fish Ingestion Rate	year/day	0.11	Calculated based on EPA, 2015c ((EDc*IRf,c/BWc) + (EDa*IRf,a/BWa))
AUFw	Area Use Factor, Water	--	0.10	Percentage of fish conservatively assumed to come from Site lakes
BCF	Fish Bioaccumulation Factor	L/kg	Chemical-specific	See Table 4
EV	Event Frequency	events/day	1	EPA, 2004
FA	Fraction Absorbed Water	--	Chemical-specific	See Table 4
Kp	Dermal Permeability Coefficient of Compound in Water	cm/hour	Chemical-specific	See Table 4
τ	Lag Time per Event	hours/event	Chemical-specific	See Table 4
t_{event}	Event Duration	hours/event	0.25	EPA, 2004
SAw,a	Skin Surface Area, Water Exposure, Adult	cm^2	6,032	EPA, 2015c
DFWa	Adult Dermal Water Contact Factor	cm^2-years/kg	1,960	Calculated based on EPA, 2015c (ED*SAw,a/BWa)

Units Abbreviations:

mg: milligram
kg: kilogram
µg: microgram
L: liter
cm: centimeter
cm^2: square centimeter
cm^3: cubic centimeter
m^3: cubic meter
--: not applicable
TCE: trichloroethene

References:

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Table B-8
Tier II Soil Action Levels
Industrial Worker Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Values [a]						Chemical Properties [a]		Industrial Worker (IW) ALs								
		Oral		Dermal		Inhalation				Noncarcinogen [b]			Carcinogen [b]					
CAS #	Chemical Name	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	VF / PEF (m^3/kg)	ABSd (Unitless)	IW Direct Contact (NC) [c] (mg/kg)	IW Inhalation (NC) [d] (mg/kg)	IW Total (NC) [e] (mg/kg)	IW Direct Contact (C) [f] (mg/kg)	IW Inhalation (C) [g] (mg/kg)	IW Total (C) [e] (mg/kg)	Csat [h] (mg/kg)	Lowest Total AL [i] (mg/kg)	
Volatiles																		
67-64-1	Acetone	NA	9.0E-01	NA	9.0E-01	3.1E+01	NA	2.0E+04	0.0E+00	2.6E+05	2.5E+05	1.3E+05	NA	NA	NA	1.1E+05	1.3E+05	sm
107-02-8	Acrolein	NA	5.0E-04	NA	5.0E-04	2.0E-05	NA	1.1E+04	0.0E+00	1.5E+02	8.4E-02	8.4E-02	NA	NA	NA	2.3E+04	8.4E-02	
71-43-2	Benzene	5.5E-02	4.0E-03	5.5E-02	4.0E-03	3.0E-02	7.8E-03	3.0E+03	0.0E+00	1.2E+03	3.5E+01	3.4E+01	1.5E+02	4.2E+00	4.1E+00	1.8E+03	4.1E+00	
78-93-3	2-Butanone	NA	6.0E-01	NA	6.0E-01	5.0E+00	NA	1.7E+04	0.0E+00	1.8E+05	3.5E+04	2.9E+04	NA	NA	NA	2.8E+04	2.9E+04	s
56-23-5	Carbon tetrachloride	7.0E-02	4.0E-03	7.0E-02	4.0E-03	1.0E-01	6.0E-03	1.9E+03	0.0E+00	1.2E+03	7.3E+01	6.9E+01	1.2E+02	3.4E+00	3.3E+00	4.6E+02	3.3E+00	
108-90-7	Chlorobenzene	NA	2.0E-02	NA	2.0E-02	5.0E-02	NA	4.9E+03	0.0E+00	5.8E+03	9.7E+01	9.6E+01	NA	NA	NA	7.6E+02	9.6E+01	
75-00-3	Chloroethane	NA	NA	NA	NA	1.0E+01	NA	1.7E+03	0.0E+00	NA	6.5E+03	6.5E+03	NA	NA	NA	2.1E+03	6.5E+03	s
67-66-3	Chloroform	3.1E-02	1.0E-02	3.1E-02	1.0E-02	9.8E-02	2.3E-02	2.9E+03	0.0E+00	2.9E+03	1.1E+02	1.1E+02	2.6E+02	1.4E+00	1.4E+00	2.5E+03	1.4E+00	
106-93-4	1,2-Dibromoethane	2.0E+00	9.0E-03	2.0E+00	9.0E-03	9.0E-03	6.0E-01	8.9E+03	0.0E+00	2.6E+03	3.2E+01	3.1E+01	4.1E+00	1.6E-01	1.6E-01	1.3E+03	1.6E-01	
95-50-1	1,2-Dichlorobenzene	NA	9.0E-02	NA	9.0E-02	2.0E-01	NA	8.4E+03	0.0E+00	2.6E+04	6.6E+02	6.5E+02	NA	NA	NA	3.8E+02	6.5E+02	s
75-34-3	1,1-Dichloroethane	5.7E-03	2.0E-01	5.7E-03	2.0E-01	NA	1.6E-03	2.4E+03	0.0E+00	5.8E+04	NA	5.8E+04	1.4E+03	1.6E+01	1.6E+01	1.7E+03	1.6E+01	
107-06-2	1,2-Dichloroethane	9.1E-02	6.0E-03	9.1E-02	6.0E-03	7.0E-03	2.6E-02	4.7E+03	0.0E+00	1.8E+03	1.3E+01	1.3E+01	9.0E+01	2.0E+00	2.0E+00	3.0E+03	2.0E+00	
75-35-4	1,1-Dichloroethene	NA	5.0E-02	NA	5.0E-02	2.0E-01	NA	1.5E+03	0.0E+00	1.5E+04	1.2E+02	1.2E+02	NA	NA	NA	1.2E+03	1.2E+02	
156-59-2	cis-1,2-Dichloroethene	NA	2.0E-03	NA	2.0E-03	NA	NA	2.7E+03	0.0E+00	5.8E+02	NA	5.8E+02	NA	NA	NA	2.4E+03	5.8E+02	
156-60-5	trans-1,2-Dichloroethene	NA	2.0E-02	NA	2.0E-02	NA	NA	2.0E+03	0.0E+00	5.8E+03	NA	5.8E+03	NA	NA	NA	1.9E+03	5.8E+03	s
60-29-7	Diethyl ether	NA	2.0E-01	NA	2.0E-01	NA	NA	4.2E+03	0.0E+00	5.8E+04	NA	5.8E+04	NA	NA	NA	1.0E+04	5.8E+04	s
123-91-1	1,4-Dioxane	1.0E-01	3.0E-02	1.0E-01	3.0E-02	3.0E-02	5.0E-03	5.9E+04	1.0E-01	6.2E+03	7.0E+02	6.3E+02	5.7E+01	1.3E+02	4.0E+01	1.2E+05	4.0E+01	
100-41-4	Ethylbenzene	1.1E-02	1.0E-01	1.1E-02	1.0E-01	1.0E+00	2.5E-03	4.1E+03	0.0E+00	2.9E+04	1.6E+03	1.5E+03	7.4E+02	1.8E+01	1.8E+01	4.8E+02	1.8E+01	
50-00-0	Formaldehyde	NA	2.0E-01	NA	2.0E-01	9.8E-03	1.3E-02	1.2E+05	1.0E-01	4.1E+04	4.6E+02	4.6E+02	NA	1.0E+02	1.0E+02	4.2E+04	1.0E+02	
67-56-1	Methanol	NA	2.0E+00	NA	2.0E+00	2.0E+01	NA	4.5E+04	1.0E-01	4.1E+05	3.5E+05	1.9E+05	NA	NA	NA	1.1E+05	1.9E+05	sm
75-09-2	Methylene chloride	2.0E-03	6.0E-03	2.0E-03	6.0E-03	6.0E-01	1.0E-05	2.6E+03	0.0E+00	1.8E+03	6.2E+02	4.6E+02	4.1E+03	2.9E+03	1.7E+03	3.3E+03	4.6E+02	
108-10-1	4-Methyl-2-pentanone	NA	8.0E-02	NA	8.0E-02	3.0E+00	NA	1.3E+04	0.0E+00	2.3E+04	1.6E+04	9.4E+03	NA	NA	NA	3.4E+03	9.4E+03	s
103-65-1	n-Propylbenzene	NA	1.0E-01	NA	1.0E-01	1.0E+00	NA	4.9E+03	0.0E+00	2.9E+04	1.9E+03	1.8E+03	NA	NA	NA	2.6E+02	1.8E+03	s
127-18-4	Tetrachloroethene	2.1E-03	6.0E-03	2.1E-03	6.0E-03	4.0E-02	2.6E-04	2.4E+03	0.0E+00	1.8E+03	3.8E+01	3.7E+01	3.9E+03	1.0E+02	9.9E+01	1.7E+02	3.7E+01	
108-88-3	Toluene	NA	8.0E-02	NA	8.0E-02	5.0E+00	NA	3.4E+03	0.0E+00	2.3E+04	6.7E+03	5.2E+03	NA	NA	NA	8.2E+02	5.2E+03	s
71-55-6	1,1,1-Trichloroethane	NA	2.0E+00	NA	2.0E+00	5.0E+00	NA	1.9E+03	0.0E+00	5.8E+05	3.8E+03	3.8E+03	NA	NA	NA	6.4E+02	3.8E+03	s
79-01-6	Trichloroethene	4.6E-02	5.0E-04	4.6E-02	5.0E-04	2.0E-03	4.1E-03	2.3E+03	0.0E+00	1.5E+02	1.8E+00	1.8E+00	1.8E+02	6.2E+00	6.0E+00	6.9E+02	1.8E+00	
95-63-6	1,2,4-Trimethylbenzene	NA	5.0E-02	NA	5.0E-02	7.0E-03	NA	5.6E+03	0.0E+00	1.5E+04	1.5E+01	1.5E+01	NA	NA	NA	2.2E+02	1.5E+01	
108-67-8	1,3,5-Trimethylbenzene	NA	1.0E-02	NA	1.0E-02	6.0E-03	NA	4.7E+03	0.0E+00	2.9E+03	1.1E+01	1.1E+01	NA	NA	NA	1.8E+02	1.1E+01	
75-01-4	Vinyl chloride	7.2E-01	3.0E-03	7.2E-01	3.0E-03	1.0E-01	4.4E-03	1.3E+03	0.0E+00	8.8E+02	5.2E+01	4.9E+01	1.1E+01	3.3E+00	2.6E+00	3.9E+03	2.6E+00	
1330-20-7	Xylenes	NA	2.0E-01	NA	2.0E-01	1.0E-01	NA	4.7E+03	0.0E+00	5.8E+04	1.9E+02	1.9E+02	NA	NA	NA	2.6E+02	1.9E+02	
Semi-Volatiles																		
83-32-9	Acenaphthene	NA	6.0E-02	NA	6.0E-02	NA	NA	9.2E+04	1.3E-01	1.1E+04	NA	1.1E+04	NA	NA	NA	NA	1.1E+04	
208-96-8	Acenaphthylene	NA	NA	NA	NA	NA	NA	1.2E+05	1.3E-01	NA	NA	NA	NA	NA	NA	NA	NA	
120-12-7	Anthracene	NA	3.0E-01	NA	3.0E-01	NA	NA	3.4E+05	1.3E-01	5.7E+04	NA	5.7E+04	NA	NA	NA	NA	5.7E+04	
56-55-3	Benzo(a)anthracene	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	2.8E+06	1.3E-01	NA	NA	NA	7.2E+00	2.9E+02	7.0E+00	NA	7.0E+00	
50-32-8	Benzo(a)pyrene	7.3E+00	NA	7.3E+00	NA	NA	1.1E+00	4.6E+09	1.3E-01	NA	NA	NA	7.2E-01	4.7E+04	7.2E-01	NA	7.2E-01	
205-99-2	Benzo(b)fluoranthene	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	4.6E+09	1.3E-01	NA	NA	NA	7.2E+00	4.7E+05	7.2E+00	NA	7.2E+00	
191-24-2	Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	4.6E+09	1.3E-01	NA	NA	NA	NA	NA	NA	NA	NA	
207-08-9	Benzo(k)fluoranthene	7.3E-02	NA	7.3E-02	NA	NA	1.1E-01	4.6E+09	1.3E-01	NA	NA	NA	7.2E+01	4.7E+05	7.2E+01	NA	7.2E+01	
218-01-9	Chrysene	7.3E-03	NA	7.3E-03	NA	NA	1.1E-02	4.6E+09	1.3E-01	NA	NA	NA	7.2E+02	4.7E+06	7.2E+02	NA	7.2E+02	
53-70-3	Dibenz(a,h)anthracene	7.3E+00	NA	7.3E+00	NA	NA	1.2E+00	4.6E+09	1.3E-01	NA	NA	NA	7.2E-01	4.3E+04	7.2E-01	NA	7.2E-01	
105-67-9	2,4-Dimethylphenol	NA	2.0E-02	NA	2.0E-02	NA	NA	4.6E+09	1.0E-01	4.1E+03	NA	4.1E+03	NA	NA	NA	NA	4.1E+03	
84-74-2	Di-n-butylphthalate	NA	1.0E-01	NA	1.0E-01	NA	NA	4.6E+09	1.0E-01	2.1E+04	NA	2.1E+04	NA	NA	NA	NA	2.1E+04	
206-44-0	Fluoranthene	NA	4.0E-02	NA	4.0E-02	NA	NA	4.6E+09	1.3E-01	7.5E+03	NA	7.5E+03	NA	NA	NA	NA	7.5E+03	
86-73-7	Fluorene	NA	4.0E-02	NA	4.0E-02	NA	NA	1.8E+05	1.3E-01	7.5E+03	NA	7.5E+03	NA	NA	NA	NA	7.5E+03	
193-39-5	Indeno(1,2,3-cd)pyrene	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	4.6E+09	1.3E-01	NA	NA	NA	7.2E+00	4.7E+05	7.2E+00	NA	7.2E+00	
90-12-0	1-Methylnaphthalene	2.9E-02	7.0E-02	2.9E-02	7.0E-02	NA	NA	3.8E+04	1.3E-01	1.3E+04	NA	1.3E+04	1.8E+02	NA	1.8E+02	NA	1.8E+02	
91-57-6	2-Methylnaphthalene	NA	4.0E-03	NA	4.0E-03	NA	NA	3.8E+04	1.3E-01	7.5E+02	NA	7.5E+02	NA	NA	NA	NA	7.5E+02	
95-48-7	2-Methylphenol	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	4.6E+09	1.0E-01	1.0E+04	1.1E+09	1.0E+04	NA	NA	NA	NA	1.0E+04	
108-39-4	3-Methylphenol	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	4.6E+09	1.0E-01	1.0E+04	1.1E+09	1.0E+04	NA	NA	NA	NA	1.0E+04	
106-44-5	4-Methylphenol	NA	1.0E-01	NA	1.0E-01	6.0E-01	NA	4.6E+09	1.0E-01	2.1E+04	1.1E+09	2.1E+04	NA	NA	NA	NA	2.1E+04	
34mp	3&4-Methylphenol [j]	--	--	--	--	--	--	--	--	1.0E+04	1.1E+09	1.0E+04	NA	NA	NA	--	1.0E+04	
91-20-3	Naphthalene	NA	2.0E-02	NA	2.0E-02	3.0E-03	3.4E-02	3.1E+04	1.3E-01	3.8E+03	3.6E+01	3.6E+01	NA	1.0E+01	1.0E+01	NA	1.0E+01	
85-01-8	Phenanthrene	NA	NA	NA	NA	NA	NA	4.2E+05	1.3E-01	NA	NA	NA	NA	NA	NA	NA	NA	
108-95-2	Phenol	NA	3.0E-01	NA	3.0E-01	2.0E-01	NA	4.6E+09	1.0E-01	6.2E+04	3.7E+08	6.2E+04	NA	NA	NA	NA	6.2E+04	
129-00-0	Pyrene	NA	3.0E-02	NA	3.0E-02	NA	NA	1.5E+06	1.3E-01	5.7E+03	NA	5.7E+03	NA	NA	NA	NA	5.7E+03	

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BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Values [a]						Chemical Properties [a]		Industrial Worker (IW) ALs								
		Oral		Dermal		Inhalation				Noncarcinogen [b]			Carcinogen [b]					
CAS #	Chemical Name	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	VF / PEF (m^3/kg)	ABSd (Unitless)	IW Direct Contact (NC) [c] (mg/kg)	IW Inhalation (NC) [d] (mg/kg)	IW Total (NC) [e] (mg/kg)	IW Direct Contact (C) [f] (mg/kg)	IW Inhalation (C) [g] (mg/kg)	IW Total (C) [e] (mg/kg)	Csat [h] (mg/kg)	Lowest Total AL [i] (mg/kg)	
Metals																		
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	--	--	
7440-36-0	Antimony	NA	4.0E-04	NA	6.0E-05	NA	NA	4.6E+09	0.0E+00	1.2E+02	NA	1.2E+02	NA	NA	NA	NA	1.2E+02	
7440-38-2	Arsenic [k]	1.5E+00	3.0E-04	1.5E+00	3.0E-04	1.5E-05	4.3E+00	4.6E+09	3.0E-02	1.2E+02	2.7E+04	1.2E+02	7.5E+00	1.2E+04	7.5E+00	NA	7.5E+00	
7440-39-3	Barium	NA	2.0E-01	NA	1.4E-02	5.0E-04	NA	4.6E+09	0.0E+00	5.8E+04	9.1E+05	5.5E+04	NA	NA	NA	NA	5.5E+04	
7440-43-9	Cadmium (food)	NA	1.0E-03	NA	2.5E-05	1.0E-05	1.8E+00	4.6E+09	1.0E-03	2.5E+02	1.8E+04	2.5E+02	NA	2.8E+04	2.8E+04	NA	2.5E+02	
7440-43-9	Cadmium (water)	NA	5.0E-04	NA	2.5E-05	1.0E-05	1.8E+00	--	1.0E-03	--	--	--	--	--	NA	--	--	
7440-47-3	Chromium	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	
16065-83-1	Chromium (III)	NA	1.5E+00	NA	2.0E-02	NA	NA	4.6E+09	0.0E+00	4.4E+05	NA	4.4E+05	NA	NA	NA	NA	4.4E+05	m
18540-29-9	Chromium (VI)	5.0E-01	3.0E-03	2.0E+01	7.5E-05	1.0E-04	8.4E+01	4.6E+09	0.0E+00	8.8E+02	1.8E+05	8.7E+02	1.6E+01	6.1E+02	1.6E+01	NA	1.6E+01	
7440-50-8	Copper	NA	4.0E-02	NA	4.0E-02	NA	NA	4.6E+09	0.0E+00	1.2E+04	NA	1.2E+04	NA	NA	NA	NA	1.2E+04	
7439-92-1	Lead	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	
7439-96-5	Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	--	--	
7487-94-7	Mercury (inorganic salts) [l]	NA	3.0E-04	NA	2.1E-05	3.0E-04	NA	4.6E+09	0.0E+00	8.8E+01	5.5E+05	8.8E+01	NA	NA	NA	NA	8.8E+01	
7439-97-6	Mercury (elemental) [l]	NA	NA	NA	NA	3.0E-04	NA	--	0.0E+00	--	--	--	--	--	NA	--	--	
7440-02-0	Nickel	NA	2.0E-02	NA	8.0E-04	9.0E-05	2.6E-01	4.6E+09	0.0E+00	5.8E+03	1.6E+05	5.6E+03	NA	2.0E+05	2.0E+05	NA	5.6E+03	
7782-49-2	Selenium	NA	5.0E-03	NA	5.0E-03	2.0E-02	NA	4.6E+09	0.0E+00	1.5E+03	3.7E+07	1.5E+03	NA	NA	NA	NA	1.5E+03	
7440-22-4	Silver	NA	5.0E-03	NA	2.0E-04	NA	NA	4.6E+09	0.0E+00	1.5E+03	NA	1.5E+03	NA	NA	NA	NA	1.5E+03	
7440-62-2	Vanadium	NA	5.0E-03	NA	1.3E-04	1.0E-04	NA	4.6E+09	0.0E+00	1.5E+03	1.8E+05	1.4E+03	NA	NA	NA	NA	1.4E+03	
7440-66-6	Zinc	NA	3.0E-01	NA	3.0E-01	NA	NA	4.6E+09	0.0E+00	8.8E+04	NA	8.8E+04	NA	NA	NA	NA	8.8E+04	
Inorganics																		
57-12-5	Cyanide	NA	6.0E-04	NA	6.0E-04	8.0E-04	NA	--	0.0E+00	1.8E+02	NA	1.8E+02	NA	NA	NA	9.7E+05	1.8E+02	

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFo: oral slope factor
RfDo: oral reference dose
SFd: dermal slope factor
RfDd: dermal reference dose
RfCi: inhalation reference concentration
URFi: inhalation unit risk factor
VF: volatilization factor
PEF: particulate emission factor
ABSd: dermal absorption factor
AL: action level
NC: noncarcinogen
C: carcinogen
Csat: soil saturation concentration
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
m^3/kg: cubic meters per kilogram
mg/kg: milligrams per kilogram
NA: not available
--: not applicable
s: concentration exceeds Csat
m: concentration exceeds ceiling limit

Footnotes:

[a] Values from Table 4.

[b] Exposure factors are provided in Table B-5. Equations provided below modified from ADEC (2008b).

[c] IW Direct contact (NC) AL = (THQ*BW*ATnc*365 d/yr) / (EF*ED*((1/RfDo*CF*IRs)+(1/RfDd*SAs*AF*ABSd*CF)))

[d] IW Inhalation (NC) AL = (THQ*ATnc*365 d/yr) / (EFs,i*ED*ET*CF*(1/RfCi)*[1/VF or 1/PEF])

[e] IW Total AL = 1/((1/direct contact AL)+(1/inhalation AL))

[f] IW Direct contact (C) AL = (TR*BW*ATc*365 d/yr) / (EF*ED*((SFo*CF*IRs)+(SFd*SAs*AF*ABSd*CF))

[g] IW Inhalation (C) AL = (TR*ATc*365 d/yr) / (EFs,i*ED*ET*CF*URFi*[1/VF or 1/PEF])

[h] Values from Table 2.

[i] Lowest of IW Total (NC) and IW Total (C). For target analytes that include the inhalation exposure route and have overall ALs that exceed the saturation limit (Csat), the ALs may be overly protective (see EPA, 2015c). If detected chemical concentrations exceed the Csat concentration, more sophisticated modeling may be necessary on a SWMU/AOC-specific basis. At chemical concentrations at and above the ceiling limit of 1×10^5 mg/kg, or 10% by weight of the soil sample, the assumptions for soil contact may be violated due to the presence of the foreign substance itself (EPA, 2015c). Target analytes with detected concentrations above the ceiling limit should be evaluated further on a SWMU/AOC-specific basis.

[j] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[k] The EPA (2012b) default relative bioavailability of 60 percent was incorporated into the soil ingestion components of the arsenic AL.

[l] Values for inorganic mercury salts were used to calculate soil ALs for mercury.

References:

Alaska Department of Environmental Conservation (ADEC). 2008b. Cleanup Levels Guidance. Division of Spill Prevention and Response, Contaminated Sites Program. June 9.

U.S. Environmental Protection Agency (EPA). 2012b. Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil. OSWER 9200.1-113, December.

EPA. 2015c. Regional Screening Level User's Guide. June. http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Table B-9
Tier II Water Action Levels
Industrial Worker Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Values [a]		Dermal Factors [a]						Industrial Worker (IW) ALs [c]		
CAS #	Chemical Name	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA$_{event}$ [b] cm/event	IW Dermal (NC) [d] (µg/L)	IW Dermal (C) [e] (µg/L)	Lowest IW AL [f] (µg/L)
Volatiles												
67-64-1	Acetone	NA	9.0E-01	5.1E-04	2.2E-01	5.3E-01	NA	1.5E-03	NA	NA	NA	NA
107-02-8	Acrolein	NA	5.0E-04	7.5E-04	2.2E-01	5.2E-01	1.0E+00	2.2E-03	1.1E-03	3.9E+03	NA	3.9E+03
71-43-2	Benzene	5.5E-02	4.0E-03	1.5E-02	2.9E-01	6.9E-01	1.0E+00	5.1E-02	2.3E-02	1.4E+03	1.8E+02	1.8E+02
78-93-3	2-Butanone	NA	6.0E-01	9.6E-04	2.7E-01	6.4E-01	1.0E+00	3.1E-03	1.5E-03	3.4E+06	NA	3.4E+06
56-23-5	Carbon tetrachloride	7.0E-02	4.0E-03	1.6E-02	7.6E-01	1.8E+00	1.0E+00	7.8E-02	3.9E-02	8.4E+02	8.4E+01	8.4E+01
108-90-7	Chlorobenzene	NA	2.0E-02	2.8E-02	4.5E-01	1.1E+00	1.0E+00	1.2E-01	5.2E-02	3.2E+03	NA	3.2E+03
75-00-3	Chloroethane	NA	NA	6.1E-03	2.4E-01	5.8E-01	1.0E+00	1.9E-02	8.9E-03	NA	NA	NA
67-66-3	Chloroform	3.1E-02	1.0E-02	6.8E-03	4.9E-01	1.2E+00	1.0E+00	2.9E-02	1.3E-02	6.3E+03	5.7E+02	5.7E+02
106-93-4	1,2-Dibromoethane	2.0E+00	9.0E-03	2.8E-03	1.2E+00	2.8E+00	1.0E+00	1.5E-02	8.4E-03	8.9E+03	1.4E+01	1.4E+01
95-50-1	1,2-Dichlorobenzene	NA	9.0E-02	4.5E-02	7.0E-01	1.7E+00	1.0E+00	2.1E-01	1.0E-01	7.2E+03	NA	7.2E+03
75-34-3	1,1-Dichloroethane	5.7E-03	2.0E-01	6.8E-03	3.8E-01	9.0E-01	1.0E+00	2.6E-02	1.2E-02	1.4E+05	3.4E+03	3.4E+03
107-06-2	1,2-Dichloroethane	9.1E-02	6.0E-03	4.2E-03	3.8E-01	9.0E-01	1.0E+00	1.6E-02	7.3E-03	6.8E+03	3.5E+02	3.5E+02
75-35-4	1,1-Dichloroethene	NA	5.0E-02	1.2E-02	3.7E-01	8.8E-01	1.0E+00	4.4E-02	2.0E-02	2.1E+04	NA	2.1E+04
156-59-2	cis-1,2-Dichloroethene	NA	2.0E-03	1.1E-02	3.7E-01	8.8E-01	NA	4.2E-02	NA	NA	NA	NA
156-60-5	trans-1,2-Dichloroethene	NA	2.0E-02	1.1E-02	3.7E-01	8.8E-01	1.0E+00	4.2E-02	1.9E-02	8.7E+03	NA	8.7E+03
60-29-7	Diethyl ether	NA	2.0E-01	2.4E-03	2.7E-01	6.6E-01	1.0E+00	7.8E-03	3.6E-03	4.6E+05	NA	4.6E+05
123-91-1	1,4-Dioxane	1.0E-01	3.0E-02	3.3E-04	3.3E-01	7.9E-01	1.0E+00	1.2E-03	5.5E-04	4.5E+05	4.2E+03	4.2E+03
100-41-4	Ethylbenzene	1.1E-02	1.0E-01	4.9E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	9.0E-02	9.2E+03	2.3E+02	2.3E+02
50-00-0	Formaldehyde	NA	2.0E-01	1.8E-03	1.5E-01	3.7E-01	1.0E+00	3.8E-03	2.4E-03	7.0E+05	NA	7.0E+05
67-56-1	Methanol	NA	2.0E+00	3.2E-04	1.6E-01	3.8E-01	1.0E+00	6.9E-04	4.2E-04	3.9E+07	NA	3.9E+07
75-09-2	Methylene chloride	2.0E-03	6.0E-03	3.5E-03	3.1E-01	7.5E-01	1.0E+00	1.3E-02	5.7E-03	8.6E+03	2.0E+04	8.6E+03
108-10-1	4-Methyl-2-pentanone	NA	8.0E-02	3.2E-03	3.8E-01	9.2E-01	1.0E+00	1.2E-02	5.6E-03	1.2E+05	NA	1.2E+05
103-65-1	n-Propylbenzene	NA	1.0E-01	9.4E-02	5.0E-01	1.2E+00	NA	4.0E-01	NA	NA	NA	NA
127-18-4	Tetrachloroethene	2.1E-03	6.0E-03	3.3E-02	8.9E-01	2.1E+00	1.0E+00	1.7E-01	8.7E-02	5.7E+02	1.3E+03	5.7E+02
108-88-3	Toluene	NA	8.0E-02	3.1E-02	3.5E-01	8.3E-01	1.0E+00	1.1E-01	5.2E-02	1.3E+04	NA	1.3E+04
71-55-6	1,1,1-Trichloroethane	NA	2.0E+00	1.3E-02	5.9E-01	1.4E+00	1.0E+00	5.6E-02	2.7E-02	6.2E+05	NA	6.2E+05
79-01-6	Trichloroethene	4.6E-02	5.0E-04	1.2E-02	5.7E-01	1.4E+00	1.0E+00	5.1E-02	2.4E-02	1.7E+02	2.1E+02	1.7E+02
95-63-6	1,2,4-Trimethylbenzene	NA	5.0E-02	8.6E-02	5.0E-01	1.2E+00	NA	3.6E-01	NA	NA	NA	NA
108-67-8	1,3,5-Trimethylbenzene	NA	1.0E-02	6.2E-02	5.0E-01	1.2E+00	NA	2.6E-01	NA	NA	NA	NA
75-01-4	Vinyl chloride	7.2E-01	3.0E-03	8.4E-03	2.4E-01	5.7E-01	1.0E+00	2.5E-02	1.2E-02	2.0E+03	2.6E+01	2.6E+01
1330-20-7	Xylenes	NA	2.0E-01	5.0E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	9.1E-02	1.8E+04	NA	1.8E+04
Semi-Volatiles												
83-32-9	Acenaphthene	NA	6.0E-02	8.6E-02	7.7E-01	1.8E+00	NA	4.1E-01	NA	NA	NA	NA
208-96-8	Acenaphthylene	NA	NA	9.1E-02	NA	NA	NA	NA	NA	NA	NA	NA
120-12-7	Anthracene	NA	3.0E-01	1.4E-01	1.0E+00	2.5E+00	NA	7.3E-01	NA	NA	NA	NA
56-55-3	Benzo(a)anthracene	7.3E-01	NA	--	2.0E+00	4.8E+00	1.0E+00	3.2E+00	--	NA	NA	NA
50-32-8	Benzo(a)pyrene	7.3E+00	NA	--	2.7E+00	6.5E+00	1.0E+00	4.4E+00	--	NA	NA	NA
205-99-2	Benzo(b)fluoranthene	7.3E-01	NA	--	2.7E+00	6.5E+00	1.0E+00	2.5E+00	--	NA	NA	NA
191-24-2	Benzo(g,h,i)perylene	NA	NA	1.1E+00	NA	NA	NA	NA	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	7.3E-02	NA	--	2.7E+00	6.5E+00	NA	4.2E+00	NA	NA	NA	NA
218-01-9	Chrysene	7.3E-03	NA	--	2.0E+00	4.8E+00	1.0E+00	3.5E+00	--	NA	NA	NA
53-70-3	Dibenz(a,h)anthracene	7.3E+00	NA	--	3.8E+00	9.1E+00	6.0E-01	6.1E+00	--	NA	NA	NA
105-67-9	2,4-Dimethylphenol	NA	2.0E-02	1.1E-02	5.1E-01	1.2E+00	1.0E+00	4.6E-02	2.1E-02	7.7E+03	NA	7.7E+03
84-74-2	Di-n-butylphthalate	NA	1.0E-01	4.2E-02	3.8E+00	9.1E+00	9.0E-01	2.7E-01	2.0E-01	4.1E+03	NA	4.1E+03
206-44-0	Fluoranthene	NA	4.0E-02	--	1.4E+00	3.4E+00	1.0E+00	1.7E+00	--	NA	NA	NA
86-73-7	Fluorene	NA	4.0E-02	1.1E-01	9.0E-01	2.2E+00	NA	5.5E-01	NA	NA	NA	NA
193-39-5	Indeno(1,2,3-cd)pyrene	7.3E-01	NA	--	3.7E+00	8.9E+00	6.0E-01	7.9E+00	--	NA	NA	NA
90-12-0	1-Methylnaphthalene	2.9E-02	7.0E-02	9.3E-02	6.6E-01	1.6E+00	NA	4.3E-01	NA	NA	NA	NA
91-57-6	2-Methylnaphthalene	NA	4.0E-03	9.2E-02	6.6E-01	1.6E+00	NA	4.2E-01	NA	NA	NA	NA
95-48-7	2-Methylphenol	NA	5.0E-02	7.7E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	1.4E-02	3.0E+04	NA	3.0E+04
108-39-4	3-Methylphenol	NA	5.0E-02	7.8E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	1.4E-02	3.0E+04	NA	3.0E+04
106-44-5	4-Methylphenol	NA	1.0E-01	7.5E-03	4.2E-01	1.0E+00	1.0E+00	3.0E-02	1.4E-02	6.1E+04	NA	6.1E+04
34mp	3&4-Methylphenol [g]	--	--	--	--	--	--	--	--	3.0E+04	NA	3.0E+04
91-20-3	Naphthalene	NA	2.0E-02	4.7E-02	5.5E-01	1.3E+00	1.0E+00	2.0E-01	9.5E-02	1.7E+03	NA	1.7E+03
85-01-8	Phenanthrene	NA	NA	--	1.1E+00	2.5E+00	1.0E+00	7.0E-01	--	NA	NA	NA
108-95-2	Phenol	NA	3.0E-01	4.3E-03	3.5E-01	8.5E-01	1.0E+00	1.6E-02	7.4E-03	3.4E+05	NA	3.4E+05
129-00-0	Pyrene	NA	3.0E-02	2.0E-01	1.4E+00	3.4E+00	NA	1.1E+00	NA	NA	NA	NA

Table B-9
Tier II Water Action Levels
Industrial Worker Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Values [a]		Dermal Factors [a]						Industrial Worker (IW) ALs [c]		
CAS #	Chemical Name	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA_{event} [b] cm/event	IW Dermal (NC) [d] (µg/L)	IW Dermal (C) [e] (µg/L)	Lowest IW AL [f] (µg/L)
Metals												
7429-90-5	Aluminum	--	--	--	--	--	--	2.0E-03	--	--	--	--
7440-36-0	Antimony	NA	6.0E-05	1.0E-03	5.1E-01	1.2E+00	--	4.2E-03	1.0E-03	5.0E+02	NA	5.0E+02
7440-38-2	Arsenic	1.5E+00	3.0E-04	1.0E-03	2.8E-01	6.6E-01	--	3.3E-03	1.0E-03	2.5E+03	1.5E+02	1.5E+02
7440-39-3	Barium	NA	1.4E-02	1.0E-03	6.2E-01	1.5E+00	--	4.5E-03	1.0E-03	1.2E+05	NA	1.2E+05
7440-43-9	Cadmium (food)	NA	2.5E-05	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	--	--	--	--
7440-43-9	Cadmium (water)	NA	2.5E-05	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	1.0E-03	2.1E+02	NA	2.1E+02
7440-47-3	Chromium	NA	NA	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	1.0E-03	NA	NA	NA
16065-83-1	Chromium (III)	NA	2.0E-02	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	1.0E-03	1.6E+05	NA	1.6E+05
18540-29-9	Chromium (VI)	2.0E+01	7.5E-05	2.0E-03	2.1E-01	4.9E-01	--	5.5E-03	2.0E-03	3.1E+02	5.8E+00	5.8E+00
7440-50-8	Copper	NA	4.0E-02	1.0E-03	2.4E-01	5.7E-01	--	3.1E-03	1.0E-03	3.3E+05	NA	3.3E+05
7439-92-1	Lead	NA	NA	1.0E-04	1.5E+00	3.7E+00	--	5.5E-04	1.0E-04	NA	NA	NA
7439-96-5	Manganese	--	--	1.0E-03	2.1E-01	5.1E-01	--	2.9E-03	--	--	--	--
7487-94-7	Mercury (inorganic salts) [h]	NA	2.1E-05	1.0E-03	3.5E+00	8.4E+00	--	6.3E-03	1.0E-03	1.7E+02	NA	1.7E+02
7439-97-6	Mercury (elemental) [h]	NA	NA	1.0E-03	1.4E+00	3.4E+00	--	5.4E-03	1.0E-03	NA	NA	NA
7440-02-0	Nickel	NA	8.0E-04	2.0E-04	2.2E-01	5.4E-01	--	5.9E-04	2.0E-04	3.3E+04	NA	3.3E+04
7782-49-2	Selenium	NA	5.0E-03	1.0E-03	2.9E-01	7.0E-01	--	3.4E-03	1.0E-03	4.1E+04	NA	4.1E+04
7440-22-4	Silver	NA	2.0E-04	6.0E-04	4.2E-01	1.0E+00	--	2.4E-03	6.0E-04	2.8E+03	NA	2.8E+03
7440-62-2	Vanadium	NA	1.3E-04	1.0E-03	2.0E-01	4.9E-01	--	2.7E-03	1.0E-03	1.1E+03	NA	1.1E+03
7440-66-6	Zinc	NA	3.0E-01	6.0E-04	2.4E-01	5.9E-01	--	1.9E-03	6.0E-04	4.1E+06	NA	4.1E+06
Inorganics												
57-12-5	Cyanide	NA	6.0E-04	1.0E-03	1.5E-01	3.5E-01	NA	2.0E-03	1.0E-03	5.0E+03	NA	5.0E+03

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFd: dermal slope factor
RfDd: dermal reference dose
Kp: dermal permeability coefficient of compound in water
τ: lag time per event
t*: time to reach steady state
FA: fraction absorbed water
B: ratio of the permeability coefficient of a compound through th
stratum corneum relative to its permeability coefficient across
the viable epidermis
DA_{event}: dermally absorbed dose per exposure event
AL: action level
NC: noncarcinogen
C: carcinogen
mg/kg-d: milligrams per kilogram body weight per day
cm/hr: centimeters per hour
hr/event: hours per event
cm/event: centimeters per event
µg/L: micrograms per liter
NA: not available
--: not applicable

Footnotes:

[a] Toxicity values and dermal factors (Kp, τ, FA, and B) from Table 4. t* = 2.4*τ (EPA 2004).

[b] For organics, where $t_{event} \leq t^*$, $DA_{event} = 2*FA*Kp*(6*\tau*t_{event}/\pi)^{0.5}$

For organics, where $t_{event} > t^*$, $DA_{event} = FA*Kp*((t_{event}/1+B) + (2*\tau*(1+3*B+3*B^2/(1+B)^2)$

For inorganics, $DA_{event} = Kp*t_{event}$

DA_{event} equations are from EPA (2004). t_{event} is shown in Table B-5.

[c] Exposure factors are provided in Table B-5. Equations provided below modified from EPA (2004).

[d] IW Dermal (NC) AL = $(THQ*BW*ATnc*365\ d/yr*CF_3) / (EF*ED*EV*(1/RfDd)*SAw*DA_{event}*CF_2)$

[e] IW Dermal (C) AL = $(TR*BW*ATc*365\ d/yr*CF_3) / (EF*ED*EV*SFd*SAw*DA_{event}*CF_2)$

[f] Value is the lower of noncarcinogen and carcinogen values.

[h] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[i] Values for elemental mercury were used, where available, to calculate water ALs for mercury; otherwise, values for inorganic salts were used.

References:

U.S. Environmental Protection Agency (EPA). 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005. July.

Table B-10
Tier II Soil Action Levels
Future Resident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]				Subsistence User ALs												
			Oral		Dermal		Inhalation						Noncarcinogen [b]					Carcinogen [b]							
CAS #	Chemical Name	Mutagen? [a]	SFo $(mg/kg\text{-}d)^{-1}$	RfDo (mg/kg-d)	SFd $(mg/kg\text{-}d)^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi $(mg/m^3)^{-1}$	VF / PEF (m^3/kg)	ABSd (Unitless)	BV (Unitless)	BTF (d/kg)	SU - Soil Ingestion (NC) [c] (mg/kg)	SU - Dermal (NC) [d] (mg/kg)	SU - Inhalation (NC) [e] (mg/kg)	SU - Diet (NC) [f] (mg/kg)	SU - Total (NC) [g] (mg/kg)	SU - Soil Ingestion (C) [h] (mg/kg)	SU - Dermal (C) [i] (mg/kg)	SU - Inhalation (C) [j] (mg/kg)	SU - Diet (C) [k] (mg/kg)	SU - Total (C) [g] (mg/kg)	Csat [l] (mg/kg)	Lowest Total AL [m] (mg/kg)	
Volatiles																									
67-64-1	Acetone	No	NA	9.0E-01	NA	9.0E-01	3.1E+01	NA	2.0E+04	0.0E+00	1.1E+01	1.4E-08	2.5E+04	NA	1.2E+05	1.6E+07	2.0E+04	NA	NA	NA	NA	NA	1.1E+05	2.0E+04	
107-02-8	Acrolein	No	NA	5.0E-04	NA	5.0E-04	2.0E-05	NA	1.1E+04	0.0E+00	7.8E+00	2.4E-08	1.4E+01	NA	3.9E-02	7.0E+03	3.9E-02	NA	NA	NA	NA	NA	2.3E+04	3.9E-02	
71-43-2	Benzene	No	5.5E-02	4.0E-03	5.5E-02	4.0E-03	3.0E-02	7.8E-03	3.0E+03	0.0E+00	4.5E-01	3.4E-06	1.1E+02	NA	1.6E+01	7.1E+03	1.4E+01	4.4E+01	NA	1.9E+00	1.6E+03	1.8E+00	1.8E+03	1.8E+00	
78-93-3	2-Butanone	No	NA	6.0E-01	NA	6.0E-01	5.0E+00	NA	1.7E+04	0.0E+00	5.2E+00	4.9E-08	1.6E+04	NA	1.6E+04	6.3E+06	8.1E+03	NA	NA	NA	NA	NA	2.8E+04	8.1E+03	
56-23-5	Carbon tetrachloride	No	7.0E-02	4.0E-03	7.0E-02	4.0E-03	1.0E-01	6.0E-03	1.9E+03	0.0E+00	1.8E-01	1.7E-05	1.1E+02	NA	3.4E+01	3.6E+03	2.6E+01	3.5E+01	NA	1.5E+00	6.3E+02	1.5E+00	4.6E+02	1.5E+00	
108-90-7	Chlorobenzene	No	NA	2.0E-02	NA	2.0E-02	5.0E-02	NA	4.9E+03	0.0E+00	1.7E-01	1.7E-05	5.5E+02	NA	4.5E+01	1.8E+04	4.1E+01	NA	NA	NA	NA	NA	7.6E+02	4.1E+01	
75-00-3	Chloroethane	No	NA	NA	NA	NA	1.0E+01	NA	1.7E+03	0.0E+00	1.1E+00	6.7E-07	NA	NA	3.0E+03	NA	3.0E+03	NA	NA	NA	NA	NA	2.1E+03	3.0E+03	s
67-66-3	Chloroform	No	3.1E-02	1.0E-02	3.1E-02	1.0E-02	9.8E-02	2.3E-02	2.9E+03	0.0E+00	5.5E-01	2.3E-06	2.7E+02	NA	5.3E+01	2.1E+04	4.4E+01	7.8E+01	NA	6.3E-01	3.3E+03	6.2E-01	2.5E+03	6.2E-01	
106-93-4	1,2-Dibromoethane	No	2.0E+00	9.0E-03	2.0E+00	9.0E-03	9.0E-03	6.0E-01	8.9E+03	0.0E+00	5.6E-01	2.3E-06	2.5E+02	NA	1.5E+01	1.9E+04	1.4E+01	1.2E+00	NA	7.3E-02	5.1E+01	6.8E-02	1.3E+03	6.8E-02	
95-50-1	1,2-Dichlorobenzene	No	NA	9.0E-02	NA	9.0E-02	2.0E-01	NA	8.4E+03	0.0E+00	7.9E-02	6.7E-05	2.5E+03	NA	3.1E+02	4.5E+04	2.7E+02	NA	NA	NA	NA	NA	3.8E+02	2.7E+02	
75-34-3	1,1-Dichloroethane	No	5.7E-03	2.0E-01	5.7E-03	2.0E-01	NA	1.6E-03	2.4E+03	0.0E+00	7.1E-01	1.5E-06	5.5E+03	NA	NA	4.9E+05	5.4E+03	4.3E+02	NA	7.3E+00	2.1E+04	7.2E+00	1.7E+03	7.2E+00	
107-06-2	1,2-Dichloroethane	No	9.1E-02	6.0E-03	9.1E-02	6.0E-03	7.0E-03	2.6E-02	4.7E+03	0.0E+00	1.1E+00	7.6E-07	1.6E+02	NA	6.0E+00	2.0E+04	5.8E+00	2.7E+01	NA	8.9E-01	1.8E+03	8.7E-01	3.0E+03	8.7E-01	
75-35-4	1,1-Dichloroethene	No	NA	5.0E-02	NA	5.0E-02	2.0E-01	NA	1.5E+03	0.0E+00	4.5E-01	3.4E-06	1.4E+03	NA	5.5E+01	8.8E+04	5.3E+01	NA	NA	NA	NA	NA	1.2E+03	5.3E+01	
156-59-2	cis-1,2-Dichloroethene	No	NA	2.0E-03	NA	2.0E-03	NA	NA	2.7E+03	0.0E+00	6.4E-01	1.8E-06	5.5E+01	NA	NA	4.6E+03	5.4E+01	NA	NA	NA	NA	NA	2.4E+03	5.4E+01	
156-60-5	trans-1,2-Dichloroethene	No	NA	2.0E-02	NA	2.0E-02	NA	NA	2.0E+03	0.0E+00	4.7E-01	3.1E-06	5.5E+02	NA	NA	3.7E+04	5.4E+02	NA	NA	NA	NA	NA	1.9E+03	5.4E+02	
60-29-7	Diethyl ether	No	NA	2.0E-01	NA	2.0E-01	NA	NA	4.2E+03	0.0E+00	2.4E+00	1.9E-07	5.5E+03	NA	NA	1.2E+06	5.4E+03	NA	NA	NA	NA	NA	1.0E+04	5.4E+03	
123-91-1	1,4-Dioxane	No	1.0E-01	3.0E-02	1.0E-01	3.0E-02	3.0E-02	5.0E-03	5.9E+04	1.0E-01	1.1E+01	1.3E-08	8.2E+02	3.5E+03	3.2E+02	5.4E+05	2.2E+02	2.4E+01	8.6E+01	5.8E+01	8.8E+03	1.4E+01	1.2E+05	1.4E+01	
100-41-4	Ethylbenzene	No	1.1E-02	1.0E-01	1.1E-02	1.0E-01	1.0E+00	2.5E-03	4.1E+03	0.0E+00	1.2E-01	3.5E-05	2.7E+03	NA	7.6E+02	6.6E+04	5.9E+02	2.2E+02	NA	8.1E+00	2.9E+03	7.8E+00	4.8E+02	7.8E+00	
50-00-0	Formaldehyde	No	NA	2.0E-01	NA	2.0E-01	9.8E-03	1.3E-02	1.2E+05	1.0E-01	4.8E+00	5.6E-08	5.5E+03	2.3E+04	2.1E+02	2.0E+06	2.0E+02	NA	NA	4.5E+01	NA	4.5E+01	4.2E+04	4.5E+01	
67-56-1	Methanol	No	NA	2.0E+00	NA	2.0E+00	2.0E+01	NA	4.5E+04	1.0E-01	2.2E+01	4.3E-09	5.5E+04	2.3E+05	1.6E+05	5.8E+07	3.5E+04	NA	NA	NA	NA	NA	1.1E+05	3.5E+04	
75-09-2	Methylene chloride	Yes	2.0E-03	6.0E-03	2.0E-03	6.0E-03	6.0E-01	1.0E-05	2.6E+03	0.0E+00	1.5E+00	4.5E-07	1.6E+02	NA	2.9E+02	2.5E+04	1.0E+02	2.7E+02	NA	4.7E+02	3.0E+04	1.7E+02	3.3E+03	1.0E+02	
108-10-1	4-Methyl-2-pentanone	No	NA	8.0E-02	NA	8.0E-02	3.0E+00	NA	1.3E+04	0.0E+00	1.3E+00	5.1E-07	2.2E+03	NA	7.3E+03	3.1E+05	1.7E+03	NA	NA	NA	NA	NA	3.4E+03	1.7E+03	
103-65-1	n-Propylbenzene	No	NA	1.0E-01	NA	1.0E-01	1.0E+00	NA	4.9E+03	0.0E+00	5.6E-02	1.2E-04	2.7E+03	NA	8.9E+02	3.9E+04	6.6E+02	NA	NA	NA	NA	NA	2.6E+02	6.6E+02	s
127-18-4	Tetrachloroethene	No	2.1E-03	6.0E-03	2.1E-03	6.0E-03	4.0E-02	2.6E-04	2.4E+03	0.0E+00	8.2E-02	6.3E-05	1.6E+02	NA	1.7E+01	3.1E+03	1.6E+01	1.2E+03	NA	4.5E+01	1.2E+04	4.3E+01	1.7E+02	1.6E+01	
108-88-3	Toluene	No	NA	8.0E-02	NA	8.0E-02	5.0E+00	NA	3.4E+03	0.0E+00	2.0E-01	1.3E-05	2.2E+03	NA	3.1E+03	7.9E+04	1.3E+03	NA	NA	NA	NA	NA	8.2E+02	1.3E+03	s
71-55-6	1,1,1-Trichloroethane	No	NA	2.0E+00	NA	2.0E+00	5.0E+00	NA	1.9E+03	0.0E+00	2.8E-01	7.7E-06	5.5E+04	NA	1.8E+03	2.5E+06	1.7E+03	NA	NA	NA	NA	NA	6.4E+02	1.7E+03	s
79-01-6	Trichloroethene	Yes	4.6E-02	5.0E-04	4.6E-02	5.0E-04	2.0E-03	4.1E-03	2.3E+03	0.0E+00	3.0E-01	6.6E-06	1.4E+01	NA	8.4E-01	6.7E+02	7.9E-01	3.1E+01	NA	1.9E+00	9.5E+02	1.8E+00	6.9E+02	7.9E-01	
95-63-6	1,2,4-Trimethylbenzene	No	NA	5.0E-02	NA	5.0E-02	7.0E-03	NA	5.6E+03	0.0E+00	6.0E-02	1.1E-04	1.4E+03	NA	7.1E+00	2.1E+04	7.1E+00	NA	NA	NA	NA	NA	2.2E+02	7.1E+00	
108-67-8	1,3,5-Trimethylbenzene	No	NA	1.0E-02	NA	1.0E-02	6.0E-03	NA	4.7E+03	0.0E+00	8.0E-02	6.6E-05	2.7E+02	NA	5.2E+00	5.1E+03	5.1E+00	NA	NA	NA	NA	NA	1.8E+02	5.1E+00	
75-01-4	Vinyl chloride	Yes	7.2E-01	3.0E-03	7.2E-01	3.0E-03	1.0E-01	4.4E-03	1.3E+03	0.0E+00	8.9E-01	1.0E-06	8.2E+01	NA	2.4E+01	8.7E+03	1.9E+01	1.0E-01	NA	2.5E-01	3.3E+01	7.2E-02	3.9E+03	7.2E-02	
1330-20-7	Xylenes	No	NA	2.0E-01	NA	2.0E-01	1.0E-01	NA	4.7E+03	0.0E+00	1.1E-01	3.6E-05	5.5E+03	NA	8.7E+01	1.3E+05	8.5E+01	NA	NA	NA	NA	NA	2.6E+02	8.5E+01	
Semi-Volatiles																									
83-32-9	Acenaphthene	No	NA	6.0E-02	NA	6.0E-02	NA	NA	9.2E+04	1.3E-01	4.1E-02	2.1E-04	1.6E+03	5.3E+03	NA	1.9E+04	1.2E+03	NA	NA	NA	NA	NA	NA	1.2E+03	
208-96-8	Acenaphthylene	No	NA	NA	NA	NA	NA	NA	1.2E+05	1.3E-01	4.0E-02	2.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
120-12-7	Anthracene	No	NA	3.0E-01	NA	3.0E-01	NA	NA	3.4E+05	1.3E-01	2.0E-02	7.1E-04	8.2E+03	2.7E+04	NA	5.6E+04	5.6E+03	NA	NA	NA	NA	NA	NA	5.6E+03	
56-55-3	Benzo(a)anthracene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	2.8E+06	1.3E-01	3.5E-03	1.4E-02	NA	NA	NA	NA	NA	7.3E-01	2.2E+00	4.6E+01	1.0E+00	3.6E-01	NA	3.6E-01	
50-32-8	Benzo(a)pyrene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.1E+00	4.6E+09	1.3E-01	2.1E-03	3.4E-02	NA	NA	NA	NA	NA	7.3E-02	2.2E-01	7.5E+03	7.3E-02	3.1E-02	NA	3.1E-02	
205-99-2	Benzo(b)fluoranthene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	4.6E+09	1.3E-01	3.4E-03	1.5E-02	NA	NA	NA	NA	NA	7.3E-01	2.2E+00	7.5E+04	1.0E+00	3.6E-01	NA	3.6E-01	
191-24-2	Benzo(g,h,i)perylene	No	NA	NA	NA	NA	NA	NA	4.6E+09	1.3E-01	1.1E-03	1.1E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
207-08-9	Benzo(k)fluoranthene	Yes	7.3E-02	NA	7.3E-02	NA	NA	1.1E-01	4.6E+09	1.3E-01	2.2E-03	3.2E-02	NA	NA	NA	NA	NA	7.3E+00	2.2E+01	7.5E+04	7.4E+00	3.2E+00	NA	3.2E+00	
218-01-9	Chrysene	Yes	7.3E-03	NA	7.3E-03	NA	NA	1.1E-02	4.6E+09	1.3E-01	3.3E-03	1.6E-02	NA	NA	NA	NA	NA	7.3E+01	2.2E+02	7.5E+05	9.9E+01	3.5E+01	NA	3.5E+01	
53-70-3	Dibenz(a,h)anthracene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.2E+00	4.6E+09	1.3E-01	9.4E-04	1.4E-01	NA	NA	NA	NA	NA	7.3E-02	2.2E-01	6.8E+03	4.0E-02	2.3E-02	NA	2.3E-02	
105-67-9	2,4-Dimethylphenol	No	NA	2.0E-02	NA	2.0E-02	NA	NA	4.6E+09	1.0E-01	3.6E-01	5.0E-06	5.5E+02	2.3E+03	NA	3.0E+04	4.4E+02	NA	NA	NA	NA	NA	NA	4.4E+02	
84-74-2	Di-n-butylphthalate	No	NA	1.0E-01	NA	1.0E-01	NA	NA	4.6E+09	1.0E-01	1.9E-02	7.9E-04	2.7E+03	1.2E+04	NA	1.8E+04	2.0E+03	NA	NA	NA	NA	NA	NA	2.0E+03	
206-44-0	Fluoranthene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	4.6E+09	1.3E-01	7.8E-03	3.6E-03	1.1E+03	3.5E+03	NA	3.8E+03	6.8E+02	NA	NA	NA	NA	NA	NA	6.8E+02	
86-73-7	Fluorene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.8E+05	1.3E-01	2.9E-02	3.8E-04	1.1E+03	3.5E+03	NA	9.7E+03	7.7E+02	NA	NA	NA	NA	NA	NA	7.7E+02	
193-39-5	Indeno(1,2,3-cd)pyrene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	4.6E+09	1.3E-01	1.0E-03	1.3E-01	NA	NA	NA	NA	NA	7.3E-01	2.2E+00	7.5E+04	4.2E-01	2.4E-01	NA	2.4E-01	
90-12-0	1-Methylnaphthalene	No	2.9E-02	7.0E-02	2.9E-02	7.0E-02	NA	NA	3.8E+04	1.3E-01	4.4E-02	1.9E-04	1.9E+03	6.2E+03	NA	2.3E+04	1.4E+03	8.4E+01	2.3E+02	NA	5.5E+02	5.5E+01	NA	5.5E+01	
91-57-6	2-Methylnaphthalene	No	NA	4.0E-03	NA	4.0E-03	NA	NA	3.8E+04	1.3E-01	4.4E-02	1.8E-04	1.1E+02	3.5E+02	NA	1.3E+03	7.9E+01	NA	NA	NA	NA	NA	NA	7.9E+01	
95-48-7	2-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	4.6E+09	1.0E-01	5.7E-01	2.2E-06	1.4E+03	5.8E+03	5.1E+08	1.1E+05	1.1E+03	NA	NA	NA	NA	NA	NA	1.1E+03	
108-39-4	3-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	4.6E+09	1.0E-01	5.6E-01	2.3E-06	1.4E+03	5.8E+03	5.1E+08	1.0E+05	1.1E+03	NA	NA	NA	NA	NA	NA	1.1E+03	
106-44-5	4-Methylphenol	No	NA	1.0E-01	NA	1.0E-01	6.0E-01	NA	4.6E+09	1.0E-01	5.8E-01	2.2E-06	2.7E+03	1.2E+04	5.1E+08	2.1E+05	2.2E+03	NA	NA	NA	NA	NA	NA	2.2E+03	
34mp	3&4-Methylphenol [n]	--	--	--	--	--	--	--	--	--	--	--	1.4E+03	5.8E+03	5.1E+08	1.0E+05	1.1E+03	NA	NA	NA	NA	NA	--	1.1E+03	
91-20-3	Naphthalene	No	NA	2.0E-02	NA	2.0E-02	3.0E-03	3.4E-02	3.1E+04	1.3E-01	9.4E-02	5.0E-05	5.5E+02	1.8E+03	1.7E+01	1.1E+04	1.6E+01	NA	NA	4.4E+00	NA	4.4E+00	NA	4.4E+00	
85-01-8	Phenanthrene	No	NA	NA	NA	NA	NA	NA	4.2E+05	1.3E-01	2.0E-02	7.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
108-95-2	Phenol	No	NA	3.0E-01	NA	3.0E-01	2.0E-01	NA	4.6E+09	1.0E-01	1.1E+00	7.2E-07	8.2E+03	3.5E+04	1.7E+08	1.0E+06	6.6E+03	NA	NA	NA	NA	NA	NA	6.6E+03	
129-00-0	Pyrene	No	NA	3.0E-02	NA	3.0E-02	NA	NA	1.5E+06	1.3E-01	1.1E-02	1.9E-03	8.2E+02	2.7E+03	NA	3.7E+03	5.4E+02	NA	NA	NA	NA	NA	NA	5.4E+02	

Table B-10
Tier II Soil Action Levels
Future Resident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]				Subsistence User ALs											
			Oral		Dermal		Inhalation						Noncarcinogen [b]					Carcinogen [b]						
CAS #	Chemical Name	Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	VF / PEF (m^3/kg)	ABSd (Unitless)	BV (Unitless)	BTF (d/kg)	SU - Soil Ingestion (NC) [c] (mg/kg)	SU - Dermal (NC) [d] (mg/kg)	SU - Inhalation (NC) [e] (mg/kg)	SU - Diet (NC) [f] (mg/kg)	SU - Total (NC) [g] (mg/kg)	SU - Soil Ingestion (C) [h] (mg/kg)	SU - Dermal (C) [i] (mg/kg)	SU - Inhalation (C) [j] (mg/kg)	SU - Diet (C) [k] (mg/kg)	SU - Total (C) [g] (mg/kg)	Csat [l] (mg/kg)	Lowest Total AL [m] (mg/kg)
Metals																								
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	No	NA	4.0E-04	NA	6.0E-05	NA	NA	4.6E+09	0.0E+00	5.0E-02	1.0E-03	1.1E+01	NA	NA	2.1E+01	7.2E+00	NA	NA	NA	NA	NA	NA	7.2E+00
7440-38-2	Arsenic [o]	No	1.5E+00	3.0E-04	1.5E+00	3.0E-04	1.5E-05	4.3E+00	4.6E+09	3.0E-02	1.0E-02	2.0E-03	1.4E+01	1.2E+02	1.3E+04	4.0E+01	9.4E+00	2.7E+00	1.9E+01	5.3E+03	4.3E+00	1.5E+00	NA	1.5E+00
7440-39-3	Barium	No	NA	2.0E-01	NA	1.4E-02	5.0E-04	NA	4.6E+09	0.0E+00	3.8E-02	1.5E-04	5.5E+03	NA	4.2E+05	9.5E+04	5.1E+03	NA	NA	NA	NA	NA	NA	5.1E+03
7440-43-9	Cadmium (food)	No	NA	1.0E-03	NA	2.5E-05	1.0E-05	1.8E+00	4.6E+09	1.0E-03	1.3E-01	5.5E-04	2.7E+01	2.9E+02	8.4E+03	3.9E+01	1.5E+01	NA	NA	1.3E+04	NA	1.3E+04	NA	1.5E+01
7440-43-9	Cadmium (water)	No	NA	5.0E-04	NA	2.5E-05	1.0E-05	1.8E+00	--	1.0E-03	1.4E-01	5.5E-04	--	--	--	--	--	--	--	--	--	--	--	--
7440-47-3	Chromium	No	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.9E-03	5.5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
16065-83-1	Chromium (III)	No	NA	1.5E+00	NA	2.0E-02	NA	NA	4.6E+09	0.0E+00	1.9E-03	5.5E-03	4.1E+04	NA	NA	3.9E+05	3.7E+04	NA	NA	NA	NA	NA	NA	3.7E+04
18540-29-9	Chromium (VI)	Yes	5.0E-01	3.0E-03	2.0E+01	7.5E-05	1.0E-04	8.4E+01	4.6E+09	0.0E+00	1.9E-03	5.5E-03	8.2E+01	NA	8.4E+04	7.7E+02	7.4E+01	1.1E+00	NA	9.8E+01	7.4E+00	9.3E-01	NA	9.3E-01
7440-50-8	Copper	No	NA	4.0E-02	NA	4.0E-02	NA	NA	4.6E+09	0.0E+00	1.0E-01	1.0E-02	1.1E+03	NA	NA	1.1E+02	9.7E+01	NA	NA	NA	NA	NA	NA	9.7E+01
7439-92-1	Lead	No	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.1E-02	4.0E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7439-96-5	Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7487-94-7	Mercury (inorganic salts) [p]	No	NA	3.0E-04	NA	2.1E-05	3.0E-04	NA	4.6E+09	0.0E+00	2.3E-01	2.5E-01	8.2E+00	NA	2.5E+05	1.4E-02	1.4E-02	NA	NA	NA	NA	NA	NA	1.4E-02
7439-97-6	Mercury (elemental) [p]	No	NA	NA	NA	NA	3.0E-04	NA	--	0.0E+00	2.3E-01	2.5E-01	--	--	--	--	--	--	--	--	--	--	--	--
7440-02-0	Nickel	No	NA	2.0E-02	NA	8.0E-04	9.0E-05	2.6E-01	4.6E+09	0.0E+00	1.5E-02	6.0E-03	5.5E+02	NA	7.6E+04	5.9E+02	2.8E+02	NA	NA	8.7E+04	NA	8.7E+04	NA	2.8E+02
7782-49-2	Selenium	No	NA	5.0E-03	NA	5.0E-03	2.0E-02	NA	4.6E+09	0.0E+00	6.3E-03	1.5E-02	1.4E+02	NA	1.7E+07	1.4E+02	7.0E+01	NA	NA	NA	NA	NA	NA	7.0E+01
7440-22-4	Silver	No	NA	5.0E-03	NA	2.0E-04	NA	NA	4.6E+09	0.0E+00	1.0E-01	3.0E-03	1.4E+02	NA	NA	4.4E+01	3.4E+01	NA	NA	NA	NA	NA	NA	3.4E+01
7440-62-2	Vanadium	No	NA	5.0E-03	NA	1.3E-04	1.0E-04	NA	4.6E+09	0.0E+00	1.4E-03	2.5E-03	1.4E+02	NA	8.4E+04	3.9E+03	1.3E+02	NA	NA	NA	NA	NA	NA	1.3E+02
7440-66-6	Zinc	No	NA	3.0E-01	NA	3.0E-01	NA	NA	4.6E+09	0.0E+00	2.6E-01	1.0E-01	8.2E+03	NA	NA	3.0E+01	3.0E+01	NA	NA	NA	NA	NA	NA	3.0E+01
Inorganics																								
57-12-5	Cyanide	No	NA	6.0E-04	NA	6.0E-04	8.0E-04	NA	--	0.0E+00	1.1E+01	1.4E-08	1.6E+01	NA	NA	1.1E+04	1.6E+01	NA	NA	NA	NA	NA	9.7E+05	1.6E+01

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFo: oral slope factor
RfDo: oral reference dose
SFd: dermal slope factor
RfDd: dermal reference dose
RfCi: inhalation reference concentration
URFi: inhalation unit risk factor
VF: volatilization factor
PEF: particulate emission factor
ABSd: dermal absorption factor
BV: soil-to-wet-plant uptake factor
BTF: beef transfer coefficient
AL: action level
SU: subsistence user
NC: noncarcinogen
C: carcinogen
Csat: soil saturation concentration
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
m^3/kg: cubic meters per kilogram
NA: not available
--: not applicable
TCE: trichloroethene
s: concentration exceeds Csat

Footnotes:

[a] Values and mutagen identification from Table 4.
[b] Exposure factors are provided in Table B-6. Equations provided below modified from ADEC (2008b) and EPA (2015c).
[c] SU Soil Ingestion (NC) AL = (THQ*ATnc,c*BWc*365 d/yr) / (EFs*EDc*(1/RfDo)*CF*IRs,c)
[d] SU Dermal (NC) AL = (THQ*ATnc,c*BWc*365 d/yr) / (EFs*EDc*(1/RfDd)*SAc*AFc*ABSd*CF)
[e] SU Inhalation (NC) AL = (THQ*ATnc,c*365 d/yr) / (EFs,i*EDc*(1/RfCi)*[1/VF or 1/PEF])
[f] SU Diet (NC) AL = (THQ*ATnc,c*BWc*365 d/yr) / (EFd*EDc*(1/RfDo)*CF*IRd,c*AUFs*CRp*BV*BTF)
[g] SU Total AL = 1/((1/soil ingestion AL)+(1/dermal AL)+(1/inhalation AL)+(1/diet AL))
[h] SU Soil Ingestion (C) AL = (TR*ATc*365 d/yr) / (EFs*SFo*IFSadj*CF)
SU Soil Ingestion (Mutagen) AL =(TR*ATc*365 d/yr) / (EFs*SFo*IFSMadj*CF)
SU Soil Ingestion (Vinyl Chloride) AL = TR / (((EFs*SFo*CF*IFSadj)/(ATc*365 d/yr)) + ((SFo*IRs,c*CF)/BWc))
SU Soil Ingestion (TCE) AL =(TR*ATc*365 d/yr) / (EFs*SFo*((CAFo*IFSadj)+(MAFo*IFSMadj))*CF)
[i] SU Dermal (C) AL = (TR*ATc*365 d/yr) / (EFs*SFd*ABSd*DFSadj*CF)
SU Dermal (Mutagen) AL = (TR*ATc*365 d/yr) / (EFs*SFd*ABSd*DFSMadj*CF)
SU Dermal (Vinyl Chloride) AL = TR / (((EFs*DFSadj*SFd*ABSd*CF)/(ATc*365 d/yr)) + ((SFd*SAs,c*AFc*ABSd*CF)/BWc))
SU Dermal (TCE) AL = (TR*ATc*365 d/yr) / (EFs*SFd*ABSd*((CAFo*DFSadj)+(MAFo*DFSMadj))*CF)
[j] SU Inhalation (C) AL = (TR*ATc*365 d/yr) / (EFs,i*ED*URFi*[1/VF or 1/PEF])
SU Inhalation (Mutagen) AL = (TR*ATc*365 d/yr) / (EFs,i*((ED_{0-2}*URFi*10)+(ED_{2-6}*URFi*3)+ (ED_{6-16}*URFi*3)+(ED_{16-26}*URFi*1))*[1/VF or 1/PEF])
SU Inhalation (Vinyl Chloride) AL = TR / (((EFs,i*ED*URFi)/(ATc*365 d/yr*VF)) + (URFi/VF))
SU Inhalation (TCE) AL = (TR*ATc*365 d/yr) / (URFi*EFs*[(CAFi*ED)+((ED_{0-2}*MAFi*10)+(ED_{2-6}*MAFi*3)+ (ED_{6-16}*MAFi*3)+(ED_{16-26}*MAFi*1))]*[1/VF or 1/PEF])
[k] SU Diet (C) AL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*IFDadj*AUFs*CRp*BV*BTF)
SU Diet (Mutagen) AL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*IFDMadj*AUFs*CRp*BV*BTF)
SU Diet (Vinyl Chloride) AL = TR / (((EFd*SFo*CF*IFDadj*AUFs*CRp*BV*BTF)/(ATc*365 d/yr)) + ((SFo*CF*IRd,c*AUFs*CRp*BTF*BV)/BWc))
SU Diet (TCE) AL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*((CAFo*IFDadj*AUFs)+(MAFo*IFDMadj*AUFs))*CRp*BV*BTF)
[l] Values from Table 2.
[m] Lowest of SU - Total (NC) and SU - Total (C). For target analytes that include the inhalation exposure route and have overall ALs that exceed the saturation limit (Csat), the ALs may be overly protective (see EPA, 2015c). If detected chemical concentrations exceed the Csat concentration, more sophisticated modeling may be necessary on a SWMU/AOC-specific basis.
[n] Action levels for the more toxic of the coeluting compounds used to represent this mixture.
[o] The EPA (2012b) default relative bioavailability of 60 percent was incorporated into the soil ingestion components of the arsenic AL.
[p] Values for inorganic mercury salts were used to calculate soil ALs for mercury.

References:

Alaska Department of Environmental Conservation (ADEC). 2008b. Cleanup Levels Guidance. Division of Spill Prevention and Response, Contaminated Sites Program. June 9.
U.S. Environmental Protection Agency (EPA). 2012b. Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil. OSWER 9200.1-113, December.
EPA. 2015c. Regional Screening Level User's Guide. June. http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Table B-11
Tier II Water Action Levels
Future Resident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]								Subsistence User ALs										
			Oral		Dermal		Inhalation		Dermal Factors								Noncarcinogen [c]					Carcinogen [c]					
CAS #	Chemical Name	Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA_{event} (NC) [b] cm/event	DA_{event} (C) [b] cm/event	Fish BCF (L/kg)	SU - Water Ingestion (NC) [d] (µg/L)	SU - Dermal (NC) [e] (µg/L)	SU - Inhalation (NC) [f] (µg/L)	SU - Diet (NC) [g] (µg/L)	SU - Total (NC) [h] (µg/L)	SU - Water Ingestion (C) [i] (µg/L)	SU - Dermal (C) [j] (µg/L)	SU - Inhalation (C) [k] (µg/L)	SU - Diet (C) [l] (µg/L)	SU - Total (C) [h] (µg/L)	Lowest Total AL [m] (µg/L)
Volatiles																											
67-64-1	Acetone	No	NA	9.0E-01	NA	9.0E-01	3.1E+01	NA	5.1E-04	2.2E-01	5.3E-01	NA	1.5E-03	NA	NA	3.2E+00	1.8E+03	NA	6.5E+03	3.9E+04	1.4E+03	NA	NA	NA	NA	NA	1.4E+03
107-02-8	Acrolein	No	NA	5.0E-04	NA	5.0E-04	2.0E-05	NA	7.5E-04	2.2E-01	5.2E-01	1.0E+00	2.2E-03	7.3E-04	--	3.2E+00	1.0E+00	1.7E+02	4.2E-03	2.2E+01	4.2E-03	NA	NA	NA	NA	NA	4.2E-03
71-43-2	Benzene	No	5.5E-02	4.0E-03	5.5E-02	4.0E-03	3.0E-02	7.8E-03	1.5E-02	2.9E-01	6.9E-01	1.0E+00	5.1E-02	1.6E-02	1.8E-02	4.3E+00	8.0E+00	6.0E+01	6.3E+00	1.3E+02	3.2E+00	1.4E+00	9.4E+00	7.2E-01	2.7E+01	4.5E-01	4.5E-01
78-93-3	2-Butanone	No	NA	6.0E-01	NA	6.0E-01	5.0E+00	NA	9.6E-04	2.7E-01	6.4E-01	1.0E+00	3.1E-03	1.0E-03	--	3.2E+00	1.2E+03	1.5E+05	1.0E+03	2.6E+04	5.4E+02	NA	NA	NA	NA	NA	5.4E+02
56-23-5	Carbon tetrachloride	No	7.0E-02	4.0E-03	7.0E-02	4.0E-03	1.0E-01	6.0E-03	1.6E-02	7.6E-01	1.8E+00	1.0E+00	7.8E-02	2.9E-02	3.2E-02	7.4E+00	8.0E+00	3.4E+01	2.1E+01	7.4E+01	4.6E+00	1.1E+00	4.2E+00	9.4E-01	1.2E+01	4.4E-01	4.4E-01
108-90-7	Chlorobenzene	No	NA	2.0E-02	NA	2.0E-02	5.0E-02	NA	2.8E-02	4.5E-01	1.1E+00	1.0E+00	1.2E-01	3.8E-02	--	1.8E+01	4.0E+01	1.3E+02	1.0E+01	1.5E+02	7.4E+00	NA	NA	NA	NA	NA	7.4E+00
75-00-3	Chloroethane	No	NA	NA	NA	NA	1.0E+01	NA	6.1E-03	2.4E-01	5.8E-01	1.0E+00	1.9E-02	6.1E-03	--	4.1E+00	NA	NA	2.1E+03	NA	2.1E+03	NA	NA	NA	NA	NA	2.1E+03
67-66-3	Chloroform	No	3.1E-02	1.0E-02	3.1E-02	1.0E-02	9.8E-02	2.3E-02	6.8E-03	4.9E-01	1.2E+00	1.0E+00	2.9E-02	9.7E-03	1.1E-02	1.3E+01	2.0E+01	2.5E+02	2.0E+01	1.1E+02	8.9E+00	2.5E+00	2.8E+01	2.4E-01	1.6E+01	2.2E-01	2.2E-01
106-93-4	1,2-Dibromoethane	No	2.0E+00	9.0E-03	2.0E+00	9.0E-03	9.0E-03	6.0E-01	2.8E-03	1.2E+00	2.8E+00	1.0E+00	1.5E-02	6.1E-03	6.9E-03	1.5E+01	1.8E+01	3.6E+02	1.9E+00	8.2E+01	1.7E+00	3.9E-02	6.9E-01	9.4E-03	2.1E-01	7.2E-03	7.2E-03
95-50-1	1,2-Dichlorobenzene	No	NA	9.0E-02	NA	9.0E-02	2.0E-01	NA	4.5E-02	7.0E-01	1.7E+00	1.0E+00	2.1E-01	7.6E-02	--	2.7E+02	1.8E+02	2.9E+02	4.2E+01	4.6E+01	1.8E+01	NA	NA	NA	NA	NA	1.8E+01
75-34-3	1,1-Dichloroethane	No	5.7E-03	2.0E-01	5.7E-03	2.0E-01	NA	1.6E-03	6.8E-03	3.8E-01	9.0E-01	1.0E+00	2.6E-02	8.4E-03	9.4E-03	7.1E+00	4.0E+02	5.8E+03	NA	3.9E+03	3.4E+02	1.4E+01	1.8E+02	3.5E+00	1.6E+02	2.7E+00	2.7E+00
107-06-2	1,2-Dichloroethane	No	9.1E-02	6.0E-03	9.1E-02	6.0E-03	7.0E-03	2.6E-02	4.2E-03	3.8E-01	9.0E-01	1.0E+00	1.6E-02	5.2E-03	5.8E-03	4.4E+00	1.2E+01	2.8E+02	1.5E+00	1.9E+02	1.3E+00	8.6E-01	1.8E+01	2.2E-01	1.6E+01	1.7E-01	1.7E-01
75-35-4	1,1-Dichloroethene	No	NA	5.0E-02	NA	5.0E-02	2.0E-01	NA	1.2E-02	3.7E-01	8.8E-01	1.0E+00	4.4E-02	1.4E-02	--	1.3E+01	1.0E+02	8.5E+02	4.2E+01	5.3E+02	2.7E+01	NA	NA	NA	NA	NA	2.7E+01
156-59-2	cis-1,2-Dichloroethene	No	NA	2.0E-03	NA	2.0E-03	NA	NA	1.1E-02	3.7E-01	8.8E-01	NA	4.2E-02	NA	NA	1.1E+01	4.0E+00	NA	NA	2.5E+01	3.5E+00	NA	NA	NA	NA	NA	3.5E+00
156-60-5	trans-1,2-Dichloroethene	No	NA	2.0E-02	NA	2.0E-02	NA	NA	1.1E-02	3.7E-01	8.8E-01	1.0E+00	4.2E-02	1.4E-02	--	1.1E+01	4.0E+01	3.6E+02	NA	2.5E+02	3.2E+01	NA	NA	NA	NA	NA	3.2E+01
60-29-7	Diethyl ether	No	NA	2.0E-01	NA	2.0E-01	NA	NA	2.4E-03	2.7E-01	6.6E-01	1.0E+00	7.8E-03	2.5E-03	--	5.4E+00	4.0E+02	2.0E+04	NA	5.1E+03	3.6E+02	NA	NA	NA	NA	NA	3.6E+02
123-91-1	1,4-Dioxane	No	1.0E-01	3.0E-02	1.0E-01	3.0E-02	3.0E-02	5.0E-03	3.3E-04	3.3E-01	7.9E-01	1.0E+00	1.2E-03	3.9E-04	4.3E-04	5.0E-01	6.0E+01	1.9E+04	6.3E+00	8.2E+03	5.7E+00	7.8E-01	2.2E+02	1.1E+00	1.3E+02	4.6E-01	4.6E-01
100-41-4	Ethylbenzene	No	1.1E-02	1.0E-01	1.1E-02	1.0E-01	1.0E+00	2.5E-03	4.9E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	6.4E-02	7.2E-02	5.6E+01	2.0E+02	3.8E+02	2.1E+02	2.5E+02	6.1E+01	7.1E+00	1.2E+01	2.2E+00	1.0E+01	1.3E+00	1.3E+00
50-00-0	Formaldehyde	No	NA	2.0E-01	NA	2.0E-01	9.8E-03	1.3E-02	1.8E-03	1.5E-01	3.7E-01	1.0E+00	3.8E-03	1.5E-03	--	3.2E+00	4.0E+02	3.2E+04	2.0E+00	8.7E+03	2.0E+00	NA	NA	4.3E-01	NA	4.3E-01	4.3E-01
67-56-1	Methanol	No	NA	2.0E+00	NA	2.0E+00	2.0E+01	NA	3.2E-04	1.6E-01	3.8E-01	1.0E+00	6.9E-04	2.7E-04	--	3.2E+00	4.0E+03	1.8E+06	4.2E+03	8.7E+04	2.0E+03	NA	NA	NA	NA	NA	2.0E+03
75-09-2	Methylene chloride	Yes	2.0E-03	6.0E-03	2.0E-03	6.0E-03	6.0E-01	1.0E-05	3.5E-03	3.1E-01	7.5E-01	1.0E+00	1.3E-02	4.0E-03	4.5E-03	2.3E+01	1.2E+01	3.7E+02	1.3E+02	3.6E+01	8.2E+00	1.3E+01	3.4E+02	2.0E+02	4.1E+01	8.9E+00	8.2E+00
108-10-1	4-Methyl-2-pentanone	No	NA	8.0E-02	NA	8.0E-02	3.0E+00	NA	3.2E-03	3.8E-01	9.2E-01	1.0E+00	1.2E-02	4.0E-03	--	3.4E+00	1.6E+02	4.9E+03	6.3E+02	3.2E+03	1.2E+02	NA	NA	NA	NA	NA	1.2E+02
103-65-1	n-Propylbenzene	No	NA	1.0E-01	NA	1.0E-01	1.0E+00	NA	9.4E-02	5.0E-01	1.2E+00	NA	4.0E-01	NA	NA	1.3E+02	2.0E+02	NA	2.1E+02	1.1E+02	5.3E+01	NA	NA	NA	NA	NA	5.3E+01
127-18-4	Tetrachloroethene	No	2.1E-03	6.0E-03	2.1E-03	6.0E-03	4.0E-02	2.6E-04	3.3E-02	8.9E-01	2.1E+00	1.0E+00	1.7E-01	6.4E-02	7.1E-02	5.2E+01	1.2E+01	2.3E+01	8.3E+00	1.6E+01	3.2E+00	3.7E+01	6.3E+01	2.2E+01	5.8E+01	9.4E+00	3.2E+00
108-88-3	Toluene	No	NA	8.0E-02	NA	8.0E-02	5.0E+00	NA	3.1E-02	3.5E-01	8.3E-01	1.0E+00	1.1E-01	3.7E-02	--	8.3E+00	1.6E+02	5.3E+02	1.0E+03	1.3E+03	1.0E+02	NA	NA	NA	NA	NA	1.0E+02
71-55-6	1,1,1-Trichloroethane	No	NA	2.0E+00	NA	2.0E+00	5.0E+00	NA	1.3E-02	5.9E-01	1.4E+00	1.0E+00	5.6E-02	2.0E-02	--	5.0E+00	4.0E+03	2.5E+04	1.0E+03	5.5E+04	7.9E+02	NA	NA	NA	NA	NA	7.9E+02
79-01-6	Trichloroethene	Yes	4.6E-02	5.0E-04	4.6E-02	5.0E-04	2.0E-03	4.1E-03	1.2E-02	5.7E-01	1.4E+00	1.0E+00	5.1E-02	1.8E-02	2.0E-02	1.6E+01	1.0E+00	6.9E+00	4.2E-01	4.3E+00	2.7E-01	1.2E+00	7.2E+00	9.6E-01	5.9E+00	4.5E-01	2.7E-01
95-63-6	1,2,4-Trimethylbenzene	No	NA	5.0E-02	NA	5.0E-02	7.0E-03	NA	8.6E-02	5.0E-01	1.2E+00	NA	3.6E-01	NA	NA	1.2E+02	1.0E+02	NA	1.5E+00	5.7E+01	1.4E+00	NA	NA	NA	NA	NA	1.4E+00
108-67-8	1,3,5-Trimethylbenzene	No	NA	1.0E-02	NA	1.0E-02	6.0E-03	NA	6.2E-02	5.0E-01	1.2E+00	NA	2.6E-01	NA	NA	1.9E+02	2.0E+01	NA	1.3E+00	7.4E+00	1.0E+00	NA	NA	NA	NA	NA	1.0E+00
75-01-4	Vinyl chloride	Yes	7.2E-01	3.0E-03	7.2E-01	3.0E-03	1.0E-01	4.4E-03	8.4E-03	2.4E-01	5.7E-01	1.0E+00	2.5E-02	8.3E-03	9.5E-03	5.5E+00	6.0E+00	8.9E+01	2.1E+01	7.5E+01	4.2E+00	2.1E-02	2.7E-01	3.4E-01	2.9E-01	1.8E-02	1.8E-02
1330-20-7	Xylenes	No	NA	2.0E-01	NA	2.0E-01	1.0E-01	NA	5.0E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	6.5E-02	--	1.5E+01	4.0E+02	7.5E+02	2.1E+01	1.9E+03	1.9E+01	NA	NA	NA	NA	NA	1.9E+01
Semi-Volatiles																											
83-32-9	Acenaphthene	No	NA	6.0E-02	NA	6.0E-02	NA	NA	8.6E-02	7.7E-01	1.8E+00	NA	4.1E-01	NA	NA	7.6E+02	1.2E+02	NA	NA	1.1E+01	1.0E+01	NA	NA	NA	NA	NA	1.0E+01
208-96-8	Acenaphthylene	No	NA	NA	NA	NA	NA	NA	9.1E-02	NA	NA	NA	NA	NA	NA	2.7E+02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
120-12-7	Anthracene	No	NA	3.0E-01	NA	3.0E-01	NA	NA	1.4E-01	1.0E+00	2.5E+00	NA	7.3E-01	NA	NA	1.8E+03	6.0E+02	NA	NA	2.3E+01	2.2E+01	NA	NA	NA	NA	NA	2.2E+01
56-55-3	Benzo(a)anthracene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	2.0E+00	4.8E+00	1.0E+00	3.2E+00	--	--	2.6E+02	NA	NA	NA	NA	NA	3.4E-02	NA	1.8E-02	1.0E-02	5.5E-03	5.5E-03
50-32-8	Benzo(a)pyrene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.1E+00	--	2.7E+00	6.5E+00	1.0E+00	4.4E+00	--	--	5.2E+03	NA	NA	--	NA	NA	3.4E-03	NA	--	5.1E-05	5.0E-05	5.0E-05
205-99-2	Benzo(b)fluoranthene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	2.7E+00	6.5E+00	1.0E+00	2.5E+00	--	--	3.0E+03	NA	NA	--	NA	NA	3.4E-02	NA	--	8.7E-04	8.5E-04	8.5E-04
191-24-2	Benzo(g,h,i)perylene	No	NA	NA	NA	NA	NA	NA	1.1E+00	NA	NA	NA	NA	NA	NA	1.1E+04	NA	NA	--	NA	NA	NA	NA	--	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	Yes	7.3E-02	NA	7.3E-02	NA	NA	1.1E-01	--	2.7E+00	6.5E+00	NA	4.2E+00	NA	NA	5.0E+03	NA	NA	--	NA	NA	3.4E-01	NA	--	5.3E-03	5.2E-03	5.2E-03
218-01-9	Chrysene	Yes	7.3E-03	NA	7.3E-03	NA	NA	1.1E-02	--	2.0E+00	4.8E+00	1.0E+00	3.5E+00	--	--	3.2E+03	NA	NA	--	NA	NA	3.4E+00	NA	--	8.3E-02	8.1E-02	8.1E-02
53-70-3	Dibenz(a,h)anthracene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.2E+00	--	3.8E+00	9.1E+00	6.0E-01	6.1E+00	--	--	9.6E+03	NA	NA	--	NA	NA	3.4E-03	NA	--	2.7E-05	2.7E-05	2.7E-05
105-67-9	2,4-Dimethylphenol	No	NA	2.0E-02	NA	2.0E-02	NA	NA	1.1E-02	5.1E-01	1.2E+00	1.0E+00	4.6E-02	1.6E-02	--	1.5E+01	4.0E+01	3.1E+02	--	1.8E+02	3.0E+01	NA	NA	--	NA	NA	3.0E+01
84-74-2	Di-n-butylphthalate	No	NA	1.0E-01	NA	1.0E-01	NA	NA	4.2E-02	3.8E+00	9.1E+00	9.0E-01	2.7E-01	1.5E-01	--	1.7E+02	2.0E+02	1.6E+02	--	8.2E+01	4.3E+01	NA	NA	--	NA	NA	4.3E+01
206-44-0	Fluoranthene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	--	1.4E+00	3.4E+00	1.0E+00	1.7E+00	--	--	3.6E+03	8.0E+01	NA	--	1.5E+00	1.5E+00	NA	NA	--	NA	NA	1.5E+00
86-73-7	Fluorene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.1E-01	9.0E-01	2.2E+00	NA	5.5E-01	NA	NA	5.3E+02	8.0E+01	NA	NA	1.0E+01	9.3E+00	NA	NA	NA	NA	NA	9.3E+00
193-39-5	Indeno(1,2,3-cd)pyrene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	3.7E+00	8.9E+00	6.0E-01	7.9E+00	--	--	1.2E+04	NA	NA	--	NA	NA	3.4E-02	NA	--	2.2E-04	2.1E-04	2.1E-04
90-12-0	1-Methylnaphthalene	No	2.9E-02	7.0E-02	2.9E-02	7.0E-02	NA	NA	9.3E-02	6.6E-01	1.6E+00	NA	4.3E-01	NA	NA	5.3E+01	1.4E+02	NA	NA	1.8E+02	7.9E+01	2.7E+00	NA	NA	4.1E+00	1.6E+00	1.6E+00
91-57-6	2-Methylnaphthalene	No	NA	4.0E-03	NA	4.0E-03	NA	NA	9.2E-02	6.6E-01	1.6E+00	NA	4.2E-01	NA	NA	7.5E+01	8.0E+00	NA	NA	7.4E+00	3.8E+00	NA	NA	NA	NA	NA	3.8E+00
95-48-7	2-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	7.7E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	1.0E-02	--	1.1E+01	1.0E+02	1.2E+03	--	6.4E+02	8.1E+01	NA	NA	--	NA	NA	8.1E+01
108-39-4	3-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	7.8E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	1.0E-02	--	9.1E+00	1.0E+02	1.2E+03	--	7.5E+02	8.2E+01	NA	NA	--	NA	NA	8.2E+01
106-44-5	4-Methylphenol	No	NA	1.0E-01	NA	1.0E-01	6.0E-01	NA	7.5E-03	4.2E-01	1.0E+00	1.0E+00	3.0E-02	1.0E-02	--	8.9E+00	2.0E+02	2.5E+03	--	1.6E+03	1.7E+02	NA	NA	--	NA	NA	1.7E+02
34mp	3&4-Methylphenol [n]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0E+02	1.2E+03	--	7.5E+02	8.2E+01	NA	NA	--	NA	NA	8.2E+01
91-20-3	Naphthalene	No	NA	2.0E-02	NA	2.0E-02	3.0E-03	3.4E-02	4.7E-02	5.5E-01	1.3E+00	1.0E+00	2.0E-01	7.0E-02	--	8.5E+01	4.0E+01	7.0E+01	6.3E-01	3.3E+01	6.0E-01	NA	NA	1.7E-01	NA	1.7E-01	1.7E-01
85-01-8	Phenanthrene	No	NA	NA	NA	NA	NA	NA	--	1.1E+00	2.5E+00	1.0E+00	7.0E-01	--	--	2.5E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
108-95-2	Phenol	No	NA	3.0E-01	NA	3.0E-01	2.0E-01	NA	4.3E-03	3.5E-01	8.5E-01	1.0E+00	1.6E-02	5.2E-03	--	1.7E+01	6.0E+02	1.4E+04	--	2.4E+03	4.6E+02	NA	NA	--	NA	NA	4.6E+02
129-00-0	Pyrene	No	NA	3.0E-02	NA	3.0E-02	NA	NA	2.0E-01	1.4E+00	3.4E+00	NA	1.1E+00	NA	NA	1.5E+03	6.0E+01	NA	NA	2.7E+00	2.6E+00	NA	NA	NA	NA	NA	2.6E+00

Table B-11
Tier II Water Action Levels
Future Resident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]								Subsistence User ALs										
			Oral		Dermal		Inhalation		Dermal Factors								Noncarcinogen [c]					Carcinogen [c]					
CAS #	Chemical Name	Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA_{event} (NC) [b] cm/event	DA_{event} (C) [b] cm/event	Fish BCF (L/kg)	SU - Water Ingestion (NC) [d] (µg/L)	SU - Dermal (NC) [e] (µg/L)	SU - Inhalation (NC) [f] (µg/L)	SU - Diet (NC) [g] (µg/L)	SU - Total (NC) [h] (µg/L)	SU - Water Ingestion (C) [i] (µg/L)	SU - Dermal (C) [j] (µg/L)	SU - Inhalation (C) [k] (µg/L)	SU - Diet (C) [l] (µg/L)	SU - Total (C) [h] (µg/L)	Lowest Total AL [m] (µg/L)
Metals																											
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	2.0E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	No	NA	4.0E-04	NA	6.0E-05	NA	NA	1.0E-03	5.1E-01	1.2E+00	--	4.2E-03	5.4E-04	--	1.0E+02	8.0E-01	2.7E+01	--	5.5E-01	3.2E-01	NA	NA	--	NA	NA	3.2E-01
7440-38-2	Arsenic	No	1.5E+00	3.0E-04	1.5E+00	3.0E-04	1.5E-05	4.3E+00	1.0E-03	2.8E-01	6.6E-01	--	3.3E-03	5.4E-04	6.7E-04	3.0E+02	6.0E-01	1.4E+02	--	1.4E-01	1.1E-01	5.2E-02	9.3E+00	--	1.4E-02	1.1E-02	1.1E-02
7440-39-3	Barium	No	NA	2.0E-01	NA	1.4E-02	5.0E-04	NA	1.0E-03	6.2E-01	1.5E+00	--	4.5E-03	5.4E-04	--	4.0E+00	4.0E+02	6.4E+03	--	6.9E+03	3.6E+02	NA	NA	--	NA	NA	3.6E+02
7440-43-9	Cadmium (food)	No	NA	1.0E-03	NA	2.5E-05	1.0E-05	1.8E+00	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	--	--	2.0E+02	--	--	--	6.9E-01	--	--	--	--	NA	--	--
7440-43-9	Cadmium (water)	No	NA	5.0E-04	NA	2.5E-05	1.0E-05	1.8E+00	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	5.4E-04	--	2.0E+02	1.0E+00	1.1E+01	--	--	3.9E-01	NA	NA	--	--	NA	3.9E-01
7440-47-3	Chromium	No	NA	NA	NA	NA	NA	NA	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	5.4E-04	--	2.0E+02	NA	NA	--	NA	NA	NA	NA	--	NA	NA	NA
16065-83-1	Chromium (III)	No	NA	1.5E+00	NA	2.0E-02	NA	NA	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	5.4E-04	--	NA	3.0E+03	8.9E+03	--	NA	2.2E+03	NA	NA	--	NA	NA	2.2E+03
18540-29-9	Chromium (VI)	Yes	5.0E-01	3.0E-03	2.0E+01	7.5E-05	1.0E-04	8.4E+01	2.0E-03	2.1E-01	4.9E-01	--	5.5E-03	1.1E-03	1.3E-03	2.0E+02	6.0E+00	1.7E+01	--	2.1E+00	1.4E+00	5.0E-02	1.1E-01	--	1.9E-02	1.2E-02	1.2E-02
7440-50-8	Copper	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.0E-03	2.4E-01	5.7E-01	--	3.1E-03	5.4E-04	--	2.0E+02	8.0E+01	1.8E+04	--	2.7E+01	2.0E+01	NA	NA	--	NA	NA	2.0E+01
7439-92-1	Lead	No	NA	NA	NA	NA	NA	NA	1.0E-04	1.5E+00	3.7E+00	--	5.5E-04	5.4E-05	--	3.0E+02	NA	NA	--	NA	NA	NA	NA	--	NA	NA	NA
7439-96-5	Manganese	--	--	--	--	--	--	--	1.0E-03	2.1E-01	5.1E-01	--	2.9E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7487-94-7	Mercury (inorganic salts) [o]	No	NA	3.0E-04	NA	2.1E-05	3.0E-04	NA	1.0E-03	3.5E+00	8.4E+00	--	6.3E-03	5.4E-04	--	1.0E+03	6.0E-01	9.5E+00	--	4.1E-02	2.4E-02	NA	NA	--	NA	NA	2.4E-02
7439-97-6	Mercury (elemental) [o]	No	NA	NA	NA	NA	3.0E-04	NA	1.0E-03	1.4E+00	3.4E+00	--	5.4E-03	5.4E-04	--	NA	NA	NA	6.3E-02	NA	2.4E-02	NA	NA	NA	NA	NA	2.4E-02
7440-02-0	Nickel	No	NA	2.0E-02	NA	8.0E-04	9.0E-05	2.6E-01	2.0E-04	2.2E-01	5.4E-01	--	5.9E-04	1.1E-04	--	1.0E+02	4.0E+01	1.8E+03	--	2.7E+01	1.6E+01	NA	NA	--	NA	NA	1.6E+01
7782-49-2	Selenium	No	NA	5.0E-03	NA	5.0E-03	2.0E-02	NA	1.0E-03	2.9E-01	7.0E-01	--	3.4E-03	5.4E-04	--	2.0E+02	1.0E+01	2.3E+03	--	3.4E+00	2.6E+00	NA	NA	--	NA	NA	2.6E+00
7440-22-4	Silver	No	NA	5.0E-03	NA	2.0E-04	NA	NA	6.0E-04	4.2E-01	1.0E+00	--	2.4E-03	3.2E-04	--	5.0E+00	1.0E+01	1.5E+02	--	1.4E+02	8.8E+00	NA	NA	--	NA	NA	8.8E+00
7440-62-2	Vanadium	No	NA	5.0E-03	NA	1.3E-04	1.0E-04	NA	1.0E-03	2.0E-01	4.9E-01	--	2.7E-03	5.4E-04	--	NA	1.0E+01	5.9E+01	--	NA	8.6E+00	NA	NA	--	NA	NA	8.6E+00
7440-66-6	Zinc	No	NA	3.0E-01	NA	3.0E-01	NA	NA	6.0E-04	2.4E-01	5.9E-01	--	1.9E-03	3.2E-04	--	1.0E+03	6.0E+02	2.3E+05	--	4.1E+01	3.9E+01	NA	NA	--	NA	NA	3.9E+01
Inorganics																											
57-12-5	Cyanide	No	NA	6.0E-04	NA	6.0E-04	8.0E-04	NA	1.0E-03	1.5E-01	3.5E-01	NA	2.0E-03	5.4E-04	--	NA	1.2E+00	2.7E+02	1.7E-01	NA	1.5E-01	NA	NA	NA	NA	NA	1.5E-01

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFo: oral slope factor
RfDo: oral reference dose
SFd: dermal slope factor
RfDd: dermal reference dose
RfCi: inhalation reference concentration
URFi: inhalation unit risk factor
Kp: dermal permeability coefficient of compound in water
τ: lag time per event
t*: time to reach steady state
FA: fraction absorbed water
B: ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis
DA_{event}: dermally absorbed dose per exposure event
BCF: fish bioaccumulation factor
AL: action level
SU: subsistence user
NC: noncarcinogen
C: carcinogen
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
cm/hr: centimeters per hour
hr/event: hours per event
cm/event: centimeters per event
L/kg: liters per kilogram
µg/L: micrograms per liter
NA: not available
--: not applicable
TCE: trichloroethene

Footnotes:

[a] Toxicity values, dermal factors (Kp, τ, FA, and B), BCFs, and mutagen identification from Table 4. t* = 2.4*τ (EPA 2004).

[b] For organics, where $t_{event} \leq t^*$, $DA_{event} = 2*FA*Kp*(6*τ*t_{event}/π)^{0.5}$
For organics, where $t_{event} > t^*$, $DA_{event} = FA*Kp*((t_{event}/1+B) + (2*τ*(1+3*B+3*B^2/(1+B)^2)$
For inorganics, $DA_{event} = Kp*t_{event}$
DA_{event} equations are from EPA (2004). t_{event} values are shown in Table B-6.
$t_{event, c}$ used to calculate DA_{event} (NC); $t_{event, adj}$ and $t_{event, madj}$ used to calculate DA_{event} (C) for carcinogens and mutagens, respectively.

[c] Exposure factors are provided in Table B-6. Equations provided below modified from ADEC (2008b) and EPA (2004, 2015c).

[d] SU Water Ingestion (NC) AL = (THQ*ATnc,c*BWc*365 d/yr) / (EFw*EDc*(1/RfDo)*IRw,c*CF_4)

[e] SU Dermal (NC) AL = (THQ*ATnc,c*BWc*365 d/yr) / (EFw*EDc*EV*(1/RfDd)*SAw,c*DA_{event}*CF_2*CF_4)

[f] SU Inhalation (NC) AL = (THQ*ATnc,c*365 d/yr) / (EFw*EDc*(1/RfCi)*K*CF_4)

[g] SU Diet (NC) AL = (THQ*ATnc,c*BWc*365 d/yr) / (EFf*EDc*IRf,c*AUFw*(1/RfDo)*BCF*CF_4)

[h] SU Total AL = 1/((1/water ingestion AL)+(1/dermal AL)+(1/inhalation AL)+(1/diet AL))

[i] SU Water Ingestion (C) AL = (TR*ATc*365 d/yr) / (EFw*SFo*IFWadj*CF_4)
SU Water Ingestion (Mutagen) AL = (TR*ATc*365 d/yr) / (EFw*SFo*IFWMadj*CF_4)
SU Water Ingestion (Vinyl Chloride) AL = TR / (((EFw*SFo*IFWadj*CF_4)/(ATc*365 d/yr)) + ((SFo*IRw,c*CF_4)/BWc))
SU Water Ingestion (TCE) AL = (TR*ATc*365 d/yr) / (EFw*SFo*((CAFo*IFWadj)+(MAFo*IFWMadj))*CF_4)

[j] SU Dermal (C) AL = (TR*ATc*365 d/yr) / (EFw*EV*SFd*DFWadj*DA_{event}*CF_2*CF_4)
SU Dermal (Mutagen) AL = (TR*ATc*365 d/yr) / (EFw*EV*SFd*DFWMadj*DA_{event}*CF_2*CF_4)
SU Dermal (Vinyl Chloride) AL = TR / (((EFw*EV*DFWadj*SFd*DA_{event}*CF_2*CF_4)/(ATc*365 d/yr)) + ((EV*SAw,c*SFd*DA_{event}*CF_2*CF_4)/BWc))
SU Dermal (TCE) AL = (TR*ATc*365 d/yr) / (EFw*EV*SFd*((CAFo*DFWadj)+(MAFo*DFWMadj))*DA_{event}*CF_2*CF_4)

[k] SU Inhalation (C) AL = (TR*ATc*365 d/yr) / (EFw*ED*URFi*K*CF_4)
SU Inhalation (Mutagen) AL = (TR*ATc*365 d/yr) / (EFw*K*((ED_{0-2}*URFi*10)+(ED_{2-6}*URFi*3)+ (ED_{6-16}*URFi*3)+(ED_{16-26}*URFi*1))*CF_4)
SU Inhalation (Vinyl Chloride) AL = TR / (((EFw*ED*URFi*CF_4*K)/(ATc*365 d/yr)) + (URFi*CF_4*K))
SU Inhalation (TCE) AL = (TR*ATc*365 d/yr) / (EFw*K*URFi*((ED*CAFi)+((ED_{0-2}*MAFi*10)+(ED_{2-6}*MAFi*3)+ (ED_{6-16}*MAFi*3)+(ED_{16-26}*MAFi*1)))*CF_4)

[l] SU Diet (C) AL = (TR*ATc*365 d/yr) / (EFf*SFo*IFFadj*AUFw*BCF*CF_4)
SU Diet (Mutagen) AL = (TR*ATc*365 d/yr) / (EFf*SFo*IFFMadj*AUFw*BCF*CF_4)
SU Diet (Vinyl Chloride) AL = TR / (((EFf*SFo*BCF*IFFadj*AUFw*CF_4)/(ATc*365 d/yr)) + ((SFo*BCF*IRf,c*AUFw*CF_4)/BWc))
SU Diet (TCE) AL = (TR*ATc*365 d/yr) / (EFf*SFo*((CAFo*IFFadj*AUFw)+(MAFo*IFFMadj*AUFw))*BCF*CF_4)

[m] Value is the lower of SU - Total (NC) and SU - Total (C).

[n] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[o] Values for elemental mercury were used, where available, to calculate water ALs for mercury; otherwise, values for inorganic salts were used.

References:

Alaska Department of Environmental Conservation (ADEC). 2008b. Cleanup Levels Guidance.

Division of Spill Prevention and Response, Contaminated Sites Program. June 9.
U.S. Environmental Protection Agency (EPA). 2004. Risk Assessment Guidance for Superfund Volume I: Human Health

Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005. July.
EPA. 2015c. Regional Screening Level User's Guide. June.
http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Table B-12
Tier II Soil Action Levels
Current Nonresident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]				Subsistence User ALs													
			Oral		Dermal		Inhalation						Noncarcinogen [b]						Carcinogen [b]							
CAS #	Chemical Name	Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	VF / PEF (m^3/kg)	ABSd (Unitless)	BV (Unitless)	BTF (d/kg)	SU - Soil Ingestion (NC) [c] (mg/kg)	SU - Dermal (NC) [d] (mg/kg)	SU - Inhalation (NC) [e] (mg/kg)	SU Adult - Diet (NC) [f] (mg/kg)	SU Child - Diet (NC) [f] (mg/kg)	SU - Total (NC) [g] (mg/kg)	SU - Soil Ingestion (C) [h] (mg/kg)	SU - Dermal (C) [i] (mg/kg)	SU - Inhalation (C) [j] (mg/kg)	SU - Diet (C) [k] (mg/kg)	SU - Total (C) [g] (mg/kg)	Csat [l] (mg/kg)	Lowest Total AL [m] (mg/kg)	
Volatiles																										
67-64-1	Acetone	No	NA	9.0E-01	NA	9.0E-01	3.1E+01	NA	2.0E+04	0.0E+00	1.1E+01	1.4E-08	8.8E+05	NA	7.7E+05	3.8E+07	1.6E+07	4.1E+05	NA	NA	NA	NA	NA	1.1E+05	4.1E+05	sm
107-02-8	Acrolein	No	NA	5.0E-04	NA	5.0E-04	2.0E-05	NA	1.1E+04	0.0E+00	7.8E+00	2.4E-08	4.9E+02	NA	2.6E-01	1.7E+04	7.0E+03	2.6E-01	NA	NA	NA	NA	NA	2.3E+04	2.6E-01	
71-43-2	Benzene	No	5.5E-02	4.0E-03	5.5E-02	4.0E-03	3.0E-02	7.8E-03	3.0E+03	0.0E+00	4.5E-01	3.4E-06	3.9E+03	NA	1.1E+02	1.7E+04	7.1E+03	1.1E+02	4.8E+02	NA	1.3E+01	1.6E+03	1.2E+01	1.8E+03	1.2E+01	
78-93-3	2-Butanone	No	NA	6.0E-01	NA	6.0E-01	5.0E+00	NA	1.7E+04	0.0E+00	5.2E+00	4.9E-08	5.8E+05	NA	1.1E+05	1.5E+07	6.3E+06	8.9E+04	NA	NA	NA	NA	NA	2.8E+04	8.9E+04	s
56-23-5	Carbon tetrachloride	No	7.0E-02	4.0E-03	7.0E-02	4.0E-03	1.0E-01	6.0E-03	1.9E+03	0.0E+00	1.8E-01	1.7E-05	3.9E+03	NA	2.3E+02	8.6E+03	3.6E+03	2.1E+02	3.7E+02	NA	1.0E+01	6.3E+02	9.7E+00	4.6E+02	9.7E+00	
108-90-7	Chlorobenzene	No	NA	2.0E-02	NA	2.0E-02	5.0E-02	NA	4.9E+03	0.0E+00	1.7E-01	1.7E-05	1.9E+04	NA	3.0E+02	4.3E+04	1.8E+04	2.9E+02	NA	NA	NA	NA	NA	7.6E+02	2.9E+02	
75-00-3	Chloroethane	No	NA	NA	NA	NA	1.0E+01	NA	1.7E+03	0.0E+00	1.1E+00	6.7E-07	NA	NA	2.0E+04	NA	NA	2.0E+04	NA	NA	NA	NA	NA	2.1E+03	2.0E+04	s
67-66-3	Chloroform	No	3.1E-02	1.0E-02	3.1E-02	1.0E-02	9.8E-02	2.3E-02	2.9E+03	0.0E+00	5.5E-01	2.3E-06	9.7E+03	NA	3.5E+02	5.0E+04	2.1E+04	3.4E+02	8.5E+02	NA	4.2E+00	3.3E+03	4.2E+00	2.5E+03	4.2E+00	
106-93-4	1,2-Dibromoethane	No	2.0E+00	9.0E-03	2.0E+00	9.0E-03	9.0E-03	6.0E-01	8.9E+03	0.0E+00	5.6E-01	2.3E-06	8.8E+03	NA	9.7E+01	4.5E+04	1.9E+04	9.6E+01	1.3E+01	NA	4.8E-01	5.1E+01	4.6E-01	1.3E+03	4.6E-01	
95-50-1	1,2-Dichlorobenzene	No	NA	9.0E-02	NA	9.0E-02	2.0E-01	NA	8.4E+03	0.0E+00	7.9E-02	6.7E-05	8.8E+04	NA	2.0E+03	1.1E+05	4.5E+04	2.0E+03	NA	NA	NA	NA	NA	3.8E+02	2.0E+03	s
75-34-3	1,1-Dichloroethane	No	5.7E-03	2.0E-01	5.7E-03	2.0E-01	NA	1.6E-03	2.4E+03	0.0E+00	7.1E-01	1.5E-06	1.9E+05	NA	NA	1.2E+06	4.9E+05	1.7E+05	4.6E+03	NA	4.9E+01	2.1E+04	4.8E+01	1.7E+03	4.8E+01	
107-06-2	1,2-Dichloroethane	No	9.1E-02	6.0E-03	9.1E-02	6.0E-03	7.0E-03	2.6E-02	4.7E+03	0.0E+00	1.1E+00	7.6E-07	5.8E+03	NA	4.0E+01	4.8E+04	2.0E+04	4.0E+01	2.9E+02	NA	6.0E+00	1.8E+03	5.8E+00	3.0E+03	5.8E+00	
75-35-4	1,1-Dichloroethene	No	NA	5.0E-02	NA	5.0E-02	2.0E-01	NA	1.5E+03	0.0E+00	4.5E-01	3.4E-06	4.9E+04	NA	3.7E+02	2.1E+05	8.8E+04	3.6E+02	NA	NA	NA	NA	NA	1.2E+03	3.6E+02	
156-59-2	cis-1,2-Dichloroethene	No	NA	2.0E-03	NA	2.0E-03	NA	NA	2.7E+03	0.0E+00	6.4E-01	1.8E-06	1.9E+03	NA	NA	1.1E+04	4.6E+03	1.7E+03	NA	NA	NA	NA	NA	2.4E+03	1.7E+03	
156-60-5	trans-1,2-Dichloroethene	No	NA	2.0E-02	NA	2.0E-02	NA	NA	2.0E+03	0.0E+00	4.7E-01	3.1E-06	1.9E+04	NA	NA	8.8E+04	3.7E+04	1.6E+04	NA	NA	NA	NA	NA	1.9E+03	1.6E+04	s
60-29-7	Diethyl ether	No	NA	2.0E-01	NA	2.0E-01	NA	NA	4.2E+03	0.0E+00	2.4E+00	1.9E-07	1.9E+05	NA	NA	2.8E+06	1.2E+06	1.8E+05	NA	NA	NA	NA	NA	1.0E+04	1.8E+05	sm
123-91-1	1,4-Dioxane	No	1.0E-01	3.0E-02	1.0E-01	3.0E-02	3.0E-02	5.0E-03	5.9E+04	1.0E-01	1.1E+01	1.3E-08	2.9E+04	6.9E+04	2.2E+03	1.3E+06	5.4E+05	1.9E+03	2.6E+02	6.2E+02	3.9E+02	8.8E+03	1.2E+02	1.2E+05	1.2E+02	
100-41-4	Ethylbenzene	No	1.1E-02	1.0E-01	1.1E-02	1.0E-01	1.0E+00	2.5E-03	4.1E+03	0.0E+00	1.2E-01	3.5E-05	9.7E+04	NA	5.0E+03	1.6E+05	6.6E+04	4.7E+03	2.4E+03	NA	5.4E+01	2.9E+03	5.2E+01	4.8E+02	5.2E+01	
50-00-0	Formaldehyde	No	NA	2.0E-01	NA	2.0E-01	9.8E-03	1.3E-02	1.2E+05	1.0E-01	4.8E+00	5.6E-08	1.9E+05	4.6E+05	1.4E+03	4.7E+06	2.0E+06	1.4E+03	NA	NA	3.0E+02	NA	3.0E+02	4.2E+04	3.0E+02	
67-56-1	Methanol	No	NA	2.0E+00	NA	2.0E+00	2.0E+01	NA	4.5E+04	1.0E-01	2.2E+01	4.3E-09	1.9E+06	4.6E+06	1.1E+06	1.4E+08	5.8E+07	6.0E+05	NA	NA	NA	NA	NA	1.1E+05	6.0E+05	sm
75-09-2	Methylene chloride	Yes	2.0E-03	6.0E-03	2.0E-03	6.0E-03	6.0E-01	1.0E-05	2.6E+03	0.0E+00	1.5E+00	4.5E-07	5.8E+03	NA	1.9E+03	6.0E+04	2.5E+04	1.4E+03	1.3E+04	NA	8.6E+03	3.0E+04	4.4E+03	3.3E+03	1.4E+03	
108-10-1	4-Methyl-2-pentanone	No	NA	8.0E-02	NA	8.0E-02	3.0E+00	NA	1.3E+04	0.0E+00	1.3E+00	5.1E-07	7.8E+04	NA	4.9E+04	7.5E+05	3.1E+05	2.9E+04	NA	NA	NA	NA	NA	3.4E+03	2.9E+04	s
103-65-1	n-Propylbenzene	No	NA	1.0E-01	NA	1.0E-01	1.0E+00	NA	4.9E+03	0.0E+00	5.6E-02	1.2E-04	9.7E+04	NA	6.0E+03	9.4E+04	3.9E+04	5.3E+03	NA	NA	NA	NA	NA	2.6E+02	5.3E+03	s
127-18-4	Tetrachloroethene	No	2.1E-03	6.0E-03	2.1E-03	6.0E-03	4.0E-02	2.6E-04	2.4E+03	0.0E+00	8.2E-02	6.3E-05	5.8E+03	NA	1.2E+02	7.4E+03	3.1E+03	1.1E+02	1.2E+04	NA	3.0E+02	1.2E+04	2.9E+02	1.7E+02	1.1E+02	
108-88-3	Toluene	No	NA	8.0E-02	NA	8.0E-02	5.0E+00	NA	3.4E+03	0.0E+00	2.0E-01	1.3E-05	7.8E+04	NA	2.1E+04	1.9E+05	7.9E+04	1.5E+04	NA	NA	NA	NA	NA	8.2E+02	1.5E+04	s
71-55-6	1,1,1-Trichloroethane	No	NA	2.0E+00	NA	2.0E+00	5.0E+00	NA	1.9E+03	0.0E+00	2.8E-01	7.7E-06	1.9E+06	NA	1.2E+04	6.0E+06	2.5E+06	1.2E+04	NA	NA	NA	NA	NA	6.4E+02	1.2E+04	s
79-01-6	Trichloroethene	Yes	4.6E-02	5.0E-04	4.6E-02	5.0E-04	2.0E-03	4.1E-03	2.3E+03	0.0E+00	3.0E-01	6.6E-06	4.9E+02	NA	5.6E+00	1.6E+03	6.7E+02	5.5E+00	5.7E+02	NA	1.8E+01	9.5E+02	1.8E+01	6.9E+02	5.5E+00	
95-63-6	1,2,4-Trimethylbenzene	No	NA	5.0E-02	NA	5.0E-02	7.0E-03	NA	5.6E+03	0.0E+00	6.0E-02	1.1E-04	4.9E+04	NA	4.7E+01	5.0E+04	2.1E+04	4.7E+01	NA	NA	NA	NA	NA	2.2E+02	4.7E+01	
108-67-8	1,3,5-Trimethylbenzene	No	NA	1.0E-02	NA	1.0E-02	6.0E-03	NA	4.7E+03	0.0E+00	8.0E-02	6.6E-05	9.7E+03	NA	3.4E+01	1.2E+04	5.1E+03	3.4E+01	NA	NA	NA	NA	NA	1.8E+02	3.4E+01	
75-01-4	Vinyl chloride	Yes	7.2E-01	3.0E-03	7.2E-01	3.0E-03	1.0E-01	4.4E-03	1.3E+03	0.0E+00	8.9E-01	1.0E-06	2.9E+03	NA	1.6E+02	2.1E+04	8.7E+03	1.5E+02	3.6E+01	NA	9.8E+00	3.3E+01	6.3E+00	3.9E+03	6.3E+00	
1330-20-7	Xylenes	No	NA	2.0E-01	NA	2.0E-01	1.0E-01	NA	4.7E+03	0.0E+00	1.1E-01	3.6E-05	1.9E+05	NA	5.8E+02	3.1E+05	1.3E+05	5.7E+02	NA	NA	NA	NA	NA	2.6E+02	5.7E+02	s
Semi-Volatiles																										
83-32-9	Acenaphthene	No	NA	6.0E-02	NA	6.0E-02	NA	NA	9.2E+04	1.3E-01	4.1E-02	2.1E-04	5.8E+04	1.1E+05	NA	4.5E+04	1.9E+04	1.9E+04	NA	NA	NA	NA	NA	NA	1.9E+04	
208-96-8	Acenaphthylene	No	NA	NA	NA	NA	NA	NA	1.2E+05	1.3E-01	4.0E-02	2.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
120-12-7	Anthracene	No	NA	3.0E-01	NA	3.0E-01	NA	NA	3.4E+05	1.3E-01	2.0E-02	7.1E-04	2.9E+05	5.3E+05	NA	1.3E+05	5.6E+04	5.6E+04	NA	NA	NA	NA	NA	NA	5.6E+04	
56-55-3	Benzo(a)anthracene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	2.8E+06	1.3E-01	3.5E-03	1.4E-02	NA	NA	NA	NA	NA	NA	3.6E+01	6.5E+01	8.5E+02	1.0E+00	9.9E-01	NA	9.9E-01	
50-32-8	Benzo(a)pyrene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.1E+00	4.6E+09	1.3E-01	2.1E-03	3.4E-02	NA	NA	NA	NA	NA	NA	3.6E+00	6.5E+00	1.4E+05	7.3E-02	7.1E-02	NA	7.1E-02	
205-99-2	Benzo(b)fluoranthene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	4.6E+09	1.3E-01	3.4E-03	1.5E-02	NA	NA	NA	NA	NA	NA	3.6E+01	6.5E+01	1.4E+06	1.0E+00	9.7E-01	NA	9.7E-01	
191-24-2	Benzo(g,h,i)perylene	No	NA	NA	NA	NA	NA	NA	4.6E+09	1.3E-01	1.1E-03	1.1E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
207-08-9	Benzo(k)fluoranthene	Yes	7.3E-02	NA	7.3E-02	NA	NA	1.1E-01	4.6E+09	1.3E-01	2.2E-03	3.2E-02	NA	NA	NA	NA	NA	NA	3.6E+02	6.5E+02	1.4E+06	7.4E+00	7.2E+00	NA	7.2E+00	
218-01-9	Chrysene	Yes	7.3E-03	NA	7.3E-03	NA	NA	1.1E-02	4.6E+09	1.3E-01	3.3E-03	1.6E-02	NA	NA	NA	NA	NA	NA	3.6E+03	6.5E+03	1.4E+07	9.9E+01	9.5E+01	NA	9.5E+01	
53-70-3	Dibenz(a,h)anthracene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.2E+00	4.6E+09	1.3E-01	9.4E-04	1.4E-01	NA	NA	NA	NA	NA	NA	3.6E+00	6.5E+00	1.3E+05	4.0E-02	3.9E-02	NA	3.9E-02	
105-67-9	2,4-Dimethylphenol	No	NA	2.0E-02	NA	2.0E-02	NA	NA	4.6E+09	1.0E-01	3.6E-01	5.0E-06	1.9E+04	4.6E+04	NA	7.2E+04	3.0E+04	1.1E+04	NA	NA	NA	NA	NA	NA	1.1E+04	
84-74-2	Di-n-butylphthalate	No	NA	1.0E-01	NA	1.0E-01	NA	NA	4.6E+09	1.0E-01	1.9E-02	7.9E-04	9.7E+04	2.3E+05	NA	4.3E+04	1.8E+04	1.8E+04	NA	NA	NA	NA	NA	NA	1.8E+04	
206-44-0	Fluoranthene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	4.6E+09	1.3E-01	7.8E-03	3.6E-03	3.9E+04	7.1E+04	NA	9.1E+03	3.8E+03	3.8E+03	NA	NA	NA	NA	NA	NA	3.8E+03	
86-73-7	Fluorene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.8E+05	1.3E-01	2.9E-02	3.8E-04	3.9E+04	7.1E+04	NA	2.3E+04	9.7E+03	9.7E+03	NA	NA	NA	NA	NA	NA	9.7E+03	
193-39-5	Indeno(1,2,3-cd)pyrene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	4.6E+09	1.3E-01	1.0E-03	1.3E-01	NA	NA	NA	NA	NA	NA	3.6E+01	6.5E+01	1.4E+06	4.2E-01	4.1E-01	NA	4.1E-01	
90-12-0	1-Methylnaphthalene	No	2.9E-02	7.0E-02	2.9E-02	7.0E-02	NA	NA	3.8E+04	1.3E-01	4.4E-02	1.9E-04	6.8E+04	1.2E+05	NA	5.5E+04	2.3E+04	2.3E+04	9.0E+02	1.6E+03	NA	5.5E+02	2.8E+02	NA	2.8E+02	
91-57-6	2-Methylnaphthalene	No	NA	4.0E-03	NA	4.0E-03	NA	NA	3.8E+04	1.3E-01	4.4E-02	1.8E-04	3.9E+03	7.1E+03	NA	3.2E+03	1.3E+03	1.3E+03	NA	NA	NA	NA	NA	NA	1.3E+03	
95-48-7	2-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	4.6E+09	1.0E-01	5.7E-01	2.2E-06	4.9E+04	1.2E+05	3.4E+09	2.5E+05	1.1E+05	3.0E+04	NA	NA	NA	NA	NA	NA	3.0E+04	
108-39-4	3-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	4.6E+09	1.0E-01	5.6E-01	2.3E-06	4.9E+04	1.2E+05	3.4E+09	2.5E+05	1.0E+05	3.0E+04	NA	NA	NA	NA	NA	NA	3.0E+04	
106-44-5	4-Methylphenol	No	NA	1.0E-01	NA	1.0E-01	6.0E-01	NA	4.6E+09	1.0E-01	5.8E-01	2.2E-06	9.7E+04	2.3E+05	3.4E+09	5.1E+05	2.1E+05	6.0E+04	NA	NA	NA	NA	NA	NA	6.0E+04	
34mp	3&4-Methylphenol [n]	--	--	--	--	--	--	--	--	--	--	--	4.9E+04	1.2E+05	3.4E+09	2.5E+05	1.0E+05	3.0E+04	NA	NA	NA	NA	NA	--	3.0E+04	
91-20-3	Naphthalene	No	NA	2.0E-02	NA	2.0E-02	3.0E-03	3.4E-02	3.1E+04	1.3E-01	9.4E-02	5.0E-05	1.9E+04	3.5E+04	1.1E+02	2.7E+04	1.1E+04	1.1E+02	NA	NA	3.0E+01	NA	3.0E+01	NA	3.0E+01	
85-01-8	Phenanthrene	No	NA	NA	NA	NA	NA	NA	4.2E+05	1.3E-01	2.0E-02	7.2E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
108-95-2	Phenol	No	NA	3.0E-01	NA	3.0E-01	2.0E-01	NA	4.6E+09	1.0E-01	1.1E+00	7.2E-07	2.9E+05	6.9E+05	1.1E+09	2.4E+06	1.0E+06	1.9E+05	NA	NA	NA	NA	NA	NA	1.9E+05	m
129-00-0	Pyrene	No	NA	3.0E-02	NA	3.0E-02	NA	NA	1.5E+06	1.3E-01	1.1E-02	1.9E-03	2.9E+04	5.3E+04	NA	8.9E+03	3.7E+03	3.7E+03	NA	NA	NA	NA	NA	NA	3.7E+03	

Table B-12
Tier II Soil Action Levels
Current Nonresident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]				Subsistence User ALs													
			Oral		Dermal		Inhalation						Noncarcinogen [b]						Carcinogen [b]						
CAS #	Chemical Name	Mutagen? [a]	SFo $(mg/kg\text{-}d)^{-1}$	RfDo (mg/kg-d)	SFd $(mg/kg\text{-}d)^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi $(mg/m^3)^{-1}$	VF / PEF (m^3/kg)	ABSd (Unitless)	BV (Unitless)	BTF (d/kg)	SU - Soil Ingestion (NC) [c] (mg/kg)	SU - Dermal (NC) [d] (mg/kg)	SU - Inhalation (NC) [e] (mg/kg)	SU Adult - Diet (NC) [f] (mg/kg)	SU Child - Diet (NC) [f] (mg/kg)	SU - Total (NC) [g] (mg/kg)	SU - Soil Ingestion (C) [h] (mg/kg)	SU - Dermal (C) [i] (mg/kg)	SU - Inhalation (C) [j] (mg/kg)	SU - Diet (C) [k] (mg/kg)	SU - Total (C) [g] (mg/kg)	Csat [l] (mg/kg)	Lowest Total AL [m] (mg/kg)
Metals																									
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	No	NA	4.0E-04	NA	6.0E-05	NA	NA	4.6E+09	0.0E+00	5.0E-02	1.0E-03	3.9E+02	NA	NA	5.1E+01	2.1E+01	2.1E+01	NA	NA	NA	NA	NA	NA	2.1E+01
7440-38-2	Arsenic [o]	No	1.5E+00	3.0E-04	1.5E+00	3.0E-04	1.5E-05	4.3E+00	4.6E+09	3.0E-02	1.0E-02	2.0E-03	4.9E+02	2.3E+03	8.4E+04	9.6E+01	4.0E+01	4.0E+01	2.9E+01	1.4E+02	3.5E+04	4.3E+00	3.7E+00	NA	3.7E+00
7440-39-3	Barium	No	NA	2.0E-01	NA	1.4E-02	5.0E-04	NA	4.6E+09	0.0E+00	3.8E-02	1.5E-04	1.9E+05	NA	2.8E+06	2.3E+05	9.5E+04	9.5E+04	NA	NA	NA	NA	NA	NA	9.5E+04
7440-43-9	Cadmium (food)	No	NA	1.0E-03	NA	2.5E-05	1.0E-05	1.8E+00	4.6E+09	1.0E-03	1.3E-01	5.5E-04	9.7E+02	5.8E+03	5.6E+04	9.3E+01	3.9E+01	3.9E+01	NA	NA	8.4E+04	NA	8.4E+04	NA	3.9E+01
7440-43-9	Cadmium (water)	No	NA	5.0E-04	NA	2.5E-05	1.0E-05	1.8E+00	--	1.0E-03	1.4E-01	5.5E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-47-3	Chromium	No	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.9E-03	5.5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
16065-83-1	Chromium (III)	No	NA	1.5E+00	NA	2.0E-02	NA	NA	4.6E+09	0.0E+00	1.9E-03	5.5E-03	1.5E+06	NA	NA	9.3E+05	3.9E+05	3.9E+05	NA	NA	NA	NA	NA	NA	3.9E+05 m
18540-29-9	Chromium (VI)	Yes	5.0E-01	3.0E-03	2.0E+01	7.5E-05	1.0E-04	8.4E+01	4.6E+09	0.0E+00	1.9E-03	5.5E-03	2.9E+03	NA	5.6E+05	1.9E+03	7.7E+02	7.7E+02	5.2E+01	NA	1.8E+03	7.4E+00	6.5E+00	NA	6.5E+00
7440-50-8	Copper	No	NA	4.0E-02	NA	4.0E-02	NA	NA	4.6E+09	0.0E+00	1.0E-01	1.0E-02	3.9E+04	NA	NA	2.6E+02	1.1E+02	1.1E+02	NA	NA	NA	NA	NA	NA	1.1E+02
7439-92-1	Lead	No	NA	NA	NA	NA	NA	NA	4.6E+09	0.0E+00	1.1E-02	4.0E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7439-96-5	Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7487-94-7	Mercury (inorganic salts) [p]	No	NA	3.0E-04	NA	2.1E-05	3.0E-04	NA	4.6E+09	0.0E+00	2.3E-01	2.5E-01	2.9E+02	NA	1.7E+06	3.4E-02	1.4E-02	1.4E-02	NA	NA	NA	NA	NA	NA	1.4E-02
7439-97-6	Mercury (elemental) [p]	No	NA	NA	NA	NA	3.0E-04	NA	--	0.0E+00	2.3E-01	2.5E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-02-0	Nickel	No	NA	2.0E-02	NA	8.0E-04	9.0E-05	2.6E-01	4.6E+09	0.0E+00	1.5E-02	6.0E-03	1.9E+04	NA	5.1E+05	1.4E+03	5.9E+02	5.9E+02	NA	NA	5.8E+05	NA	5.8E+05	NA	5.9E+02
7782-49-2	Selenium	No	NA	5.0E-03	NA	5.0E-03	2.0E-02	NA	4.6E+09	0.0E+00	6.3E-03	1.5E-02	4.9E+03	NA	1.1E+08	3.4E+02	1.4E+02	1.4E+02	NA	NA	NA	NA	NA	NA	1.4E+02
7440-22-4	Silver	No	NA	5.0E-03	NA	2.0E-04	NA	NA	4.6E+09	0.0E+00	1.0E-01	3.0E-03	4.9E+03	NA	NA	1.1E+02	4.4E+01	4.4E+01	NA	NA	NA	NA	NA	NA	4.4E+01
7440-62-2	Vanadium	No	NA	5.0E-03	NA	1.3E-04	1.0E-04	NA	4.6E+09	0.0E+00	1.4E-03	2.5E-03	4.9E+03	NA	5.6E+05	9.3E+03	3.9E+03	3.2E+03	NA	NA	NA	NA	NA	NA	3.2E+03
7440-66-6	Zinc	No	NA	3.0E-01	NA	3.0E-01	NA	NA	4.6E+09	0.0E+00	2.6E-01	1.0E-01	2.9E+05	NA	NA	7.3E+01	3.0E+01	3.0E+01	NA	NA	NA	NA	NA	NA	3.0E+01
Inorganics																									
57-12-5	Cyanide	No	NA	6.0E-04	NA	6.0E-04	8.0E-04	NA	--	0.0E+00	1.1E+01	1.4E-08	5.8E+02	NA	NA	2.5E+04	1.1E+04	5.7E+02	NA	NA	NA	NA	NA	9.7E+05	5.7E+02

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFo: oral slope factor
RfDo: oral reference dose
SFd: dermal slope factor
RfDd: dermal reference dose
RfCi: inhalation reference concentration
URFi: inhalation unit risk factor
VF: volatilization factor
PEF: particulate emission factor
ABSd: dermal absorption factor
BV: soil-to-wet-plant uptake factor
BTF: beef transfer coefficient
AL: action level
SU: subsistence user
NC: noncarcinogen
C: carcinogen
Csat: soil saturation concentration
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
m^3/kg: cubic meters per kilogram
NA: not available
--: not applicable
TCE: trichloroethene
s: concentration exceeds Csat
m: concentration exceeds ceiling limit

Footnotes:

[a] Values and mutagen identification from Table 4.

[b] Exposure factors are provided in Table B-7. Equations provided below modified from ADEC (2008b) and EPA (2015c).

[c] SU Soil Ingestion (NC) AL = (THQ*ATnc*BWa*365 d/yr) / (EFs*ED*(1/RfDo)*CF*IRs,a)

[d] SU Dermal (NC) AL = (THQ*ATnc*BWa*365 d/yr) / (EFs*ED*(1/RfDd)*SAa*AFa*ABSd*CF)

[e] SU Inhalation (NC) AL = (THQ*ATnc*365 d/yr) / (EFs*ED*(1/RfCi)*[1/VF or 1/PEF])

[f] SU Adult Diet (NC) AL = (THQ*ATnc,a*BWa*365 d/yr) / (EFd*EDa*(1/RfDo)*CF*IRd,a*AUFs*CRp*BV*BTF)
SU Child Diet (NC) AL = (THQ*ATnc,c*BWc*365 d/yr) / (EFd*EDc*(1/RfDo)*CF*IRd,c*AUFs*CRp*BV*BTF)

[g] SU Total (NC) AL = Lower of (1/((1/soil ingestion AL)+(1/dermal AL)+(1/inhalation AL)+(1/adult diet AL))) and child diet AL
SU Total (C) AL = 1/((1/soil ingestion AL)+(1/dermal AL)+(1/inhalation AL)+(1/adult diet AL))

[h] SU Soil Ingestion (C) AL = (TR*ATc*365 d/yr) / (EFs*SFo*IFSa*CF)

[i] SU Dermal (C) AL = (TR*ATc*365 d/yr) / (EFs*SFd*ABSd*DFSa*CF)

[j] SU Inhalation (C) AL = (TR*ATc*365 d/yr) / (EFs*ED*URFi*[1/VF or 1/PEF])

[k] SU Diet (C) AL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*IFDadj*AUFs*CRp*BV*BTF)
SU Diet (Mutagen) AL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*IFDMadj*AUFs*CRp*BV*BTF)
SU Diet (Vinyl Chloride) AL = TR / (((EFd*SFo*CF*IFDadj*AUFs*CRp*BV*BTF)/(ATc*365 d/yr)) + ((SFo*CF*IRd,c*AUFs*CRp*BTF*BV)/BWc))
SU Diet (TCE) AL = (TR*ATc*365 d/yr) / (EFd*SFo*CF*((CAFo*IFDadj*AUFs)+(MAFo*IFDMadj*AUFs))*CRp*BV*BTF)

[l] Values from Table 2.

[m] Lowest of SU - Total (NC) and SU - Total (C). For target analytes that include the inhalation exposure route and have overall ALs that exceed the saturation limit (Csat), the ALs may be overly protective (see EPA, 2015c).
If detected chemical concentrations exceed the Csat concentration, more sophisticated modeling may be necessary on a SWMU/AOC-specific basis. At chemical concentrations at and above the ceiling limit of 1 x 10^5 mg/kg, or 10% by weight of the soil sample, the assumptions for soil contact may be violated due to the presence of the foreign substance itself (EPA, 2015c). Target analytes with detected concentrations above the ceiling limit should be evaluated further on a SWMU/AOC-specific basis.

[n] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[o] The EPA (2012b) default relative bioavailability of 60 percent was incorporated into the soil ingestion components of the arsenic AL.

[p] Values for inorganic mercury salts were used to calculate soil ALs for mercury.

References:

Alaska Department of Environmental Conservation (ADEC). 2008b. Cleanup Levels Guidance.
Division of Spill Prevention and Response, Contaminated Sites Program. June 9.

U.S. Environmental Protection Agency (EPA). 2012b. Recommendations for Default Value for
Relative Bioavailability of Arsenic in Soil. OSWER 9200.1-113, December.

EPA. 2015c. Regional Screening Level User's Guide. June.
http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Table B-13
Tier II Water Action Levels
Current Nonresident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]							Subsistence User ALs							
			Oral		Dermal		Inhalation		Dermal Factors							Noncarcinogen [c]				Carcinogen [c]			
CAS #	Chemical Name	Mutagen? [a]	SFo $(mg/kg\text{-}d)^{-1}$	RfDo (mg/kg-d)	SFd $(mg/kg\text{-}d)^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi $(mg/m^3)^{-1}$	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA_{event} [b] cm/event	Fish BCF (L/kg)	SU - Dermal (NC) [d] (μg/L)	SU Adult - Diet (NC) [e] (μg/L)	SU Child - Diet (NC) [e] (μg/L)	SU - Total (NC) [f] (μg/L)	SU - Dermal (C) [g] (μg/L)	SU - Diet (C) [h] (μg/L)	SU - Total (C) [f] (μg/L)	Lowest Total AL [i] (μg/L)
Volatiles																							
67-64-1	Acetone	No	NA	9.0E-01	NA	9.0E-01	3.1E+01	NA	5.1E-04	2.2E-01	5.3E-01	NA	1.5E-03	NA	3.2E+00	NA	7.8E+04	3.9E+04	3.9E+04	NA	NA	NA	3.9E+04
107-02-8	Acrolein	No	NA	5.0E-04	NA	5.0E-04	2.0E-05	NA	7.5E-04	2.2E-01	5.2E-01	1.0E+00	2.2E-03	4.8E-04	3.2E+00	1.7E+04	4.3E+01	2.2E+01	2.2E+01	NA	NA	NA	2.2E+01
71-43-2	Benzene	No	5.5E-02	4.0E-03	5.5E-02	4.0E-03	3.0E-02	7.8E-03	1.5E-02	2.9E-01	6.9E-01	1.0E+00	5.1E-02	1.1E-02	4.3E+00	5.8E+03	2.6E+02	1.3E+02	1.3E+02	7.1E+02	2.7E+01	2.6E+01	2.6E+01
78-93-3	2-Butanone	No	NA	6.0E-01	NA	6.0E-01	5.0E+00	NA	9.6E-04	2.7E-01	6.4E-01	1.0E+00	3.1E-03	6.9E-04	3.2E+00	1.4E+07	5.2E+04	2.6E+04	2.6E+04	NA	NA	NA	2.6E+04
56-23-5	Carbon tetrachloride	No	7.0E-02	4.0E-03	7.0E-02	4.0E-03	1.0E-01	6.0E-03	1.6E-02	7.6E-01	1.8E+00	1.0E+00	7.8E-02	2.0E-02	7.4E+00	3.3E+03	1.5E+02	7.4E+01	7.4E+01	3.2E+02	1.2E+01	1.2E+01	1.2E+01
108-90-7	Chlorobenzene	No	NA	2.0E-02	NA	2.0E-02	5.0E-02	NA	2.8E-02	4.5E-01	1.1E+00	1.0E+00	1.2E-01	2.6E-02	1.8E+01	1.2E+04	3.1E+02	1.5E+02	1.5E+02	NA	NA	NA	1.5E+02
75-00-3	Chloroethane	No	NA	NA	NA	NA	1.0E+01	NA	6.1E-03	2.4E-01	5.8E-01	1.0E+00	1.9E-02	4.1E-03	4.1E+00	NA	NA	NA	NA	NA	NA	NA	NA
67-66-3	Chloroform	No	3.1E-02	1.0E-02	3.1E-02	1.0E-02	9.8E-02	2.3E-02	6.8E-03	4.9E-01	1.2E+00	1.0E+00	2.9E-02	6.6E-03	1.3E+01	2.4E+04	2.1E+02	1.1E+02	1.1E+02	2.1E+03	1.6E+01	1.6E+01	1.6E+01
106-93-4	1,2-Dibromoethane	No	2.0E+00	9.0E-03	2.0E+00	9.0E-03	9.0E-03	6.0E-01	2.8E-03	1.2E+00	2.8E+00	1.0E+00	1.5E-02	4.2E-03	1.5E+01	3.5E+04	1.6E+02	8.2E+01	8.2E+01	5.2E+01	2.1E-01	2.1E-01	2.1E-01
95-50-1	1,2-Dichlorobenzene	No	NA	9.0E-02	NA	9.0E-02	2.0E-01	NA	4.5E-02	7.0E-01	1.7E+00	1.0E+00	2.1E-01	5.2E-02	2.7E+02	2.8E+04	9.2E+01	4.6E+01	4.6E+01	NA	NA	NA	4.6E+01
75-34-3	1,1-Dichloroethane	No	5.7E-03	2.0E-01	5.7E-03	2.0E-01	NA	1.6E-03	6.8E-03	3.8E-01	9.0E-01	1.0E+00	2.6E-02	5.7E-03	7.1E+00	5.6E+05	7.8E+03	3.9E+03	3.9E+03	1.3E+04	1.6E+02	1.6E+02	1.6E+02
107-06-2	1,2-Dichloroethane	No	9.1E-02	6.0E-03	9.1E-02	6.0E-03	7.0E-03	2.6E-02	4.2E-03	3.8E-01	9.0E-01	1.0E+00	1.6E-02	3.6E-03	4.4E+00	2.7E+04	3.7E+02	1.9E+02	1.9E+02	1.3E+03	1.6E+01	1.6E+01	1.6E+01
75-35-4	1,1-Dichloroethene	No	NA	5.0E-02	NA	5.0E-02	2.0E-01	NA	1.2E-02	3.7E-01	8.8E-01	1.0E+00	4.4E-02	9.8E-03	1.3E+01	8.2E+04	1.1E+03	5.3E+02	5.3E+02	NA	NA	NA	5.3E+02
156-59-2	cis-1,2-Dichloroethene	No	NA	2.0E-03	NA	2.0E-03	NA	NA	1.1E-02	3.7E-01	8.8E-01	NA	4.2E-02	NA	1.1E+01	NA	4.9E+01	2.5E+01	2.5E+01	NA	NA	NA	2.5E+01
156-60-5	trans-1,2-Dichloroethene	No	NA	2.0E-02	NA	2.0E-02	NA	NA	1.1E-02	3.7E-01	8.8E-01	1.0E+00	4.2E-02	9.2E-03	1.1E+01	3.5E+04	4.9E+02	2.5E+02	2.5E+02	NA	NA	NA	2.5E+02
60-29-7	Diethyl ether	No	NA	2.0E-01	NA	2.0E-01	NA	NA	2.4E-03	2.7E-01	6.6E-01	1.0E+00	7.8E-03	1.7E-03	5.4E+00	1.9E+06	1.0E+04	5.1E+03	5.1E+03	NA	NA	NA	5.1E+03
123-91-1	1,4-Dioxane	No	1.0E-01	3.0E-02	1.0E-01	3.0E-02	3.0E-02	5.0E-03	3.3E-04	3.3E-01	7.9E-01	1.0E+00	1.2E-03	2.6E-04	5.0E-01	1.8E+06	1.6E+04	8.2E+03	8.2E+03	1.7E+04	1.3E+02	1.3E+02	1.3E+02
100-41-4	Ethylbenzene	No	1.1E-02	1.0E-01	1.1E-02	1.0E-01	1.0E+00	2.5E-03	4.9E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	4.4E-02	5.6E+01	3.7E+04	4.9E+02	2.5E+02	2.5E+02	9.0E+02	1.0E+01	1.0E+01	1.0E+01
50-00-0	Formaldehyde	No	NA	2.0E-01	NA	2.0E-01	9.8E-03	1.3E-02	1.8E-03	1.5E-01	3.7E-01	1.0E+00	3.8E-03	9.9E-04	3.2E+00	3.3E+06	1.7E+04	8.7E+03	8.7E+03	NA	NA	NA	8.7E+03
67-56-1	Methanol	No	NA	2.0E+00	NA	2.0E+00	2.0E+01	NA	3.2E-04	1.6E-01	3.8E-01	1.0E+00	6.9E-04	1.8E-04	3.2E+00	1.8E+08	1.7E+05	8.7E+04	8.7E+04	NA	NA	NA	8.7E+04
75-09-2	Methylene chloride	Yes	2.0E-03	6.0E-03	2.0E-03	6.0E-03	6.0E-01	1.0E-05	3.5E-03	3.1E-01	7.5E-01	1.0E+00	1.3E-02	2.7E-03	2.3E+01	3.5E+04	7.1E+01	3.6E+01	3.6E+01	7.9E+04	4.1E+01	4.1E+01	3.6E+01
108-10-1	4-Methyl-2-pentanone	No	NA	8.0E-02	NA	8.0E-02	3.0E+00	NA	3.2E-03	3.8E-01	9.2E-01	1.0E+00	1.2E-02	2.7E-03	3.4E+00	4.7E+05	6.5E+03	3.2E+03	3.2E+03	NA	NA	NA	3.2E+03
103-65-1	n-Propylbenzene	No	NA	1.0E-01	NA	1.0E-01	1.0E+00	NA	9.4E-02	5.0E-01	1.2E+00	NA	4.0E-01	NA	1.3E+02	NA	2.2E+02	1.1E+02	1.1E+02	NA	NA	NA	1.1E+02
127-18-4	Tetrachloroethene	No	2.1E-03	6.0E-03	2.1E-03	6.0E-03	4.0E-02	2.6E-04	3.3E-02	8.9E-01	2.1E+00	1.0E+00	1.7E-01	4.4E-02	5.2E+01	2.2E+03	3.2E+01	1.6E+01	1.6E+01	4.7E+03	5.8E+01	5.8E+01	1.6E+01
108-88-3	Toluene	No	NA	8.0E-02	NA	8.0E-02	5.0E+00	NA	3.1E-02	3.5E-01	8.3E-01	1.0E+00	1.1E-01	2.5E-02	8.3E+00	5.1E+04	2.6E+03	1.3E+03	1.3E+03	NA	NA	NA	1.3E+03
71-55-6	1,1,1-Trichloroethane	No	NA	2.0E+00	NA	2.0E+00	5.0E+00	NA	1.3E-02	5.9E-01	1.4E+00	1.0E+00	5.6E-02	1.3E-02	5.0E+00	2.4E+06	1.1E+05	5.5E+04	5.5E+04	NA	NA	NA	5.5E+04
79-01-6	Trichloroethene	Yes	4.6E-02	5.0E-04	4.6E-02	5.0E-04	2.0E-03	4.1E-03	1.2E-02	5.7E-01	1.4E+00	1.0E+00	5.1E-02	1.2E-02	1.6E+01	6.7E+02	8.6E+00	4.3E+00	4.3E+00	7.8E+02	5.9E+00	5.8E+00	4.3E+00
95-63-6	1,2,4-Trimethylbenzene	No	NA	5.0E-02	NA	5.0E-02	7.0E-03	NA	8.6E-02	5.0E-01	1.2E+00	NA	3.6E-01	NA	1.2E+02	NA	1.1E+02	5.7E+01	5.7E+01	NA	NA	NA	5.7E+01
108-67-8	1,3,5-Trimethylbenzene	No	NA	1.0E-02	NA	1.0E-02	6.0E-03	NA	6.2E-02	5.0E-01	1.2E+00	NA	2.6E-01	NA	1.9E+02	NA	1.5E+01	7.4E+00	7.4E+00	NA	NA	NA	7.4E+00
75-01-4	Vinyl chloride	Yes	7.2E-01	3.0E-03	7.2E-01	3.0E-03	1.0E-01	4.4E-03	8.4E-03	2.4E-01	5.7E-01	1.0E+00	2.5E-02	5.6E-03	5.5E+00	8.6E+03	1.5E+02	7.5E+01	7.5E+01	1.1E+02	2.9E-01	2.9E-01	2.9E-01
1330-20-7	Xylenes	No	NA	2.0E-01	NA	2.0E-01	1.0E-01	NA	5.0E-02	4.1E-01	9.9E-01	1.0E+00	2.0E-01	4.4E-02	1.5E+01	7.3E+04	3.7E+03	1.9E+03	1.9E+03	NA	NA	NA	1.9E+03
Semi-Volatiles																							
83-32-9	Acenaphthene	No	NA	6.0E-02	NA	6.0E-02	NA	NA	8.6E-02	7.7E-01	1.8E+00	NA	4.1E-01	NA	7.6E+02	NA	2.2E+01	1.1E+01	1.1E+01	NA	NA	NA	1.1E+01
208-96-8	Acenaphthylene	No	NA	NA	NA	NA	NA	NA	9.1E-02	NA	NA	NA	NA	NA	2.7E+02	NA	NA	NA	NA	NA	NA	NA	NA
120-12-7	Anthracene	No	NA	3.0E-01	NA	3.0E-01	NA	NA	1.4E-01	1.0E+00	2.5E+00	NA	7.3E-01	NA	1.8E+03	NA	4.6E+01	2.3E+01	2.3E+01	NA	NA	NA	2.3E+01
56-55-3	Benzo(a)anthracene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	2.0E+00	4.8E+00	1.0E+00	3.2E+00	--	2.6E+02	NA	NA	NA	NA	NA	1.0E-02	1.0E-02	1.0E-02
50-32-8	Benzo(a)pyrene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.1E+00	--	2.7E+00	6.5E+00	1.0E+00	4.4E+00	--	5.2E+03	NA	NA	NA	NA	NA	5.1E-05	5.1E-05	5.1E-05
205-99-2	Benzo(b)fluoranthene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	2.7E+00	6.5E+00	1.0E+00	2.5E+00	--	3.0E+03	NA	NA	NA	NA	NA	8.7E-04	8.7E-04	8.7E-04
191-24-2	Benzo(g,h,i)perylene	No	NA	NA	NA	NA	NA	NA	1.1E+00	NA	NA	NA	NA	NA	1.1E+04	NA	NA	NA	NA	NA	NA	NA	NA
207-08-9	Benzo(k)fluoranthene	Yes	7.3E-02	NA	7.3E-02	NA	NA	1.1E-01	--	2.7E+00	6.5E+00	NA	4.2E+00	NA	5.0E+03	NA	NA	NA	NA	NA	5.3E-03	5.3E-03	5.3E-03
218-01-9	Chrysene	Yes	7.3E-03	NA	7.3E-03	NA	NA	1.1E-02	--	2.0E+00	4.8E+00	1.0E+00	3.5E+00	--	3.2E+03	NA	NA	NA	NA	NA	8.3E-02	8.3E-02	8.3E-02
53-70-3	Dibenz(a,h)anthracene	Yes	7.3E+00	NA	7.3E+00	NA	NA	1.2E+00	--	3.8E+00	9.1E+00	6.0E-01	6.1E+00	--	9.6E+03	NA	NA	NA	NA	NA	2.7E-05	2.7E-05	2.7E-05
105-67-9	2,4-Dimethylphenol	No	NA	2.0E-02	NA	2.0E-02	NA	NA	1.1E-02	5.1E-01	1.2E+00	1.0E+00	4.6E-02	1.1E-02	1.5E+01	3.0E+04	3.6E+02	1.8E+02	1.8E+02	NA	NA	NA	1.8E+02
84-74-2	Di-n-butylphthalate	No	NA	1.0E-01	NA	1.0E-01	NA	NA	4.2E-02	3.8E+00	9.1E+00	9.0E-01	2.7E-01	1.0E-01	1.7E+02	1.6E+04	1.6E+02	8.2E+01	8.2E+01	NA	NA	NA	8.2E+01
206-44-0	Fluoranthene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	--	1.4E+00	3.4E+00	1.0E+00	1.7E+00	--	3.6E+03	NA	3.0E+00	1.5E+00	1.5E+00	NA	NA	NA	1.5E+00
86-73-7	Fluorene	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.1E-01	9.0E-01	2.2E+00	NA	5.5E-01	NA	5.3E+02	NA	2.1E+01	1.0E+01	1.0E+01	NA	NA	NA	1.0E+01
193-39-5	Indeno(1,2,3-cd)pyrene	Yes	7.3E-01	NA	7.3E-01	NA	NA	1.1E-01	--	3.7E+00	8.9E+00	6.0E-01	7.9E+00	--	1.2E+04	NA	NA	NA	NA	NA	2.2E-04	2.2E-04	2.2E-04
90-12-0	1-Methylnaphthalene	No	2.9E-02	7.0E-02	2.9E-02	7.0E-02	NA	NA	9.3E-02	6.6E-01	1.6E+00	NA	4.3E-01	NA	5.3E+01	NA	3.6E+02	1.8E+02	1.8E+02	NA	4.1E+00	4.1E+00	4.1E+00
91-57-6	2-Methylnaphthalene	No	NA	4.0E-03	NA	4.0E-03	NA	NA	9.2E-02	6.6E-01	1.6E+00	NA	4.2E-01	NA	7.5E+01	NA	1.5E+01	7.4E+00	7.4E+00	NA	NA	NA	7.4E+00
95-48-7	2-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	7.7E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	6.9E-03	1.1E+01	1.2E+05	1.3E+03	6.4E+02	6.4E+02	NA	NA	NA	6.4E+02
108-39-4	3-Methylphenol	No	NA	5.0E-02	NA	5.0E-02	6.0E-01	NA	7.8E-03	4.2E-01	1.0E+00	1.0E+00	3.1E-02	7.0E-03	9.1E+00	1.2E+05	1.5E+03	7.5E+02	7.5E+02	NA	NA	NA	7.5E+02
106-44-5	4-Methylphenol	No	NA	1.0E-01	NA	1.0E-01	6.0E-01	NA	7.5E-03	4.2E-01	1.0E+00	1.0E+00	3.0E-02	6.8E-03	8.9E+00	2.4E+05	3.1E+03	1.6E+03	1.6E+03	NA	NA	NA	1.6E+03
34mp	3&4-Methylphenol [j]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2E+05	1.5E+03	7.5E+02	7.5E+02	NA	NA	NA	7.5E+02
91-20-3	Naphthalene	No	NA	2.0E-02	NA	2.0E-02	3.0E-03	3.4E-02	4.7E-02	5.5E-01	1.3E+00	1.0E+00	2.0E-01	4.8E-02	8.5E+01	6.8E+03	6.5E+01	3.3E+01	3.3E+01	NA	NA	NA	3.3E+01
85-01-8	Phenanthrene	No	NA	NA	NA	NA	NA	NA	--	1.1E+00	2.5E+00	1.0E+00	7.0E-01	--	2.5E+03	NA	NA	NA	NA	NA	NA	NA	NA
108-95-2	Phenol	No	NA	3.0E-01	NA	3.0E-01	2.0E-01	NA	4.3E-03	3.5E-01	8.5E-01	1.0E+00	1.6E-02	3.6E-03	1.7E+01	1.4E+06	4.7E+03	2.4E+03	2.4E+03	NA	NA	NA	2.4E+03
129-00-0	Pyrene	No	NA	3.0E-02	NA	3.0E-02	NA	NA	2.0E-01	1.4E+00	3.4E+00	NA	1.1E+00	NA	1.5E+03	NA	5.5E+00	2.7E+00	2.7E+00	NA	NA	NA	2.7E+00

Table B-13
Tier II Water Action Levels
Current Nonresident Subsistence User Receptor
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes			Toxicity Values [a]						Chemical Properties [a]							Subsistence User ALs							
			Oral		Dermal		Inhalation		Dermal Factors							Noncarcinogen [c]				Carcinogen [c]			
CAS #	Chemical Name	Mutagen? [a]	SFo (mg/kg-d)$^{-1}$	RfDo (mg/kg-d)	SFd (mg/kg-d)$^{-1}$	RfDd (mg/kg-d)	RfCi (mg/m^3)	URFi (mg/m^3)$^{-1}$	Kp (cm/hr)	τ (hr/event)	t* (hr/event)	FA (Unitless)	B (Unitless)	DA_{event} [b] cm/event	Fish BCF (L/kg)	SU - Dermal (NC) [d] (μg/L)	SU Adult - Diet (NC) [e] (μg/L)	SU Child - Diet (NC) [e] (μg/L)	SU - Total (NC) [f] (μg/L)	SU - Dermal (C) [g] (μg/L)	SU - Diet (C) [h] (μg/L)	SU - Total (C) [f] (μg/L)	Lowest Total AL [i] (μg/L)
Metals																							
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	2.0E-03	--	--	--	--	--	--	--	--	--	--
7440-36-0	Antimony	No	NA	4.0E-04	NA	6.0E-05	NA	NA	1.0E-03	5.1E-01	1.2E+00	--	4.2E-03	2.5E-04	1.0E+02	3.9E+03	1.1E+00	5.5E-01	5.5E-01	NA	NA	NA	5.5E-01
7440-38-2	Arsenic	No	1.5E+00	3.0E-04	1.5E+00	3.0E-04	1.5E-05	4.3E+00	1.0E-03	2.8E-01	6.6E-01	--	3.3E-03	2.5E-04	3.0E+02	1.9E+04	2.7E-01	1.4E-01	1.4E-01	1.2E+03	1.4E-02	1.4E-02	1.4E-02
7440-39-3	Barium	No	NA	2.0E-01	NA	1.4E-02	5.0E-04	NA	1.0E-03	6.2E-01	1.5E+00	--	4.5E-03	2.5E-04	4.0E+00	9.0E+05	1.4E+04	6.9E+03	6.9E+03	NA	NA	NA	6.9E+03
7440-43-9	Cadmium (food)	No	NA	1.0E-03	NA	2.5E-05	1.0E-05	1.8E+00	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	--	2.0E+02	--	1.4E+00	6.9E-01	--	--	NA	--	--
7440-43-9	Cadmium (water)	No	NA	5.0E-04	NA	2.5E-05	1.0E-05	1.8E+00	1.0E-03	4.5E-01	1.1E+00	--	4.1E-03	2.5E-04	2.0E+02	1.6E+03	--	--	6.9E-01	NA	--	NA	6.9E-01
7440-47-3	Chromium	No	NA	NA	NA	NA	NA	NA	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	2.5E-04	2.0E+02	NA	NA	NA	NA	NA	NA	NA	NA
16065-83-1	Chromium (III)	No	NA	1.5E+00	NA	2.0E-02	NA	NA	1.0E-03	2.1E-01	4.9E-01	--	2.8E-03	2.5E-04	NA	1.3E+06	NA	NA	1.3E+06	NA	NA	NA	1.3E+06
18540-29-9	Chromium (VI)	Yes	5.0E-01	3.0E-03	2.0E+01	7.5E-05	1.0E-04	8.4E+01	2.0E-03	2.1E-01	4.9E-01	--	5.5E-03	5.0E-04	2.0E+02	2.4E+03	4.1E+00	2.1E+00	2.1E+00	4.3E+01	1.9E-02	1.9E-02	1.9E-02
7440-50-8	Copper	No	NA	4.0E-02	NA	4.0E-02	NA	NA	1.0E-03	2.4E-01	5.7E-01	--	3.1E-03	2.5E-04	2.0E+02	2.6E+06	5.5E+01	2.7E+01	2.7E+01	NA	NA	NA	2.7E+01
7439-92-1	Lead	No	NA	NA	NA	NA	NA	NA	1.0E-04	1.5E+00	3.7E+00	--	5.5E-04	2.5E-05	3.0E+02	NA	NA	NA	NA	NA	NA	NA	NA
7439-96-5	Manganese	--	--	--	--	--	--	--	1.0E-03	2.1E-01	5.1E-01	--	2.9E-03	--	--	--	--	--	--	--	--	--	--
7487-94-7	Mercury (inorganic salts) [k]	No	NA	3.0E-04	NA	2.1E-05	3.0E-04	NA	1.0E-03	3.5E+00	8.4E+00	--	6.3E-03	2.5E-04	1.0E+03	1.4E+03	8.2E-02	4.1E-02	4.1E-02	NA	NA	NA	4.1E-02
7439-97-6	Mercury (elemental) [k]	No	NA	NA	NA	NA	3.0E-04	NA	1.0E-03	1.4E+00	3.4E+00	--	5.4E-03	2.5E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
7440-02-0	Nickel	No	NA	2.0E-02	NA	8.0E-04	9.0E-05	2.6E-01	2.0E-04	2.2E-01	5.4E-01	--	5.9E-04	5.0E-05	1.0E+02	2.6E+05	5.5E+01	2.7E+01	2.7E+01	NA	NA	NA	2.7E+01
7782-49-2	Selenium	No	NA	5.0E-03	NA	5.0E-03	2.0E-02	NA	1.0E-03	2.9E-01	7.0E-01	--	3.4E-03	2.5E-04	2.0E+02	3.2E+05	6.9E+00	3.4E+00	3.4E+00	NA	NA	NA	3.4E+00
7440-22-4	Silver	No	NA	5.0E-03	NA	2.0E-04	NA	NA	6.0E-04	4.2E-01	1.0E+00	--	2.4E-03	1.5E-04	5.0E+00	2.2E+04	2.7E+02	1.4E+02	1.4E+02	NA	NA	NA	1.4E+02
7440-62-2	Vanadium	No	NA	5.0E-03	NA	1.3E-04	1.0E-04	NA	1.0E-03	2.0E-01	4.9E-01	--	2.7E-03	2.5E-04	NA	8.4E+03	NA	NA	8.4E+03	NA	NA	NA	8.4E+03
7440-66-6	Zinc	No	NA	3.0E-01	NA	3.0E-01	NA	NA	6.0E-04	2.4E-01	5.9E-01	--	1.9E-03	1.5E-04	1.0E+03	3.2E+07	8.2E+01	4.1E+01	4.1E+01	NA	NA	NA	4.1E+01
Inorganics																							
57-12-5	Cyanide	No	NA	6.0E-04	NA	6.0E-04	8.0E-04	NA	1.0E-03	1.5E-01	3.5E-01	NA	2.0E-03	2.5E-04	NA	3.9E+04	NA	NA	3.9E+04	NA	NA	NA	3.9E+04

Abbreviations:

CAS #: Chemical Abstract Service registry number
SFo: oral slope factor
RfDo: oral reference dose
SFd: dermal slope factor
RfDd: dermal reference dose
RfCi: inhalation reference concentration
URFi: inhalation unit risk factor
Kp: dermal permeability coefficient of compound in water
τ: lag time per event
t*: time to reach steady state
FA: fraction absorbed water
B: ratio of the permeability coefficient of a compound through
the stratum corneum relative to its permeability coefficient
across the viable epidermis
DA_{event}: dermally absorbed dose per exposure event
BCF: fish bioaccumulation factor
AL: action level
SU: subsistence user
NC: noncarcinogen
C: carcinogen
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
cm/hr: centimeters per hour
hr/event: hours per event
cm/event: centimeters per event
L/kg: liters per kilogram
μg/L: micrograms per liter
NA: not available
--: not applicable
TCE: trichloroethene

Footnotes:

[a] Toxicity values, dermal factors (Kp, τ, FA, and B), BCFs, and mutagen identification from Table 4. t* = 2.4*τ (EPA 2004).

[b] For organics, where $t_{event} \le t^*$, $DA_{event} = 2*FA*Kp*(6*\tau*t_{event}/\pi)^{0.5}$
For organics, where $t_{event} > t^*$, $DA_{event} = FA*Kp*((t_{event}/1+B) + (2*\tau*(1+3*B+3*B^2/(1+B)^2)$
For inorganics, $DA_{event} = Kp*t_{event}$
DA_{event} equations are from EPA (2004). t_{event} values are shown in Table B-7.

[c] Exposure factors are provided in Table B-7. Equations provided below modified from ADEC (2008b) and EPA (2004, 2015c).

[d] SU Dermal (NC) AL = (THQ*ATnc*BWa*365 d/yr) / (EFw*ED*EV*(1/RfDd)*SAw,a*DA_{event}*CF_2*CF_4)

[e] SU Adult Diet (NC) AL = (THQ*ATnc,a*BWa*365 d/yr) / (EFf*EDa*IRf,a*AUFw*(1/RfDo)*BCF*CF_4)
SU Child Diet (NC) AL = (THQ*ATnc,c*BWc*365 d/yr) / (EFf*EDc*IRf,c*AUFw*(1/RfDo)*BCF*CF_4)

[f] SU Total (NC) AL = Lower of (1/((1/dermal AL)+(1/adult diet AL))) and child diet AL
SU Total (C) AL = 1/((1/dermal AL)+(1/diet AL))

[g] SU Dermal (C) AL = (TR*ATc*365 d/yr) / (EFw*EV*SFd*DFWa*DA_{event}*CF_2*CF_4)

[h] SU Diet (C) AL = (TR*ATc*365 d/yr) / (EFf*SFo*IFFadj*AUFw*BCF*CF_4)
SU Diet (Mutagen) AL = (TR*ATc*365 d/yr) / (EFf*SFo*IFFMadj*AUFw*BCF*CF_4)
SU Diet (Vinyl Chloride) AL = TR / (((EFf*SFo*BCF*IFFadj*AUFw*CF_4)/(ATc*365 d/yr)) + ((SFo*BCF*IRf,c*AUFw*CF_4)/BWc))
SU Diet (TCE) AL = (TR*ATc*365 d/yr) / (EFf*SFo*((CAFo*IFFadj*AUFw)+(MAFo*IFFMadj*AUFw))*BCF*CF_4)

[i] Value is the lower of SU - Total (NC) and SU - Total (C).

[j] Action levels for the more toxic of the coeluting compounds used to represent this mixture.

[k] Values for elemental mercury were used, where available, to calculate water ALs for mercury; otherwise, values for inorganic salts were used.

References:

Alaska Department of Environmental Conservation (ADEC). 2008b. Cleanup Levels Guidance.
Division of Spill Prevention and Response, Contaminated Sites Program. June 9.

U.S. Environmental Protection Agency (EPA). 2004. Risk Assessment Guidance for Superfund Volume I: Human Health
Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005. July.

EPA. 2015c. Regional Screening Level User's Guide. June.
http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015

Table B-14
Critical Effect Basis for Human Health Non-Cancer Toxicity Values
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Values and Basis [a]			
		Oral		Inhalation	
CAS #	Chemical Name	RfDo (mg/kg-d)	RfDo Critical Effect	RfCi (mg/m^3)	RfCi Critical Effect
Volatiles					
67-64-1	Acetone	9.0E-01	Nephropathy	3.1E+01	Neurological effects
107-02-8	Acrolein	5.0E-04	Survival	2.0E-05	Nasal lesions
71-43-2	Benzene	4.0E-03	Hematological effects	3.0E-02	Hematological effects
78-93-3	2-Butanone	6.0E-01	Reproduction	5.0E+00	Developmental toxicity
56-23-5	Carbon tetrachloride	4.0E-03	Elevated serum SDH (biomarker of liver toxicity)	1.0E-01	Liver (fatty changes)
108-90-7	Chlorobenzene	2.0E-02	Liver	5.0E-02	Gastrointestinal tract, kidney, reproductive system
75-00-3	Chloroethane	NA	--	1.0E+01	Developmental toxicity
67-66-3	Chloroform	1.0E-02	Liver, elevated serum glutamate-pyruvate transaminase	9.8E-02	Liver
106-93-4	1,2-Dibromoethane	9.0E-03	Testicular atrophy, liver peliosis, adrenal cortical degeneration	9.0E-03	Nasal inflammation
95-50-1	1,2-Dichlorobenzene	9.0E-02	No adverse effects observed	2.0E-01	Decreased weight gain
75-34-3	1,1-Dichloroethane	2.0E-01	Kidney	NA	--
107-06-2	1,2-Dichloroethane	6.0E-03	Kidney	7.0E-03	Gastrointestinal tract
75-35-4	1,1-Dichloroethene	5.0E-02	Liver	2.0E-01	Liver toxicity
156-59-2	cis-1,2-Dichloroethene	2.0E-03	Kidney	NA	--
156-60-5	trans-1,2-Dichloroethene	2.0E-02	Autoimmune effects	NA	--
60-29-7	Diethyl ether	2.0E-01	Depressed body weight	NA	--
123-91-1	1,4-Dioxane	3.0E-02	Liver and kidney toxicity	3.0E-02	Nasal, liver, and kidney toxicity
100-41-4	Ethylbenzene	1.0E-01	Liver and kidney toxicity	1.0E+00	Developmental toxicity
50-00-0	Formaldehyde	2.0E-01	Reduced body weight gain	9.8E-03	Respiratory system; eyes
67-56-1	Methanol	2.0E+00	Developmental toxicity	2.0E+01	Developmental toxicity
75-09-2	Methylene chloride	6.0E-03	Liver	6.0E-01	Liver
108-10-1	4-Methyl-2-pentanone	8.0E-02	Liver and kidney	3.0E+00	Reproduction, developmental toxicity
103-65-1	n-Propylbenzene	1.0E-01	Ototoxicity, liver and kidney toxicity	1.0E+00	Developmental toxicity
127-18-4	Tetrachloroethene	6.0E-03	Neurotoxicity	4.0E-02	Neurotoxicity
108-88-3	Toluene	8.0E-02	Kidney	5.0E+00	Neurotoxicity
71-55-6	1,1,1-Trichloroethane	2.0E+00	Reduced body weight	5.0E+00	Liver toxicity
79-01-6	Trichloroethene	5.0E-04	Thymus	2.0E-03	Thymus
95-63-6	1,2,4-Trimethylbenzene	5.0E-02	Liver, kidney	7.0E-03	Central nervous system
108-67-8	1,3,5-Trimethylbenzene	1.0E-02	Liver, kidney	6.0E-03	Central nervous system
75-01-4	Vinyl chloride	3.0E-03	Liver	1.0E-01	Liver
1330-20-7	Xylenes	2.0E-01	Body weight, mortality	1.0E-01	Central nervous system
Semi-Volatiles					
83-32-9	Acenaphthene	6.0E-02	Liver toxicity	NA	--
208-96-8	Acenaphthylene	NA	--	NA	--
120-12-7	Anthracene	3.0E-01	No observed effects	NA	--
56-55-3	Benzo(a)anthracene	NA	--	NA	--
50-32-8	Benzo(a)pyrene	NA	--	NA	--
205-99-2	Benzo(b)fluoranthene	NA	--	NA	--
191-24-2	Benzo(g,h,i)perylene	NA	--	NA	--
207-08-9	Benzo(k)fluoranthene	NA	--	NA	--
218-01-9	Chrysene	NA	--	NA	--
53-70-3	Dibenz(a,h)anthracene	NA	--	NA	--
105-67-9	2,4-Dimethylphenol	2.0E-02	Hematological changes	NA	--
84-74-2	Di-n-butylphthalate	1.0E-01	Increased mortality	NA	--
206-44-0	Fluoranthene	4.0E-02	Nephropathy	NA	--
86-73-7	Fluorene	4.0E-02	Hematological effects	NA	--
193-39-5	Indeno(1,2,3-cd)pyrene	NA	--	NA	--
90-12-0	1-Methylnaphthalene	7.0E-02	Hematological effects, liver, central nervous system, eyes, respiratory system	NA	--
91-57-6	2-Methylnaphthalene	4.0E-03	Respiratory system	NA	--
95-48-7	2-Methylphenol	5.0E-02	Reduced body weight gain	6.0E-01	Nervous system
108-39-4	3-Methylphenol	5.0E-02	Neurotoxicity	6.0E-01	Neurotoxicity
106-44-5	4-Methylphenol	1.0E-01	Respiratory system	6.0E-01	Nervous system
34mp	3&4-Methylphenol	--	--	--	--
91-20-3	Naphthalene	2.0E-02	Body weight	3.0E-03	Nose
85-01-8	Phenanthrene	NA	--	NA	--
108-95-2	Phenol	3.0E-01	Reproduction	2.0E-01	Gastrointestinal tract, cardiovascular system, kidney, nervous system
129-00-0	Pyrene	3.0E-02	Kidney	NA	--

Table B-14
Critical Effect Basis for Human Health Non-Cancer Toxicity Values
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Facility, Alaska
BP Exploration (Alaska) Inc.

Target Analytes		Toxicity Values and Basis [a]			
		Oral		Inhalation	
CAS #	Chemical Name	RfDo (mg/kg-d)	RfDo Critical Effect	RfCi (mg/m^3)	RfCi Critical Effect
Metals					
7429-90-5	Aluminum	--	--	--	--
7440-36-0	Antimony	4.0E-04	Longevity, blood glucose, and cholesterol	NA	--
7440-38-2	Arsenic	3.0E-04	Skin	1.5E-05	Development, cardiovascular system, nervous system, lung, skin
7440-39-3	Barium	2.0E-01	Kidney	5.0E-04	Reproduction
7440-43-9	Cadmium (food)	1.0E-03	Kidney	1.0E-05	Kidney
7440-43-9	Cadmium (water)	5.0E-04	Kidney	1.0E-05	Kidney
7440-47-3	Chromium	NA	--	NA	--
16065-83-1	Chromium (III)	1.5E+00	No effects observed	NA	--
18540-29-9	Chromium (VI)	3.0E-03	None reported	1.0E-04	Lung
7440-50-8	Copper	4.0E-02	Gastrointestinal system irritation	NA	--
7439-92-1	Lead	NA	--	NA	--
7439-96-5	Manganese	--	--	--	--
7487-94-7	Mercury (inorganic salts)	3.0E-04	Autoimmune effects	3.0E-04	Central nervous system
7439-97-6	Mercury (elemental)	NA	--	3.0E-04	Central nervous system
7440-02-0	Nickel	2.0E-02	Decreased body weights	9.0E-05	Respiratory system effects
7782-49-2	Selenium	5.0E-03	Clinical selenosis	2.0E-02	Gastrointestinal tract, cardiovascular system, neurological
7440-22-4	Silver	5.0E-03	Skin (argyria)	NA	--
7440-62-2	Vanadium	5.0E-03	Decreased hair cysteine	1.0E-04	Respiratory
7440-66-6	Zinc	3.0E-01	Hematological effects	NA	--
Inorganics					
57-12-5	Cyanide	6.0E-04	Testicular	8.0E-04	Thyroid enlargement, altered iodide uptake

Abbreviations:

CAS #: Chemical Abstract Service registry number
RfDo: oral reference dose
RfCi: inhalation reference concentration
mg/kg-d: milligrams per kilogram body weight per day
mg/m^3: milligrams per cubic meter
NA: not available
--: not applicable

Footnotes:

[a] Toxicity values are from EPA (2015b).
The RfDo value for 1,2,4-trimethylbenzene and the RfCi value for 1,3,5-trimethylbenzene are the recommended values from EPA (1999a), as requested by ADEC.
The URFi for naphthalene is the recommended value from EPA (2007) and is consistent with EPA (2015b).
The critical effect basis for each value was identified using the original value source. Sources cited in EPA (2015b) for each value were used to identify the basis for that value.

References:

U.S. Environmental Protection Agency (EPA). 1999a. Risk Assessment Issue Paper For: Derivation of a Provisional RfD for 1,2,4-Trimethylbenzene (CASRN 95-63-6) and 1,3,5-Trimethylbenzene (CASRN 108-67-8). Superfund Health Risk Technical Support Center, for internal use only. June 30.

EPA. 2007. Recommendations for Human Health Risk-based Chemical Screening and Related Issues at EPA Region 10 CERCLA and RCRA Sites. Memorandum from Michael Cox, Manager, Risk Evaluation Unit, Office of Environmental Assessment. April 17.

EPA. 2015b. Regional Screening Level Table. June. http://www2.epa.gov/risk/risk-based-screening-table-generic-tables

APPENDIX C

TOXICOLOGICAL SUMMARIES AND TIER II SITE-SPECIFIC ACTION LEVEL SPREADSHEETS

APPENDIX C

TOXICOLOGICAL SUMMARIES FOR TIER II ACTION LEVELS

1 VOLATILES

1.1 ACETONE

Based on the literature review, Tier II ALs for acetone were developed for mammals, birds, algae, zooplankton, and fish.

A reproductive study on both rats and mice represents the data used to develop mammalian Tier II ALs. Subchronic NOAELs were identified in this study and used as the basis for TRVs, which ranged from 53 mg/kg to 105 mg/kg across the three indicator species, incorporating UFs ranging from 10 to 20. Resulting Tier II ALs ranged from 6.2 mg/kg (lemming) to 16,000 mg/kg (weasel).

A study on embryo development of acetone-exposed mallard duck embryos represents data used to develop Tier II ALs for birds. A NOAEL value was identified and used as the basis for TRVs for the five indicator bird species, which ranged from 5,000 mg/kg-day to 20,000 mg/kg-day, incorporating UFs ranging from 5 to 20. Resulting Tier II ALs ranged from 670 mg/kg (ptarmigan) to essentially pure product (over 1,000,000 mg/kg for the snowy owl). The Tier II AL is also over 1,000,000 mg/kg for the loon ingesting fish.

Two studies examining growth of acetone-exposed aquatic plants represent data used to develop Tier II ALs for algae. A NOEC value was identified and used as the basis of a Tier II AL of 3,400 mg/L. No UF was needed since the value was a NOEC for relevant species.

Ten reproduction, growth, and/or survival studies with eight species (including *Daphnia magna*, *Daphnia pulex*, and *Ceriodaphnia dubia*), represent data used to develop Tier II ALs for zooplankton. All available studies had nominal concentration measurements rather than measured. NOEC values were identified in all studies, and the 10th percentile value of 484 mg/L was used as the Tier II AL.

Two toxicity studies regarding the effect of acetone on fathead minnows (*Pimephales promelas*) represent data used to develop Tier II ALs for fish. LC_{50} values for the one measured study were determined and used as the basis for a Tier II AL of 621 mg/L, incorporating a UF of 10.

1.2 ACROLEIN

Based on the literature review, Tier II ALs for acrolein were developed for mammals, zooplankton, and fish.

Seven ingestion studies on rats, mice, and/or rabbits examining growth, reproduction, and mortality represent the data considered to develop a Tier II AL for mammals. Five bounded reproductive and growth NOAELs were available for rats and mice across four studies, and the geometric mean of these values of 2.8 mg/kg-day was used as the basis for the TRV. This was lower than the lowest paired chronic LOAEL, so was directly used to develop the TRV. No duration-based UF was necessary since the geometric mean encompassed both subchronic and chronic growth studies and reproductive endpoints. The geometric mean value was divided by taxonomic-based UFs of 2 (for the lemming) or 4 (for the shrew and weasel), resulting in TRVs of 0.7 mg/kg-day for the shrew and weasel, and 1.4 mg/kg-day for the lemming. Resulting Tier II ALs ranged from 0.11 mg/kg (lemming) to 270 mg/kg (shrew).

Five studies examining short-term mortality and long-term reproduction effects to acrolein-exposed daphnids represent data used to develop a Tier II AL for zooplankton. A NOEC value of 0.0169 mg/L was identified and used as the basis of the Tier II AL because it was the lowest bounded, measured NOEC from a chronic reproduction study with the longest duration that used a flow-through test system. No UFs were applied to the NOEC value.

Five mortality, growth and reproduction studies with six different species (including *Pimephales promelas, Oncorhynchus mykiss,* and *Jordanella floridae*), represent data used to develop a Tier II AL for fish. A NOEC value of 0.0114 mg/L was identified and used as the basis of the Tier II AL because it was the lowest bounded, measured NOEC from a chronic reproduction study with the longest duration that used a flow-through test system. The 10th percentile of the LC_{50} values was also calculated to compare to the NOEC value. The results showed that the NOEC value is lower than the 10th percentile of the LC_{50} values. No UFs were applied to the NOEC value.

1.3 BENZENE

Based on the literature review, Tier II ALs for benzene were developed for mammals, algae, zooplankton, and fish.

Three studies on rats, mice, rabbits, and guinea pigs were reviewed for Tier II AL development. One chronic rat study in which a NOAEL was identified for organ histopathology and growth was used as the basis for developing TRVs, which ranged from 0.25 to 0.50 mg/kg-day after incorporating taxonomic-based UFs of 2 or 4. Resulting Tier II ALs ranged from 0.69 mg/kg (lemming) to 97 mg/kg (shrew).

Four photosynthesis and growth studies on five different algae species were reviewed for Tier II AL development. The lowest LC_{50} value, and the only one based on measured concentrations, was used in combination with a UF of 10 to calculate a Tier II AL of 2.9 mg/L for algae.

For zooplankton, four LC_{50} values covering three species and incorporating measured concentrations were identified and used as the basis for calculating a Tier II AL of 1.5 mg/L, including a UF of 10 to extrapolate from a 96-hour LC_{50} to a LOEC.

For fish, a total of five studies covering eight species were reviewed for Tier II AL development. The lowest of the five LC_{50} values from measured studies, including four survival and one growth study on fathead minnows and rainbow trout were used as the basis for calculating a Tier II AL of 0.53 mg/L for fish. A UF of 10 was incorporated to extrapolate from an LC_{50} to a LOEC.

1.4 2-BUTANONE

Based on the literature review, Tier II ALs for 2-butanone (aka methyl ethyl ketone) were developed only for mammals.

A single subchronic rat ingestion study was used for Tier II AL development. This study evaluated many endpoints, including reproduction. A NOAEL was identified, and a UF of 5 was incorporated to extrapolate from subchronic to chronic duration. A second UF of 2 or 4 was also used based on taxonomic differences, resulting in TRVs ranging from 60 mg/kg-day to 120 mg/kg-day. These then yield Tier II ALs for mammalian indicator species ranging from 14 mg/kg (lemming) to 23,000 mg/kg (shrew).

1.5 CARBON TETRACHLORIDE

Based on the literature review, Tier II ALs for carbon tetrachloride were developed for mammals, birds, algae, zooplankton, and fish.

Seven ingestion studies on rats and/or mice examining growth, reproduction, and mortality represent the data considered to develop a Tier II AL for mammals. Although three growth and reproductive NOELs were available for rats, the geometric mean of these values was above the lowest paired LOAEL. Therefore, the subchronic growth study in rats with a measured NOEL of 10 mg/kg-day was used as the basis for the TRV. Since the chronic 2-year reproductive study had the same lower-bound NOEL (although unbounded with a LOEL), no duration-based UF of 10 was necessary. This NOEL was divided by taxonomic-based UFs of 2 (for the lemming) or 4 (for the shrew and weasel), resulting in TRVs of 2.5 mg/kg-day for the shrew and weasel and 5 mg/kg-day for the lemming. Resulting Tier II ALs ranged from 0.35 mg/kg (shrew) to 780 mg/kg (weasel).

One ingestion study on chickens examining growth, reproduction, and mortality represents the data considered to develop a Tier II AL for birds. Two different exposure durations were used, and the longer of the two durations was used as the basis for the TRV. The chronic reproduction NOAEL of 35.6 mg/kg-day from this study was used, and no duration-based UF was necessary. This NOAEL was then divided by taxonomic-based UFs of 2 for the ptarmigan and 4 for the goose, loon, Lapland longspur, and snowy owl, resulting in TRVs of 1.8 mg/kg-day for the latter species, and 3.6 mg/kg-day for the ptarmigan. Resulting Tier II ALs ranged from 0.41 mg/kg (Lapland longspur) to 690 mg/kg (snowy owl).

Two growth studies on two different algae species were reviewed for Tier II AL development. The measured EC_{10} value of 0.0717 mg/L was used calculate a Tier II AL for algae and other phytoplankton. This particular study also employed a sealed bipartite test vessel, which given carbon tetrachloride's volatility, contained the concentration losses due to evaporation and reduced algae growth. No UFs were applied to the EC_{10} value.

Five different toxicity studies covering three different species (*Daphnia magna*, *Monina macrocopa*, and *Tetrahymena pyriformis*) represent the data used to develop a Tier II AL for zooplankton. A mortality-based NOEC value of 7.7 mg/L was used as the basis of the Tier II AL because of the longer duration of the study. The NOEC value was divided by a UF of 5 to extrapolate from a subchronic to chronic duration, resulting in a Tier II AL of 1.54 mg/L.

Three mortality studies for two different species (*Lepomis macrochirus* and *Orizias latipes*) represent the data used to develop a Tier II AL for fish. The lowest LC_{50} value of 27 mg/L for the longer duration was used as the basis of the Tier II AL. The LC_{50} value was divided by a UF of 10 to extrapolate from an LC_{50} to a LOEC value, resulting in a Tier II AL of 2.7 mg/L.

1.6 CHLOROBENZENE

Based on the literature review, Tier II ALs for chlorobenzene were developed for mammals, algae, zooplankton, and fish.

Three studies on mice, rats, and rabbits were evaluated for Tier II AL development. Two rat studies and one mouse study represented the data used to develop Tier II ALs. One of the rat studies was an inhalation study focusing on embryotoxicity and teratogenicity; the other was a chronic oral study that evaluated many body systems. The mouse was also evaluated in this second study. NOAEL values were identified in all studies, and the geometric mean of these values was used as the basis for TRVs for the arctic shrew, brown lemming, and least weasel. After incorporating a taxonomic-based UF ranging from 2 to 4, TRVs ranged from 26 mg/kg to 53 mg/kg, resulting in Tier II ALs between 190 mg/kg (lemming) and 10,000 mg/kg (shrew).

For aquatic species, nine studies across two species of daphnids represented the data used to develop Tier II ALs. The survival study with measured data and the lowest LC_{50} was used to develop a Tier II AL for zooplankton of 0.53 mg/L, after incorporating a UF of 10 to extrapolate from an LC_{50} to a LOEC.

For fish, four studies covering two species were evaluated for Tier II AL development. LC_{50} values were identified in all studies; the value associated with the one measured concentration study was used to develop a Tier II AL for fish of 0.77 mg/L, incorporating a UF of 10 to extrapolate from an LC_{50} to a LOEC.

A single algal study was used that identified an EC_{50} for growth inhibition. This study was used to develop a Tier II value for algae of 1.25 mg/L, incorporating a UF of 10 to extrapolate from an EC_{50} to a LOEC.

1.7 CHLOROETHANE

No relevant toxicity studies could be identified for this chemical, so Tier II ALs were not developed for chloroethane. If necessary, research can be conducted to identify values for chloromethane that can be used as a structural surrogate for evaluating this chemical in a site-specific ecological risk assessment.

1.8 CHLOROFORM

Based on the literature review, Tier II ALs for chloroform were developed for mammals, algae, zooplankton, and fish.

Four ingestion studies on rats, mice, and/or rabbits examining growth, reproduction, and mortality represent the data considered to develop a Tier II AL for mammals. Three reproductive NOAELs in rats and mice were identified, and the geometric mean of these NOAELs of 74.4 mg/kg-day was used as the basis for the TRV. This was lower than the lowest paired LOAEL, so was used to develop the TRV. Since reproductive endpoints were measured, no duration-based UF was necessary. This geometric mean NOAEL was then divided by taxonomic-based UFs of 2 and 4 for the lemming, and the shrew and weasel, respectively, resulting in TRVs of 18.6 mg/kg-day for the shrew and weasel, and 37.2 mg/kg-day for the lemming. Resulting Tier II ALs ranged from 11 mg/kg (shrew) to 5,800 mg/kg (weasel).

Three growth studies on three different algae species (*Skeletonema costatum*, *Chlamydomonas reinhardtii*, and *Scendesmus quadricauda*) represent the data used to develop a Tier II AL for algae and other phytoplankton. The lowest measured EC_{10} value of 3.61 mg/L was used as the basis of the Tier II AL. This particular study also employed a sealed bipartite test vessel, which given chloroform's volatility, contained the concentration losses due to evaporation and reduced algae growth. No UFs were applied to the EC_{10} value.

Five studies on two different species (*Daphnia magna* and *Ceriodaphnia dubia*) represent the data used to develop a Tier II AL for zooplankton. The lowest NOEC value of 6.3 mg/L from a chronic reproduction study that used a closed test vessel was used as the basis of the Tier II AL. No UFs were applied to the NOEC value.

Three mortality studies on four different species (*Micropterus salmoides*, *Ictalurus punctatus*, *Lepomis macrochirus* and *Oncorhynchus mykiss*) represent the data considered to develop a Tier II AL for fish. The lowest measured LC_1 value of 0.0049 mg/L from the longest duration study in hard water was used as the basis of the Tier II AL. Hard water has the closest similarities to the North Slope water quality characteristics based on background values from the Consolidated Background Report (SLR, 2012). This study also employed a continuous flow, closed test system devoid of standing air space which therefore greatly reduced volatility as a test variable. No UFs were applied to the LC_1 value.

1.9 1,2-DIBROMOETHANE

Based on the literature review, Tier II ALs for 1,2-dibromoethane were developed for mammals, birds, zooplankton, and fish.

Seven inhalation studies on rats and/or mice examining growth, reproduction, and mortality represent the data considered to develop a Tier II AL for mammals. Two reproductive NOAELs in rats and two chronic growth NOAELs in rats and mice were identified, and the geometric mean of these four NOAELs of 27.8 mg/kg-day was used as the basis for the TRV. This was lower than the lowest paired chronic LOAEL, so was used to develop the TRV. Since reproductive endpoints and chronic growth endpoints were measured, no duration-based UF was necessary. This geometric mean NOAEL was then divided by taxonomic-based UFs of 2 and 4 for the lemming, and the shrew and weasel, respectively, resulting in TRVs of 6.95 mg/kg-day for the shrew and weasel, and 13.9 mg/kg-day for the lemming. Resulting Tier II ALs ranged from 15 mg/kg (lemming) to 2,700 mg/kg (shrew).

Three ingestion studies on Japanese quail and/or chickens examining growth, reproduction, and mortality represent the data considered to develop a Tier II AL for birds. Two growth NOAELs in quails and chickens and one reproductive NOAEL in chickens were identified, but the geometric mean of these three NOAELs was higher than the lowest paired LOAEL. Therefore, the highest paired NOAEL below the lowest paired LOAEL of 0.28 mg/kg-day (based on reproduction) was used as the basis for the TRV. Since a reproductive endpoint was measured and was the basis for the TRV, no duration-based UF was necessary. This NOAEL was then divided by taxonomic-based UFs of 2 for the ptarmigan and 4 for the goose, loon, Lapland longspur, and snowy owl, resulting in TRVs of 0.07 mg/kg-day for the latter species, and 0.14 mg/kg-day for the ptarmigan. Resulting Tier II ALs ranged from 0.34 mg/kg (ptarmigan) to 27 mg/kg (snowy owl).

A single acute mortality study on two species of daphnids (*Daphnia magna and Ceriodaphnia dubia*) was used to develop the Tier II AL for zooplankton. The lowest measured LC_{50} value of 3.61 mg/L was used as the basis of the Tier II AL. A UF of 10 was incorporated to extrapolate from an LC_{50} to a LOEC value, resulting in a Tier II AL of 0.36 mg/L.

Three mortality and growth studies with three different species (*Oryzias latipes*, *Pimephales promelas*, and *Cyprinodon variegates*) represent the data used to develop a Tier II AL for fish. A NOEC value of 5.81 mg/L was identified and used as the basis of a Tier II AL because it was the lowest bounded, measured NOEC from a chronic growth study with the longest duration that used a flow-through test system. No UF was applied to the NOEC value.

1.10 1,2-DICHLOROBENZENE

Based on the literature review, Tier II ALs were developed for mammals, algae, zooplankton, and fish.

A single 2-year study on systemic effects of 1,2-dichlorobenzene in rats and mice resulted in a chronic LOAEL value. This value was used as the basis for TRVs for the arctic shrew, brown lemming and least weasel, which ranged from 3 mg/kg-day to 6 mg/kg-day. These values include a UF of 5 to extrapolate from a LOAEL to a NOAEL, and taxonomic UFs of 2 and 4. Overall UFs for mammals therefore ranged from 10 to 20. Resulting Tier II ALs ranged from 45 mg/kg (lemming) to 1,200 mg/kg (shrew).

For aquatic species, seven studies across three species represented the data considered to develop Tier II ALs. Since all studies used nominal concentrations, the lowest NOEC was used to develop a Tier II AL for zooplankton of 0.36 mg/L. No UF was needed since the endpoint was a NOEC.

For fish, three studies covering two species were evaluated for Tier II AL development. LC_{50} values were identified in all studies; the lowest LC_{50} value associated with the one measured concentration study was used to develop a Tier II AL for fish of 0.48 mg/L, incorporating a UF of 10 to extrapolate from an LC_{50} to a LOEC.

A single algal study was used that identified an EC_{50} for growth inhibition. This study was used to develop a Tier II value for algae of 1.7 mg/L, incorporating a UF of 10 to extrapolate from an EC_{50} to a LOEC.

1.11 1,1-DICHLOROETHANE

Based on the literature review, Tier II ALs were developed only for fish.

A single lethality study on fathead minnows was used that identified a 24-hour NOEC. After incorporating a UF of 5 to extrapolate from subchronic to chronic duration, the resulting fish Tier II AL was 20 mg/L.

For terrestrial species, the more toxic 1,2-dichloroethane is used as a structural surrogate for screening this chemical (Section 1.12).

1.12 1,2-DICHLOROETHANE

Based on the literature review, Tier II ALs for 1,2 DCA were developed for mammals, birds, zooplankton, and fish.

Two reproductive studies (one each on rats and mice) provided two chronic NOAEL values for reproduction. The growth NOAEL was not included because it was an endpoint in the parent rather than the offspring. The lower of the two chronic NOAELs of 50 mg/kg-day was used as the basis for Tier II ALs for the arctic shrew, brown lemming and least weasel. TRVs ranged from 13 mg/kg-day to 25 mg/kg-day after incorporating taxonomic-based UFs of 2 (lemming) or 4 (shrew and weasel). Resulting Tier II ALs ranged from 15 mg/kg (lemming) to 4,800 mg/kg (shrew).

A single study on the reproductive effects of 1,2 DCA on the leghorn chicken represents the data used in development for Tier II ALs for the five indicator bird species. Chronic LOAEL values for reduced egg weight and reduced egg production were determined in the study. These values were then used to develop TRVs that ranged from 0.44 mg/kg-day to 1.75 mg/kg-day after incorporating a toxicity-based UF of 5 for all five indicator species and an additional taxonomic UF of 4 for the goose and loon. Resulting Tier II ALs ranged from 1.8 mg/kg (goose) to 170 mg/kg (owl). Incorporating fish ingestion by the loon yielded a Tier II AL of 420 mg/kg.

For aquatic species, three studies on *Daphnia magna* represented the data considered to develop Tier II ALs. The 28-day study on reproduction was also the only one with measured data; the NOEC from this study was used to develop a Tier II AL for zooplankton of 11 mg/L. No UF was needed since the endpoint was a NOEC.

For fish, two studies on the fathead minnow were evaluated for Tier II AL development. A maximum allowable tolerable concentration (MATC) for reproduction was identified in the study with measured data. The MATC value was used to develop a Tier II AL for fish of 5.8 mg/L, incorporating a UF of 5 to extrapolate from short-term to chronic duration.

1.13 1,1-DICHLOROETHENE

Based on the literature review, only mammalian Tier II ALs were developed for 1,1-dichloroethene.

Four different studies represent data used in AL development in which various effects of 1,1-dichloroethene on rats and rabbits were examined. Both ingestion and inhalation exposures were studied. The four study results chosen to develop Tier II ALs were related to reproductive effects such as fertility, abnormal fetuses, percent of live births, and fertility indices, included both tested species, and covered both exposure routes. NOAEL values were identified in all studies and provided the basis for Tier II ALs for the arctic shrew, brown lemming, and least weasel. The geometric mean of the reproductive NOAELs were used to develop TRVs ranging from 3.7 mg/kg-day to 7.4 mg/kg-day after incorporating taxonomic-based UF of two (lemming) and four (shrew and weasel). Resulting Tier II ALs ranged from 10 mg/kg (lemming) to 1,400 mg/kg (shrew).

1.14 CIS-1,2-DICHLOROETHENE

Literature studies did not differentiate between the cis- and trans- isomers. Therefore, the information provided below for trans-1,2-dichloroethene (DCE) is also directly relevant for this isomer.

1.15 TRANS-1,2-DICHLOROETHENE

Based on the literature review, Tier II ALs for trans-1,2-DCE were developed for zooplankton and fish.

Sample et al. (1997) identified a mammalian benchmark of 45 mg/kg-day, which was incorporated as the mammalian TRV for this study given a lack of available literature. From this TRV, Tier II ALs were developed that ranged from 59 mg/kg (lemming) to 18,000 mg/kg (shrew). Note that a different plant BAF is used for cis-1,2-DCE, leading to a Tier II AL of 44 mg/kg for the lemming.

A single study on lethality of 1,2 DCE to *Daphnia* represents data used in development of a Tier II AL for zooplankton. A 48-hour LC_{50} value was determined and used as the basis for a Tier II AL of 22 mg/L after incorporating a UF of 10 to convert from an LC_{50} to a LOEC. A single study on lethality of 1,2 DCE to the fathead minnow represents data used in development of a Tier II AL for fish. A 24-hour NOEC value was identified and used as the basis for a Tier II AL for fish of 20 mg/L after incorporating a UF of 5 to extrapolate from short-term to chronic duration.

1.16 DIETHYL ETHER

Based on the literature review, Tier II ALs for diethyl ether were developed for mammals and fish.

Three inhalation studies on rats, mice, and guinea pigs examining growth, reproduction, and mortality represent the data considered to develop a Tier II AL for mammals. One reproductive NOAEL in mice and two subchronic growth NOAELs in rats were identified, and the geometric mean of these three NOAELs of 7,219 mg/kg-day was used as the basis for the TRV. There were no paired LOAELs for any study, so the geometric mean was used to develop the TRV. Since reproductive endpoints were measured, no duration-based UF was necessary. This geometric mean NOAEL was then divided by taxonomic-based UFs of 2 and 4 for the lemming, and the shrew and weasel, respectively, resulting in TRVs of 1,805 mg/kg-day for the shrew and weasel, and 3,610 mg/kg-day for the lemming. Resulting Tier II ALs ranged from 960 mg/kg (lemming) to 700,000 mg/kg (shrew).

Three studies covering three different species (*Lepomis macrochirus*, *Pimephales promelas*, and *Leuciscus idus ssp. Melantus*) represent the data used for the development of a Tier II AL for fish. The lowest measured LC_{50} value of 2,560 mg/L from the longer duration study that used a flow-through test system was used to develop a Tier II AL. The LC_{50} value was divided by a UF of 10 to extrapolate to a LOEC value, resulting in a Tier II AL of 260 mg/L.

1.17 1,4-DIOXANE

Based on the literature review, only mammalian Tier II ALs were developed. The single chronic study used to develop ALs was conducted with rats and examined internal organ damage after a 2-year exposure to 1,4-dioxane. An NOAEL value was identified and used as the basis for determining Tier II ALs for the arctic shrew, brown lemming and least weasel. TRVs ranged from 25 mg/kg-day to 50 mg/kg-day after incorporating UFs of 2 or 4 for taxonomic differences. Resulting Tier II ALs ranged from 2.8 mg/kg (lemming) to 7,800 mg/kg (weasel).

1.18 ETHYLBENZENE

Based on the literature review, Tier II ALs were developed for mammals, algae, zooplankton, and fish.

A single chronic study on rats, mice, rabbits, guinea pigs and rhesus monkeys was reviewed for Tier II AL development. One rat study was used to develop ALs, in which a NOAEL was identified for organ histopathology and growth. This NOAEL was used as the basis for calculating TRVs of 34 mg/kg-day and 68 mg/kg-day after incorporating UFs of 2 or 4 for taxonomic differences. This yielded Tier II ALs ranging from 360 mg/kg (lemming) to 13,000 mg/kg (shrew).

For aquatic organisms, EC_{50} values were available from three growth and photosynthesis inhibition studies on four different algae species. The single study based on measured concentrations, which also had the lowest EC_{50}, was used as the basis for calculating a Tier II AL of 0.46 mg/L for algae after incorporating a UF of 10 to convert from an LC_{50} to a LOEC.

Five mortality studies on two species of zooplankton were reviewed for Tier II AL development. LC_{50} values in all studies were available; the lowest point estimate value from measured studies (2.2 mg/L) was used as the basis for calculating a Tier II AL of 0.22 mg/L for zooplankton after incorporating a UF of 10 to convert from an LC_{50} to a LOEC.

Eighteen mortality studies in seven species of fish were reviewed for Tier II AL development. Fewer than 10 measured study values were available when considering only the longest duration measured within a study. Therefore, the lowest LC_{50} from measured data was used as the basis for calculating a Tier II AL of 0.42 mg/L for fish after incorporating a UF of 10 to convert from an LC_{50} to a LOEC.

1.19 FORMALDEHYDE

Based on the literature review, Tier II ALs were developed for mammals, algae, zooplankton, and fish.

Two studies on rats, two studies on dogs, and one study on mice were considered to develop ALs for mammalian indicator species. NOAELs were identified in all of the studies. One dog and one mouse study focused on growth and development endpoints, and the lowest three NOAELs from these two studies were used as the basis for calculating the TRVs. The geometric mean of 72.5 mg/kg-day was divided by a UF of 5 to extrapolate from subchronic to chronic duration, and taxonomic-based UFs of 2 (weasel) and 4 (lemming and shrew) were also incorporated, resulting in mammalian TRVs ranging from 3.6 mg/kg-day to 7.2 mg/kg-day. This yields Tier II ALs ranging from 0.47 mg/kg (lemming) to 2,200 mg/kg (weasel).

For aquatic plants, two studies on different species of algae were reviewed; the one measured concentration study identified a 14-day EC_5 value for photosynthesis. This chronic value was used to develop a Tier II AL of 3.7 mg/L for algae. No UF was necessary since a chronic EC_5 is consistent with the LOEC target for aquatic organisms.

For zooplankton, four survival studies and one growth study on four species were considered to develop Tier II ALs. An EC_{10} was identified in one measured concentration study, which was used preferentially over a nominal-based EC_{10} value, to develop a Tier II AL of 1.9 mg/L. As for algae, no UF was necessary since an EC_{10} was used to develop the AL.

For fish, the single 48-hour LC_{10} on rainbow trout was used to develop a Tier II AL of 29 mg/L. As for algae, no UF was necessary since an EC_{10} was used to develop the AL.

1.20 METHANOL

Based on the literature review, Tier II ALs were developed for mammals, zooplankton, and fish.

One subchronic rat study was used to develop ALs for mammalian indicator species. A NOAEL was identified in the study, which evaluated numerous endpoints. The NOAEL was used as the basis for calculating Tier II ALs. After incorporating a UF of 5 to extrapolate from subchronic to chronic duration and taxonomic factors of 2 and 4, overall UFs of 10 and 20 were used to arrive at TRVs ranging from 25 mg/kg-day to 50 mg/kg-day. Calculated Tier II ALs ranged from 1.4 mg/kg (lemming) to 9,700 mg/kg (shrew). Since the Tier II AL for the lemming is below the Tier I SL of 30 mg/kg, which is the lowest regulatory screening value available, this value of 1.4 mg/kg is considered artificially low due to the incorporation of a UF and high modeled plant uptake. Therefore, the Tier I SL of 30 mg/kg will be used as the Tier II AL for the lemming. For the shrew and weasel, the calculated Tier II ALs are above the Tier I SL and will be used as Tier II values.

Seven studies on eight species of zooplankton, including *Daphnia*, were considered in AL development. LC_{50} values were identified in the seven studies, incorporating different species and the longest duration of exposure for each species. All studies had nominal concentrations, and the lowest LC_{50} was used in combination with a UF of 10 to extrapolate from an LC_{50} to a LOEC to develop a Tier II AL for zooplankton of 329 mg/L.

Five studies on four species of fish were considered in developing an AL for fish. Only LC_{50} values were available, and the lower value across the two studies based on measured concentrations was used to develop Tier II AL for fish of 1,550 mg/L. This incorporates a UF of 10 to extrapolate from an LC_{50} to a LOEC.

1.21 METHYLENE CHLORIDE

Based on the literature review, Tier II ALs for methylene chloride were developed for mammals, algae, zooplankton, and fish.

Three ingestion studies on rats examining growth, reproduction, and mortality represent the data considered to develop a Tier II AL for mammals. One reproductive NOAEL and two chronic growth NOAELs were identified, and the geometric mean of these three NOAELs of 79 mg/kg-day was used as the basis for the TRV. This is lower than the lowest paired LOAEL, so the geometric mean was used to develop the TRV. Since reproductive endpoints and chronic growth endpoints were measured, no duration-based UF was necessary. This geometric mean NOAEL was then divided by taxonomic-based UFs of 2 and 4 for the lemming, and the shrew and weasel, respectively, resulting in TRVs of 19.8 mg/kg-day for the shrew and weasel, and 39.5 mg/kg-day for the lemming. Resulting Tier II ALs ranged from 17 mg/kg (lemming) to 6,100 mg/kg (weasel).

Two growth studies for two different species of algae (*Selenastrum capricornutum* and *Chlamydomonas reinhardtii*) represented the data considered to develop a Tier II AL for algae and other phytoplankton. The lowest NOEC value of 56 mg/L from the longer duration study was used to develop a Tier II AL. No UFs were applied to the NOEC value.

Six mortality studies on two different species (*Daphnia magna* and *Streptocephalus proboscideus*) represent the data considered to develop a Tier II AL for zooplankton. The lowest bounded NOEC value of 68 mg/L was used to develop a Tier II AL. The NOEC value was divided by a UF of 5 to extrapolate from a subchronic to chronic duration, resulting in a Tier II AL of 13.6 mg/L.

Four studies covering three different species (*Pimephales promelas*, *Lepomis macrochirus*, and *Cyprinodon variegates*) represent the data considered to develop a Tier II AL for fish. The lowest measured LC_{10} value of 51.2 mg/L, from the longest duration in the study that used a flow-through system, was used to develop a Tier II AL. The LC_{10} value was divided by a UF of 5 to extrapolate from a subchronic to chronic duration, resulting in a Tier II AL of 10.24 mg/L.

1.22 4-METHYL-2-PENTANONE

Based on the literature review, Tier II ALs were developed only for aquatic organisms, including algae, zooplankton, and fish. One study on algae, one on zooplankton, and three on fish species were reviewed for Tier II AL development.

Sample et al. (1997) identified a mammalian benchmark of 25 mg/kg-day, which was incorporated as the mammalian TRV for this study given a lack of available literature. From this TRV, Tier II ALs were developed that ranged from 12 mg/kg (lemming) to 9,700 mg/kg (shrew).

The single 2-hour study on algae examined enzyme activity and identified an EC_5, which was used as the basis for a Tier II AL. Since an EC_5 is essentially equal to a LOEC, no UF was needed. Therefore, a Tier II AL of 580 mg/L was identified for this measured concentration study.

The one zooplankton study was a chronic study on *Daphnia* with effects on reproduction. A 21-day NOEC was identified in this study and used as the basis for a Tier II AL of 3.9 mg/L. No UF was incorporated since this was a chronic NOEC study.

For fish, a measured concentration chronic reproductive study on fathead minnows identified a NOAEL, which was used as the basis for a Tier II AL of 57 mg/L for fish. No UF was incorporated since this was a chronic NOEC study.

1.23 N-PROPYLBENZENE

Based on the literature review, Tier II ALs for n-propylbenzene were developed for mammals, algae, zooplankton, and fish.

Two studies on rats and one study on rabbits were considered to develop ALs for mammalian indicator species. One NOAEL was identified from the study on rabbits (NAS, 1977). Unfortunately the National Academy of Sciences (1977) summary lacked sufficient study detail and citation information to either confirm the toxicity levels or obtain the full reference. The remaining two rat studies focused on ototoxicity following ingestion, and body and liver weights and cytochrome P450 expression following intraperitoneal injection. LOAELs were identified in both rat studies and the lowest LOAEL of 1018 mg/kg-day from the longest relevant study was used as the basis for calculating mammal TRVs. There were no paired LOAELs for any study, so the ototoxicity LOAEL was used to develop the TRV. This subchronic LOAEL was then divided by a UF of 10 to extrapolate to a chronic NOAEL, and taxonomic-based UFs of 2 (lemming) and 4 (weasel and shrew) were also incorporated, resulting in mammalian TRVs of 25 mg/kg-day for the shrew and weasel, and 51 mg/kg-day (for the lemming). Resulting Tier II ALs ranged from 520 mg/kg (lemming) to 9,900 mg/kg (shrew).

For aquatic organisms, EC_{50} values were available from two growth and photosynthesis inhibition studies on three different species of algae (*Chlorella vulgaris, Selenastrum capricornutum* and *Chlamydomonas angulosa*). The single longest study based on measured concentrations, which also had the lowest EC_{50}, was used as the basis for calculating a Tier II AL for algae. A UF of 10 was applied to convert from an EC_{50} to a LOEC value, resulting in a Tier II AL of 0.18 mg/L.

Two mortality studies on *Daphnia magna* were reviewed for Tier II AL development. LC_{50} values were the same in both measured studies (2.0 mg/L). This was divided by a UF of 10 to convert from an LC_{50} to a LOEC, resulting in a Tier II AL of 0.20 mg/L.

Two mortality studies covering two different species of fish (*Salmo gairdneri and Bryconamericus iheringii*) represent the data considered to develop a Tier II AL. Both studies focused on 96-hr mortality with measured concentrations; however one study used a warm water species while the other used a cold water species. Therefore, the lowest LC_{50} from cold water species measured data of 1.55 mg/L was used as the basis to develop a Tier II AL. The LC_{50} value was divided by a UF of 10 to extrapolate from an LC_{50} to a LOEC, resulting in a Tier II AL of 0.16 mg/L for fish.

1.24 TETRACHLOROETHENE

Based on results of the literature review, only mammalian Tier II ALs were developed for tetrachloroethene (PCE).

The Tier II AL was developed for PCE using two subchronic hepatotoxicity studies conducted with rats and mice. NOAEL values were identified in both studies and were used as the basis for Tier II ALs developed for the arctic shrew, brown lemming, and least weasel. A toxicity-based UF of 5 was applied to extrapolate from subchronic to chronic duration, and taxonomic-based UFs of 2 and 4 were used to develop TRVs ranging from 0.7 mg/kg-day to 1.4 mg/kg-day. This results in Tier II ALs ranging from 10 mg/kg (lemming) to 270 mg/kg (shrew).

1.25 TOLUENE

Based on the literature review, Tier II ALs were developed for mammals, plants, algae, zooplankton, and fish.

Three studies involving rats, mice, and rabbits were reviewed for Tier II AL development. A NOAEL value from one subchronic rat general toxicity study was used as the basis to calculate Tier II ALs for mammals. A toxicity-based UF of 5 was applied to extrapolate from subchronic to chronic duration, and taxonomic-based UFs of 2 and 4 were used to develop TRVs ranging from 0.62 to 1.25 mg/kg-day. This yields Tier II ALs ranging from 3.8 mg/kg (lemming) to 240 mg/kg (shrew).

For terrestrial plants, one growth study on three different species (corn, soybeans, and fescue) was used to develop an AL for terrestrial plants. The geometric mean of the EC_{10} values from the three studies were used as a basis for calculating a Tier II AL of 684 mg/kg for terrestrial plants. No UF was incorporated since an EC_{10} is consistent with the target for this receptor group.

For algae, three growth and photosynthesis inhibition studies on four different algae species were considered in developing a Tier II AL. EC_{50} values were identified in all studies; the EC_{50} value from the measured study was used to develop the Tier II AL. A UF of 10 was applied to extrapolate from an EC_{50} to a LOEC, resulting in a Tier II AL of 1.25 mg/L.

Eight mortality studies on two species of zooplankton were used as the basis for calculating a Tier II AL. Seven LC_{50} and EC_{50} values for reproduction were identified; the two measured studies both identified LC_{50}/EC_{50} values of 7 mg/L. This value was divided by a UF of 10 to extrapolate from an EC_{50} to a LOEC, resulting in a Tier II AL of 0.70 mg/L for zooplankton.

A total of 14 studies representing different six species of fish were reviewed for Tier II AL development. Six values were based on measured concentrations. The lowest NOEC value from these six studies was used as the basis for calculating a Tier II AL of 4.0 mg/L for fish. No UF was incorporated since a chronic (32-day) NOEC was identified.

1.26 1,1,1-TRICHLOROETHANE

Based on the literature review, Tier II ALs were developed for mammals, algae, zooplankton, and fish.

Three studies on rats and mice were reviewed for Tier II AL development, and chronic reproductive and developmental studies on these species were used to develop Tier II ALs. NOAELs were identified in all studies, and the geometric mean was used in combination with taxonomic-based UFs of 2 and 4 to generate TRVs for mammals ranging from 23 mg/kg-day to 46 mg/kg-day. This results in Tier II ALs ranging from 100 mg/kg (lemming) to 9,000 mg/kg (shrew).

For aquatic organisms, one 14-day photosynthesis study on algae was used to develop a Tier II AL. An EC_{20} of 31 mg/L was identified for algae, which was identified as the Tier II AL. No UF was incorporated since an EC_{20} is consistent with the objectives for this receptor group.

Three studies were reviewed to develop a Tier II AL for zooplankton. A single chronic survival and reproduction study on *Daphnia* identified a NOEC based on measured concentrations and was used to develop a Tier II AL of 1.3 mg/L for zooplankton.

Three studies were reviewed to develop a Tier II AL for fish. Two of the fish studies evaluated survival and equilibrium in fathead minnows. EC_{10} and EC_{50} values based on measured concentrations were identified, the lower of which was used to develop a Tier II AL of 9.0 mg/L for fish. No UF was incorporated since an EC_{10} was identified.

1.27 TRICHLOROETHENE

Based on the literature review, only mammalian Tier II ALs were developed for trichloroethene.

Data from two studies on mice and rats were used in the development of Tier II ALs for the arctic shrew, brown lemming and least weasel. One study, utilizing both rats and mice exposed to trichloroethene, monitored general toxicity for two years. The lowest LOAEL from this study on rats was used as the basis for TRVs, which ranged from 1.1 mg/kg-day to 2.2 mg/kg-day for mammals after incorporating UFs of 5 to extrapolate from a chronic LOAEL to a chronic NOAEL, and 2 or 4 for taxonomic differences. Resulting Tier II ALs ranged from 4.5 mg/kg (lemming) to 430 mg/kg (shrew).

1.28 1,2,4-TRIMETHYLBENZENE

Based on the literature review, Tier II ALs were developed for mammals, zooplankton, and fish.

Three studies examining reproduction and mortality represent the data considered to develop a Tier II AL for mammals. The study on both rats and mice was an inhalation study that did not evaluate target endpoints. The single oral study was chronic, but evaluated only survival. The remaining study evaluated reproductive effects in rats, and a NOAEL of 463.6 mg/kg-day was used as the basis for the TRV. The parent generation exhibited toxicity (reduced body weight gain and food consumption) at the same dose level as did the offspring (927.2 mg/kg-day), so the developmental toxicity seen may have been related to a lack of nutrition. Based on this, the NOAEL was divided by a UF of 5 to extrapolate from subchronic to chronic duration, which should be protective of chronic exposure by the parent. This resulting value was then divided by taxonomic-based UFs of 2 and 4 for the lemming, and the shrew and weasel, respectively, resulting in TRVs of 23.2 mg/kg-day for the shrew and weasel, and 46.4 mg/kg-day for the lemming. Resulting Tier II ALs ranged from 440 mg/kg (lemming) to 9,000 mg/kg (shrew).

A single short-term immobility study on *Daphnia magna* was used to develop a Tier II AL for zooplankton. The two day LC_{50} value of 3.61 mg/L was used as the basis of a Tier II AL. A UF of 10 was incorporated to extrapolate from an LC_{50} to a LOEC value, resulting in a Tier II AL of 0.36 mg/L.

Three mortality studies of four different species (*Oncorhynchus mykiss*, *Petromyzon marinus*, *Tilapia zillii,* and *Pimephales promelas*) represent the data used to develop a Tier II AL for fish. The lowest LC_{50} value of 7.72 mg/L was used as the basis of a Tier II AL as it was the only measured value from a study that used a flow-through test system. The lower unbounded NOEC was rejected because it was a very short-term, static test that applied a single dose to the organisms. The LC_{50} value was divided by a UF of 10 to extrapolate to a LOEC value, resulting in a Tier II AL of 0.77 mg/L.

1.29 1,3,5-TRIMETHYLBENZENE

Based on the literature review, only mammalian Tier II ALs were developed for 1,3,5-trimethylbenzene.

Data were available for only a single inhalation-based reproduction study on rats. The NOAEL from this study on rats was used as the basis for TRVs, which ranged from 0.97 mg/kg-day to 1.9 mg/kg-day for mammals after incorporating UFs of 5 to extrapolate from a subchronic to a chronic NOAEL, and 2 or 4 for taxonomic differences. Resulting Tier II ALs ranged from 14 mg/kg (lemming) to 380 mg/kg (shrew).

1.30 VINYL CHLORIDE

Based on the literature review, only mammalian Tier II screening levels were developed for vinyl chloride.

Four inhalation studies and one oral study on rats, mice, guinea pigs and rabbits were reviewed for use in Tier II AL development. These studies evaluated reproduction and growth, all identified NOAELs, and most were chronic duration. Therefore, a geometric mean NOAEL was calculated; this value was above the lowest paired LOAEL. A taxonomic UF of 2 or 4 was applied to generate TRVs ranging from 10.8 mg/kg-day to 21.6 mg/kg-day. This then yields Tier II ALs ranging from 15 mg/kg (lemming) to 3,300 mg/kg (weasel).

1.31 XYLENES

Based on the literature review, Tier II ALs were developed for mammals, zooplankton, and fish.

Two inhalation studies on mice and rats were identified. Both studies included chronic toxicity testing, and reproductive endpoints were evaluated in the mouse study (fetal development).

Although there are sufficient data to identify a geometric mean NOAEL, this value is above the lowest paired LOAEL. Therefore, the lowest NOAEL with no additional toxicity-based UF was identified and used as the basis for Tier II ALs. After incorporating taxonomic-based UFs of 2 and 4, TRVs ranged from 63 mg/kg-day to 125 mg/kg-day. This then results in Tier II ALs ranging from 630 mg/kg (lemming) to 24,000 mg/kg (shrew).

For aquatic receptors, two studies evaluating five species were considered for Tier II AL development for zooplankton. LC_{50} values were identified in all species, and all used only nominal concentrations. The lowest LC_{50} value was used as the basis for calculating a Tier II AL for zooplankton. This was divided by a UF of 10 to extrapolate from an LC_{50} to a LOEC, resulting in a Tier II AL of 0.86 mg/L for zooplankton.

An LC_{50} value from one 4-day mortality study on fathead minnows was used as the basis for calculating a Tier II AL. This was divided by a UF of 10 to extrapolate from an LC_{50} to a LOEC, resulting in an AL of 4.2 mg/L for fish.

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2 SEMI-VOLATILE ORGANIC COMPOUNDS

2.1 ACENAPHTHENE

Based on the literature review, Tier II ALs for acenaphthene were developed for mammals, zooplankton, and fish.

The study used for mammals was a subchronic general toxicity study on mice and examined internal organ damage and resulting survivability. A LOAEL was identified for this study and was used as the basis for the Tier II AL. UFs of 10 to extrapolate from a subchronic LOAEL to a chronic NOAEL and either 2 (lemming) or 4 (shrew and weasel) were incorporated, resulting in TRVs ranging from 4.4 mg/kg-day to 8.8 mg/kg-day for mammals. This results in Tier II ALs ranging from 30 mg/kg (shrew) to 1,400 mg/kg (weasel).

Three studies on *Daphnia* were considered for zooplankton Tier II AL development. Studies examined LC_{50} values at varying nominal concentrations. A 48-hour NOEC was identified in one study and used as the basis for the Tier II AL of 0.06 mg/L. No UF was incorporated since a NOEC was identified.

Five studies on five species of fish were considered in Tier II AL development. A total of nine LC_{50} values were available from these studies, and two NOECs. The two studies with NOEC values were preferentially selected since they were chronic in duration and evaluated more than just mortality, but also included growth. The lower of the two chronic NOECs of 0.345 mg/L was identified and used as the Tier II AL for fish.

2.2 ACENAPHTHYLENE

No relevant toxicity studies could be identified for this chemical, so Tier II ALs were not developed for acenaphthylene. Tier II values for the structurally similar acenaphthene (Section 2.1) can be used as surrogate ALs for risk assessment.

2.3 ANTHRACENE

Based on the literature review, Tier II ALs for anthracene were developed for terrestrial plants, zooplankton, and fish.

Three terrestrial plant studies incorporating six species were considered in developing a Tier II AL for plants. Three EC_{50} values involving growth of cucumber, soybean, and oat seedlings represent the data used. A geometric mean of these values was calculated and divided by a UF of 5 to extrapolate from an EC_{50} to a LOEC (e.g., EC_{10}). The resulting Tier II AL for terrestrial plants is 56 mg/kg.

In water, eight studies on three species were considered in developing a Tier II AL for zooplankton. A 21-day study on *Daphnia* reproduction was used to develop a Tier II AL, which represented the only measured concentration study. A chronic LOEC was identified and used as the basis for a Tier II AL of 0.0021 mg/L. No UF was incorporated since a chronic LOEC was used.

For fish, two nominal concentration studies on fathead minnows were considered for Tier II AL development. A chronic (8-week) study on fathead minnow reproduction represents data used to develop Tier II ALs. A LOEC was identified and used as the basis for a Tier II AL of 0.012 mg/L.

2.4 BENZO(A)ANTHRACENE

Based on the literature review, Tier II ALs were developed for benzo(a)anthracene only for zooplankton.

Three studies on two species of *Daphnia* were considered for developing Tier II ALs for zooplankton. The LC_{50} value from the single measured concentration study was used as the basis for a Tier II AL of 0.0010 mg/L, which incorporates a UF of 10 for extrapolation from an LC_{50} to a LOEC.

2.5 BENZO(A)PYRENE

Based on the literature review, Tier II ALs for benzo(a)pyrene were developed for mammals, algae, and zooplankton.

A chronic study examining reproduction of mice orally exposed to benzo(a)pyrene represents the data used to develop Tier II ALs for mammals. A NOAEL value was identified and used as the basis for the TRVs, which ranged from 0.12 mg/kg-day to 0.25 mg/kg-day after incorporating taxonomic-based UFs of 2 or 4. This yields Tier II ALs ranging from 0.89 mg/kg (shrew) to 37 mg/kg (weasel).

A nominal concentration study examining affected growth of seven different species of algae was considered in developing a Tier II AL for algae. The lowest EC_{50} value was identified and used as the basis for a Tier II AL of 0.0005 mg/L (0.5 micrograms per liter; ug/L), which incorporates a UF of 10 to extrapolate from an EC_{50} to a LOEC.

Four studies examining toxicity of benzo(a)pyrene in two different species of *Daphnia* were considered in developing a Tier II AL for zooplankton. The lowest LC_{50} value from the measured concentration study with the longest duration (4 days) was determined and used as the basis for a Tier II AL of 0.0005 mg/L (0.5 ug/L) for zooplankton.

2.6 BENZO(B)FLUORANTHENE

Based on the literature review, Tier II ALs were developed only for zooplankton.

An AL was developed using the data from the one study on survival of *Daphnia* in which simulated sunlight was used. An EC_{50} value was determined and used as the basis for a Tier II AL of 0.0010 mg/L, which incorporates a UF of 10 for extrapolation from an LC_{50} to a LOEC. This is below the Tier I SL for this chemical, which implies that it is overly conservative relative to the lowest regulatory-based value. Therefore, the Tier I SL of 0.0091 mg/L will be used to represent benzo(b)fluoranthene in Tier II.

For mammals, pyrene can be used as a surrogate chemical for screening, as discussed below for benzo(g,h,i)perylene (Section 2.7).

2.7 BENZO(G,H,I)PERYLENE

No relevant toxicity studies could be identified for this chemical, so Tier II ALs were not developed for benzo(g,h,i)perylene. NCEA and ADEC both indicate that pyrene (Section 2.24) can serve as an appropriate surrogate compound for mammals.

2.8 BENZO(K)FLUORANTHENE

No relevant toxicity studies could be identified for this chemical, so Tier II ALs were not developed for benzo(k)fluoranthene. As necessary, benzo(b)fluoranthene can be used as a structural surrogate for screening this chemical in aquatic systems.

For mammals, pyrene (Section 2.24) can be used as a surrogate chemical for screening, as discussed above for benzo(g,h,i)perylene (Section 2.7).

2.9 CHRYSENE

Based on the literature review, Tier II ALs were developed only for zooplankton.

Two nominal concentration studies on *Daphnia* were reviewed, and the study examining lethality of chrysene to daphnia represents the data used to develop Tier II ALs for zooplankton. This single study was selected since exposure included both UV-A and UV-B light in addition to visible light, and also was a 2-day exposure rather than a 1-day exposure. An EC_{50} value was determined and used as the basis for a Tier II AL of 0.40 mg/L, which incorporates a UF of 10 to extrapolate from an EC_{50} to a LOEC.

For mammals, pyrene (Section 2.24) can be used as a surrogate chemical for screening, as discussed above for benzo(g,h,i)perylene (Section 2.7).

2.10 DIBENZ(A,H)ANTHRACENE

Based on the literature review, Tier II ALs were developed only for zooplankton.

Three nominal concentration studies on *Daphnia* were reviewed for Tier II AL development, and the lowest EC_{50} that evaluated lethality using a combination of visible and UV-A and UV-B light represented the data used to develop Tier II ALs. A UF of 10 was applied to extrapolate from an EC_{50} to a LOEC, resulting in a Tier II AL of 0.00046 mg/L (0.46 ug/L) for zooplankton.

For mammals, pyrene (Section 2.24) can be used as a surrogate chemical for screening, as discussed above for benzo(g,h,i)perylene (Section 2.7).

2.11 2,4-DIMETHYLPHENOL

Based on the literature review, Tier II ALs for 2,4-dimethylphenol were developed for mammals, zooplankton, and fish.

One subchronic rat ingestion study examining growth and mortality represent the data considered to develop a Tier II AL for mammals. The lower of the two NOAELs (for growth) of 60 mg/kg-day was used as the basis for the TRV. The NOAEL was divided by a UF of 5 to extrapolate to chronic duration. This resulting value was then divided by taxonomic-based UFs of 2 and 4 for the lemming, and the shrew and weasel, respectively, resulting in TRVs of 3.0 mg/kg-day for the shrew and weasel, and 6.0 mg/kg-day for the lemming. This results in Tier II ALs ranging from 10 mg/kg (lemming) to 1,200 mg/kg (shrew).

Five studies on two different species (*Daphnia magna* and *Ceriodaphnia dubia*) were considered in developing a Tier II AL for zooplankton. The lowest measured and bounded NOEC value of 0.81 mg/L from the reproduction study was used as the basis for a Tier II AL. No UFs were applied to the NOEC value.

Five studies on four different species (*Pimephales promelas, Salmo gairdneri, Lepomis macrochirus, and Oryzias latipes*) were considered in developing a Tier II AL for fish. The lowest measured and bounded NOEC, from the longest duration growth study that used a flow-though test system, was used as the basis for a Tier II AL. No UFs were applied to the NOEC value of 1.97 mg/L.

2.12 DI-N-BUTYLPHTHALATE

Based on the literature review, Tier II ALs were developed for mammals, birds, algae, zooplankton, and fish.

Four studies on mice and rats were reviewed, and data from the longer of the two reproductive studies were used to develop Tier II ALs for mammals. A subchronic LOAEL was identified and used as the basis for TRVs, which ranged from 2.6 mg/kg-day to 5.1 mg/kg-day after incorporating a toxicity-based UF of 10 to extrapolate to a chronic NOAEL, and taxonomic-based UFs of 2 or 4 (overall UF of 20 to 40). This yields Tier II ALs ranging from 16 mg/kg (shrew) to 800 mg/kg (weasel).

Sample et al. (1997) identified an avian benchmark of 0.11 mg/kg-day based on eggshell thickness, which was incorporated as the avian TRV for this study given a lack of available literature. From this TRV, Tier II ALs were developed that ranged from 1.0 mg/kg (Lapland longspur) to 43 mg/kg (owl). Incorporating fish ingestion for the loon results in an aquatic Tier II AL of 2.9 mg/L, which is the lowest aquatic value for this chemical. This is lower than the Tier I SL, which implies that it is overly conservative relative to the lowest regulatory-based value. Therefore, the Tier I SL of 3.0 mg/L will be used to represent di-n-butylphthalate for the loon in Tier II.

In water, two studies on different species of algae were considered in developing a Tier II AL. The NOEC of 0.21 mg/L associated with the measured concentration study was used directly as the Tier II AL. No UF was incorporated since a NOEC was identified.

Four studies on *Daphnia magna* were considered in developing a Tier II AL for zooplankton. A 21-day study on *Daphnia* reproduction was used to develop a Tier II AL, which represented the lower of the measured concentration studies. A chronic NOEC was identified and used as the basis for a Tier II AL of 0.96 mg/L. No UF was incorporated since a chronic NOEC was used.

For fish, three studies on five species were considered for Tier II AL development. A measured concentration 3-day survival study on fathead minnows represents data used to develop Tier II ALs. A NOEC was identified and used as the basis for a Tier II AL of 0.32 mg/L. No UF was incorporated since a NOEC was identified.

2.13 FLUORANTHENE

Based on the literature review, Tier II ALs for fluoranthene were developed for terrestrial plants, fish and zooplankton.

A single 21-day study on seedling growth of ryegrass represents data used in the development of Tier II ALs for terrestrial plants. An EC_{20} concentration of fluoranthene for seedling growth was identified and used as the basis for a Tier II AL of 98 mg/kg, which incorporates a UF of 5 to convert from an EC_{20} to an EC_{10} (or LOEC).

Eleven studies encompassing five species of zooplankton were reviewed for Tier II development. Since fewer than ten values were available for the same endpoint from measured concentration studies, the lowest NOEC from the longest duration study was used as the basis for the Tier II AL of 0.0014 mg/L (1.4 ug/L) for zooplankton. No UF was incorporated since a NOEC was identified.

Five studies were reviewed on survival and behavior of fathead minnows exposed to fluoranthene for Tier II AL development. One measured concentration 21-day study identified a NOEC, and was used as the basis for the Tier II AL of 0.0014 mg/L (1.4 ug/L).

2.14 FLUORENE

Based on the literature review, Tier II ALs for fluorene were developed for mammals and zooplankton.

A single general subchronic toxicity study on mice represents the data used in the development of Tier II ALs for mammals. A LOAEL was identified and used as the basis for Tier II ALs for the arctic shrew, brown lemming and least weasel. A UF of 10 was incorporated to extrapolate from a subchronic LOAEL to a chronic NOAEL, and taxonomic-based UFs of 2 or 4 were also applied (overall UFs between 20 and 40). Resulting TRVs for mammals ranged from 3.1 mg/kg-day to 6.2 mg/kg-day. This results in Tier II ALs ranging from 3.3 mg/kg (shrew) to 970 mg/kg (weasel). The Tier II AL for the shrew is well below the Tier I SL for this chemical, which implies that it is overly conservative relative to the lowest regulatory-based value. Therefore, the Tier I SL of 30 mg/kg will be used to represent fluorene for the shrew in Tier II.

A single study on lethality of fluorene to *Daphnia* represents the data used in the development of Tier II ALs for zooplankton. An EC_{50} was identified and used as the basis for a Tier II AL of 2.8 mg/L for zooplankton. This value incorporates a UF of 10 to extrapolate from an EC_{50} to a LOEC.

2.15 INDENO(1,2,3-CD)PYRENE

No relevant toxicity studies could be identified for this chemical, and no appropriate surrogate has been identified. Therefore, Tier II ALs were not developed for indeno(1,2,3-cd)pyrene.

Pyrene (Section 2.24) can be used as a surrogate chemical for screening, as discussed above for benzo(g,h,i)perylene (Section 2.7).

2.16 1-METHYLNAPHTHALENE

Based on the literature review, Tier II ALs for 1-methylnaphthalene were developed for mammals, algae, zooplankton, and fish.

One chronic mouse ingestion study examining growth and mortality represents the data considered to develop a Tier II AL for mammals. The NOAEL for growth of 140.2 mg/kg-day was used as the basis for the TRV. Since a chronic growth endpoint was measured, no duration-based UF was necessary. This NOAEL value was then divided by taxonomic-based UFs of 2 and 4 for the lemming, and the shrew and weasel, respectively, resulting in TRVs of 35.1 mg/kg-day for the shrew and weasel, and 70.1 mg/kg-day for the lemming. This results in Tier II ALs ranging from 900 mg/kg (lemming) to 14,000 mg/kg (shrew).

Two studies on three species of algae were considered for developing a Tier II AL for algae and other phytoplankton. The IC_{10} value of 6 mg/L from the longer duration growth study was used as the basis for a Tier II AL. No UF was applied since the IC_{10} value is representative of a LOEC value.

A single short-term immobility study was considered for developing a Tier II AL for zooplankton. A two-day EC_{50} of 1.422 mg/L for *Daphnia magna* immobility was used to develop a Tier II AL. A UF of 10 was incorporated to extrapolate from an EC_{50} to a LOEC value, resulting in a Tier II AL of 0.14 mg/L.

A single short-term mortality study on *Pimephales promelas* was considered for developing a Tier II AL for fish. A 96-hr LC_{50} of 9 mg/L was used to develop a Tier II AL. A UF of 10 to was incorporated to extrapolate from an LC_{50} to a LOEC value, resulting in a Tier II AL of 0.9 mg/L.

2.17 2-METHYLNAPHTHALENE

Based on the literature review, Tier II ALs were developed for mammals, algae, and zooplankton.

One chronic study on mice was used to develop ALs for mammalian indicator species. A LOAEL for pulmonary enzyme effects was identified in the study, and was used as the basis for calculating the Tier II ALs for mammals. A UF of 5 to extrapolate from a LOAEL to a NOAEL in combination with taxonomic-based UFs of 2 or 4 was used, resulting in TRVs ranging from 2.5 mg/kg-day to 5 mg/kg-day. These TRVs yield Tier II ALs ranging from 64 mg/kg (lemming) to 980 mg/kg (shrew).

One study on two species of algae was considered in developing ALs. EC_{50} values for photosynthesis were identified for algae in the one study, and the lowest value was combined with a UF of 10 to extrapolate from an EC_{50} to a LOEC resulting in a Tier II AL for algae of 0.45 mg/L.

Three studies on a single species of zooplankton (*Daphnia*) were considered in developing ALs. LC_{50} values were identified in two of the three studies, with a resulting Tier II AL for zooplankton, after incorporating a UF of 10 for extrapolating from an LC_{50} to a LOEC, of 145 mg/L.

2.18 2-METHYLPHENOL

Based on the literature review, only mammalian Tier II ALs were developed for 2-methylphenol.

The AL value was developed using a single chronic reproduction study on mink. A NOAEL value was identified in this study and used as the basis of the TRVs for mammals. Taxonomic-based UFs ranging from 2 (weasel) to 4 (lemming and shrew) were used, resulting in TRVs that ranged from 67 mg/kg-day to 268 mg/kg-day. These TRVs yielded Tier II ALs ranging from 73 mg/kg (lemming) to 83,000 mg/kg (weasel).

2.19 3-METHYLPHENOL

Based on the literature review, Tier II ALs were developed for zooplankton and fish.

Three studies examining lethality of 3-methylphenol *to Daphnia* were reviewed, and the longest study (2 days) with the lowest LC_{50} value was used as the basis for a Tier II AL of 1.88 mg/L for zooplankton. This value incorporates a UF of 10 to extrapolate from an EC_{50} to a LOEC.

For fish, a single 3-day study examining lethality of 3-methylphenol to rainbow trout and the fathead minnow represent data considered to develop Tier II ALs. The lower of the two LC_{50} values was used as the basis for a Tier II AL of 0.89 mg/L, which incorporates a UF of 10 to extrapolate from an EC_{50} to a LOEC.

For mammals, the structural isomer 2-methylphenol (Section 2.18) can be used as a surrogate for screening.

2.20 4-METHYLPHENOL

Based on the literature review, Tier II ALs were developed only for aquatic organisms including, fish, algae, and zooplankton.

A single study observing lethality of 4-methylphenol to *Spirogyra* represents data used in development of Tier II ALs for algae. A NOEC value was identified and used as the basis for a Tier II AL of 4.6 mg/L for algae. No UF was applied since the study identified a NOEC.

Six toxicity studies examining lethality of 4-methylphenol to *Daphnia*, *Hyallela*, and *Tetrahymena* represent data considered in developing Tier II ALs for zooplankton. The lowest of the eight LC_{50} values was used as the basis for a Tier II AL which, after incorporation of a UF of 10 to extrapolate from an LC_{50} to a LOEC, resulted in a value of 0.14 mg/L for zooplankton.

Four toxicity studies examining lethality of 4-methylphenol to rainbow trout and fathead minnow over a 4-day period represent data used to develop Tier II ALs for fish. Shorter study durations were excluded from consideration. The lowest LOEC from a 4-day study was used to develop a Tier II AL of 5.6 mg/L for fish. No UF was applied since the study identified a LOEC.

2.21 NAPHTHALENE

Based on the literature review, Tier II ALs were developed for mammals, fish, algae, and zooplankton.

Seven studies examining reproduction and growth effects of naphthalene to rats and mice represent the data used as the basis for Tier II ALs for the arctic shrew, brown lemming and least weasel. All seven studies were conducted at a sensitive life stage, and ranged from 9 days to 6 months. A geometric mean of the seven values was calculated, and taxonomic-based UFs of 2 or 4 were applied to result in TRVs ranging from 24 mg/kg-day to 48 mg/kg-day. These yield Tier II ALs ranging from 12 mg/kg (lemming) to 7,500 mg/kg (weasel).

Six studies on five species of algae were reviewed for development of Tier II ALs. Measured concentrations were used in only studies that reported EC_{50} values. The lowest EC_{50} was used (associated with photosynthesis inhibition) to develop Tier II ALs for algae. After incorporating a UF of 10 to extrapolate to a LOEC, a Tier II AL of 0.28 mg/L was identified for algae.

Thirteen studies on three species of zooplankton were reviewed for Tier II development. The lowest LOEC associated with measured concentration studies (in *Daphnia*) was identified for development of a Tier II AL. The 1-day LOEC was divided by a UF of 5 to extrapolate to a longer-term exposure, resulting in a Tier II AL of 1.0 mg/L for zooplankton.

Five studies on five species of fish were reviewed for Tier II development. Two chronic studies noting the effects of naphthalene on fathead minnow reproduction, growth and lethality were available, and the one based on measured concentrations was used to develop a Tier II AL for fish. No UF was incorporated since a 30-day NOEC was identified. The resulting Tier II AL for fish is 0.45 mg/L.

2.22 PHENANTHRENE

Based on the literature review, Tier II ALs were developed for algae and zooplankton.

A mammalian TRV of 66 mg/kg-day for low molecular weight PAHs is available in the EcoSSL document (EPA, 2005). This TRV is specifically derived for 1-naphthaleneacetic acid, so represents an ideal surrogate for phenanthrene, and was incorporated as the mammalian TRV for this study, as outlined in Section 7 of the main document. From this TRV, Tier II ALs were developed that ranged from 380 mg/kg (shrew) to 20,000 mg/kg (weasel).

One study examining the inhibition of photosynthesis in two different algae species was considered for developing Tier II ALs. The lower of the two EC_{50} values was identified and used as the basis for a Tier II AL of 0.094 mg/L, which incorporates a UF of 10 to extrapolate from an EC_{50} to a LOEC.

Twelve studies were reviewed for zooplankton but only two provide NOEC and/or LOEC values; only one of these is a measured concentration study. This is also the longest duration study (21 days) of those reviewed. A chronic NOEC value was determined and used as the basis for a Tier II AL of 0.048 mg/L for zooplankton. No UF was applied since a chronic NOEC was identified.

2.23 PHENOL

Based on the literature review, Tier II ALs for phenol were developed for mammals, terrestrial plants, fish, algae, and zooplankton.

Two studies involving rats or mice represent the data considered to develop Tier II ALs for mammals. Phenol-exposed test subjects were monitored for affected reproduction, teratology, and growth rates. One of the studies was multi-generational. The NOAEL value from this latter study was identified and used as the basis for Tier II ALs for the arctic shrew, brown lemming and least weasel. TRVs ranged from 17.5 mg/kg-day to 35 mg/kg-day, and incorporate a taxonomic UF of either two (lemming) or four (shrew and weasel). Resulting Tier II ALs range from 20 mg/kg (shrew) to 5,400 mg/kg (weasel).

A single study observing the yield and growth of corn plants when exposed to phenol over a 56-day period represents data used to develop Tier II ALs for terrestrial plants. A NOAEL value was identified and used as the basis for a Tier II AL of 6.8 mg/kg. No UF was incorporated since a NOAEL was identified.

A single study represents the data used in Tier II AL development for algae. The study identified an effect concentration lethal to ten percent of the given population (EC_{10}). The EC_{10} value was used as the basis for a Tier II AL of 184 mg/L. No UF was incorporated since an EC_{10} value was identified.

Twelve studies covering 14 species were evaluated for Tier II AL development for zooplankton. Studies examined phenol's effect on reproduction, ingestion rates, and lethality. The lowest value associated with a measured concentration study, representing an EC_{50} from a 2-day study on *Daphnia*, was used in Tier II AL development for zooplankton. A UF of 10 was applied to extrapolate from an EC_{50} to a LOEC, resulting in a Tier II AL of 0.55 mg/L for zooplankton.

Six studies on fish toxicity across three species were reviewed for Tier II development. Three studies represent the data used in Tier II AL development for fish. Rainbow trout and the fathead minnow were test subjects monitored for the effect of phenol on survivability, hatchability, and growth. The lowest LOEC from a measured concentration study, which was a 32-day study on fathead minnows, was used as the basis for a Tier II AL of 3.57 mg/L. No UF was incorporated since the AL is based on a chronic LOEC.

2.24 PYRENE

Based on the literature review, Tier II ALs were developed for mammals, zooplankton, and fish.

One subchronic systemic toxicity study on mice was identified. The NOAEL value from the mouse study was used as the basis for calculating Tier II ALs for mammals. After incorporating toxicity-based UFs of 5 to extrapolate from subchronic to chronic duration, and taxonomic-based UFs of 2 or 4, TRVs range from 3.8 mg/kg-day to 7.5 mg/kg-day. These then yield Tier II ALs ranging from 22 mg/kg (shrew) to 1,200 mg/kg (weasel).

Six nominal concentration studies on zooplankton were considered in developing Tier II ALs. The 2-day study that included both UV-A and UV-B light in addition to visible light was used as it most closely approximates sunlight. After incorporating a UF of 10 to extrapolate to a LOEC, a Tier II AL of 0.00046 mg/L (0.46 ug/L) was identified for zooplankton.

One study on fathead minnows was used to develop Tier II ALs for fish. Two LC_{50} values from the mortality study were available, and the one based on the longer duration was used as the basis for calculating a Tier II AL of 0.022 mg/L for fish. This AL incorporates a UF of 10 to extrapolate from a LC_{50} to a LOEC.

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3 METALS

3.1 ANTIMONY

Based on the literature review, Tier II ALs for antimony were developed for mammals, fish, and zooplankton.

Although a literature review was conducted for mammals, the EcoSSL TRV of 0.059 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 0.23 mg/kg (lemming) to 16 mg/kg (weasel). The Tier II AL for the lemming is lower than the Tier I SL (0.26 mg/kg). Therefore, the Tier I SL of 0.27 mg/kg is used as the Tier II AL for the lemming.

For zooplankton, one measured concentration study that identified 7-day LC_{50} values in *Hyallela* was used to derive a Tier II AL of 0.069 mg/L for zooplankton, incorporating a UF of 10 to extrapolate from an LC_{50} to a LOEC.

For fish, a LOEC identified in a nominal concentration 4-day survival study on sheepshead minnows was used to develop a fish Tier II AL value of 6.2 mg/L. No UF was incorporated since a LOEC was identified.

3.2 ARSENIC

Based on the literature review, Tier II ALs were developed for mammals, birds, terrestrial plants, zooplankton, and fish.

Although a literature review was conducted for mammals, the EcoSSL TRV of 1.0 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 53 mg/kg (lemming) to 290 mg/kg (weasel).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 2.2 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 120 mg/kg (ptarmigan) to 840 mg/kg (owl), and 0.032 mg/L for the loon ingesting fish.

Two studies were used to develop an AL for terrestrial plants, one on barley and one on ryegrass. Chronic (1 year) NOAELs were identified in both studies, and endpoints focused on growth and yield. A Tier II AL of 10 mg/kg was developed for terrestrial plants; no UF was incorporated since a chronic NOAEL was used.

For aquatic organisms, one study covering three species, including *Daphnia*, was used to develop an AL for zooplankton. The lowest of the four 2-day LC_{50} values across three species was used to develop a Tier II AL of 0.17 mg/L, which incorporates a UF of 10 to extrapolate from an LC_{50} to a LOEC.

The single fish study, a 2-day survival study on fathead minnows, identified an LC_1. This sensitive indicator of a LOEC was used to develop a Tier II AL of 1.8 mg/L for fish. No UF was incorporated since an LC_1 was used.

3.3 BARIUM

Based on the literature review, Tier II ALs for barium were developed for mammals, birds, terrestrial plants, and zooplankton.

Although a literature review was conducted for mammals, the EcoSSL TRV of 52 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 900 mg/kg (lemming) to 16,000 mg/kg (weasel).

A 28-day study involving growth rate of juvenile chickens identified a NOEC value, which was used to develop TRVs for the avian indicator species ranging from 6.2 mg/kg-day to 24.8 mg/kg-day, and incorporate a toxicity-based UF of 5 to extrapolate from subchronic to chronic exposure, and a taxonomic-based UF of 4 for all of the indicator species except the ptarmigan. Resulting Tier II ALs range from 400 mg/kg (Lapland longspur) to 2,400 mg/kg (owl), and 6.5 mg/L for the loon ingesting fish.

A study tracking growth/yield rates of agricultural plants (beans and barley) represent the data used to develop a Tier II AL for terrestrial plants. A 14-day LOAEL of 500 mg/kg was identified, which was directly used as the Tier II AL for plants. No UF was applied because a LOAEL for a relevant endpoint (yield) was identified.

Two aquatic studies were reviewed, and one nominal concentration-based study measuring reproductive effects was used to develop a Tier II AL for zooplankton. A 21-day toxicity test on *Daphnia magna* identified a reproductive EC_{16} value, which resulted in a Tier II AL value of 5.8 mg/L for zooplankton. No UFs were applied to the EC_{16} value.

3.4 CADMIUM

Based on the literature review, Tier II ALs were developed for mammals, birds, terrestrial plants, algae, and zooplankton.

Although a literature review was conducted for mammals, the EcoSSL TRV of 0.77 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 0.92 mg/kg (shrew) to 140 mg/kg (weasel).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 1.5 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 3.8 mg/kg (Lapland longspur) to 480 mg/kg (owl), and 0.032 mg/L for the loon ingesting fish.

Twelve studies were considered in developing Tier II ALs for terrestrial plants. A total of five studies were used; these studies involved various grasses and oat plants. Affected aspects such as yield, growth, and biomass were evaluated in these studies. Seven NOEC values were determined in these studies encompassing six species, and a geometric mean of these NOECs was identified as the Tier II AL of 18 mg/kg for terrestrial plants. No UF was incorporated since a NOEC was used.

Two algae studies were reviewed, and one measuring inhibition of photosynthesis was used to develop a Tier II AL. The 2-day EC_{50} was divided by a UF of 10 to extrapolate from an EC_{50} to a LOEC, resulting in a Tier II AL for algae of 0.00032 mg/L (0.32 ug/L).

Three zooplankton studies were considered for development of Tier II ALs. One aquatic invertebrate study examining reproduction of *Daphnia* over a 21-day period was the basis for a Tier II AL of 0.0032 mg/L for zooplankton. No UF was incorporated into the AL since a chronic NOEC was identified.

3.5 CHROMIUM

Based on the literature review, Tier II ALs for chromium were developed for mammals, birds and terrestrial plants. Where possible, chromium was speciated and separate ALs were developed for hexavalent (Cr^{+6}) and trivalent (Cr^{+3}) forms.

3.5.1 CHROMIUM

For ALs for total chromium, an assumption was made that only trivalent chromium is present at a site unless hexavalent chromium is suspected to be present and/or detected at a site.

3.5.2 CHROMIUM III

Although a literature review was conducted for mammals, the EcoSSL TRV of 2.4 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 73 mg/kg (shrew) to 260 mg/kg (weasel).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 2.7 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 94 mg/kg (Lapland longspur) to 590 mg/kg (owl), and 0.058 mg/L for the loon ingesting fish.

A study on growth rates of oats when exposed to chromium III was used in development of Tier II ALs for chromium III. A 14-day NOEC for growth was used as the basis for a Tier II AL of 10 mg/kg for chromium III. No UF was incorporated since a NOEC was identified.

3.5.3 CHROMIUM VI

Although a literature review was conducted for mammals, the EcoSSL TRV of 5.7 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 170 mg/kg (shrew) to 720 mg/kg (weasel).

A single 14-day study on the root growth of rye grass when exposed to chromium VI was used in the development of Tier II ALs for terrestrial plants. An EC_{50} was identified and divided by a UF of 5 to extrapolate from an EC_{50} to a LOEC, resulting in a plant-based Tier II AL of 0.4 mg/kg for chromium VI.

3.6 COPPER

Based on the literature review, Tier II ALs were developed for mammals, birds, terrestrial plants, algae, zooplankton, and fish.

Although a literature review was conducted for mammals, the EcoSSL TRV of 5.6 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 3.6 mg/kg (weasel) to 150 mg/kg (lemming).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 4.1 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 5.5 mg/kg (owl) to 770 mg/kg (goose), and 0.088 mg/L for the loon ingesting fish.

Five studies on seven species of terrestrial plants were considered in developing Tier II ALs. The lowest value across these studies, an 84-day EC_{25} for weight reduction in big bluestem, was used as the basis of the Tier II AL for terrestrial plants. No UF was incorporated since the EC_{25} was below other reported EC_{10} and NOEL concentrations. The resulting Tier II AL for terrestrial plants is 37 mg/kg.

Five studies on four species of algae were considered in Tier II AL development. The NOEC based on survival from the longest-term study (21 days) was used as the basis for the Tier II AL 0.029 mg/L. No UF was incorporated since a NOEC was identified.

A total of 26 studies on zooplankton were considered in developing ALs. LC_{50} and EC_{50} values were identified in 19 studies, and the 10^{th} percentile across these studies was used, resulting in a value of 0.011 mg/L for zooplankton. A UF of 10 was incorporated since a 10^{th} percentile value based on mortality was developed, resulting in a Tier II AL of 0.0011 mg/L.

Nine studies on four species of fish were considered in Tier II AL development. The lowest NOEC, which was associated with the longest duration study (7 days), was used as the basis for the Tier II AL for fish of 0.007 mg/L. This value incorporates a UF of 10 to extrapolate from an LC_{50} to a LOEC.

3.7 LEAD

Based on the literature review, Tier II ALs were developed for mammals, birds, terrestrial plants, algae, and zooplankton.

Although a literature review was conducted for mammals, the EcoSSL TRV of 4.7 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 140 mg/kg (shrew) to 740 mg/kg (weasel).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 1.6 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 50 mg/kg (Lapland longspur) to 370 mg/kg (owl), and 0.024 mg/L for the loon ingesting fish.

Seven studies were considered in developing an AL for terrestrial plants; three on grasses and five on grain crops. NOAELs were identified in all studies, and endpoints focused on yield reduction, germination, and root elongation. Although there are sufficient data to identify a geometric mean NOAEL, this value is above the lowest paired LOAEL. Therefore, the lowest NOAEL of the studies (30 days) was used as the basis for the Tier II AL. A Tier II AL of 100 mg/kg was developed for terrestrial plants; no UF was incorporated since a NOAEL was identified.

One 2-day survival study on algae was used to develop an AL. The single algae study identified an EC_{50} with photosynthesis as an endpoint; a UF of 10 was applied to extrapolate to a LOEC, resulting in a Tier II AL of 2.1 mg/L for algae.

For zooplankton, one study covering four species, including *Daphnia*, was used to develop an AL. The lowest 2-day LC_{50} value was identified and divided by a UF of 10 to extrapolate to a LOEC, resulting in Tier II AL of 0.053 mg/L for zooplankton.

3.8 MERCURY

Based on the literature review, Tier II ALs for mercury were developed for mammals, birds and terrestrial plants.

Two studies were used in Tier II AL development for mammals; one tracking kidney damage in rats and mice exposed to mercury and one on general toxicity effects of mercury to mink. The rat and mouse studies were used to develop TRVs for the shrew and lemming, and the mink study was used to develop TRVs for the least weasel. Chronic NOAEL values were identified in each study and used as the basis for the TRVs ranging from 0.08 mg/kg-day (shrew) to 1.0 mg/kg-day (weasel) after incorporating taxonomic-based UFs of 2 and 4 for the lemming and shrew, respectively. These TRVs result in Tier II ALs ranging from 0.26 mg/kg (shrew) to 320 mg/kg (weasel).

Two avian studies on Japanese quail were reviewed for use in Tier II AL development, and the single study examining effects of mercury on quail reproduction represented the data used in Tier II AL development for birds. A chronic NOAEL value was identified and used as the basis for TRVs for the avian indicator species. After incorporating taxonomic-based UFs of 4 for the goose, loon, Lapland longspur, and owl, TRVs ranged from 0.21 mg/kg-day to 0.83 mg/kg-day. These yield Tier II ALs ranging from 1.1 mg/kg (Lapland longspur) to 81 mg/kg (owl), and 0.00091 mg/L for the loon ingesting fish.

Two plant studies were evaluated for use in Tier II AL development, including root growth of ryegrass and barley yield. The 7-day study in which a NOEC was identified represented the data used in development of Tier II ALs for terrestrial plants. No UF was incorporated since a NOEC was identified. The resulting Tier II AL is 5.0 mg/L for terrestrial plants.

3.9 NICKEL

Based on the literature review, Tier II ALs were developed for mammals, birds, and zooplankton.

Although a literature review was conducted for mammals, the EcoSSL TRV of 1.7 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 90 mg/kg (lemming) to 200 mg/kg (weasel).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 6.7 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 390 mg/kg (Lapland longspur) to 2,100 mg/kg (owl), and 0.29 mg/L for the loon ingesting fish.

One 2-day survival study on *Daphnia magna* was identified for aquatic Tier II development. The EC_{50} was divided by a UF of 10 to extrapolate to a LOEC, resulting in a Tier II AL for zooplankton of 0.10 mg/L.

3.10 SELENIUM

Based on the literature review, Tier II ALs were developed for mammals, birds, terrestrial plants, zooplankton, and fish.

Although a literature review was conducted for mammals, the EcoSSL TRV of 0.14 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 0.85 mg/kg (lemming) to 4.1 mg/kg (weasel).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 0.29 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 3.1 mg/kg (ptarmigan) to 59 mg/kg (owl), and 0.0063 mg/L for the loon ingesting fish.

For terrestrial plants, three yield studies were identified on sorghum, wheat, and alfalfa. The lowest NOEC, associated with a 42-day study in sorghum, was used as the basis for a Tier II AL of 1.0 mg/kg for terrestrial plants. No UF was incorporated since a NOEC was identified.

Four zooplankton studies encompassing six species were considered in developing Tier II ALs. LOEC and NOEC values were determined, and since the lowest LOEC from a measured study, which was from a 21-day study, was below the NOECs from other studies, the lowest LOEC was used as the basis for development of a Tier II AL of 0.002 mg/L for zooplankton.

Three studies on the fathead minnow were considered in developing Tier II ALs for fish. NOEC values were determined for effects on body weight and reproduction. However, an EC value for reproduction was below the NOEC values, so the EC value was used in combination with a UF of 5 to convert the EC to a LOEC. The resulting Tier II AL for fish is 0.002 mg/L.

3.11 SILVER

Based on the literature review, Tier II ALs for silver were developed for mammals, birds, algae, zooplankton, and fish.

The EcoSSL TRV of 6.02 mg/kg-day was used to develop Tier II ALs for mammals, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 29 mg/kg (shrew) to 1,600 mg/kg (weasel).

The EcoSSL TRV of 2.02 mg/kg-day was used to develop Tier II ALs for birds, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 15 mg/kg (Lapland longspur) to 730 mg/kg (snowy owl), and a Tier II AL of 1.7 mg/L for the loon ingesting fish.

Three growth studies covering four different species of algae were considered for developing a Tier II AL for algae and other phytoplankton. The lowest LOEC value of 0.00066 mg/L was used to develop a Tier II AL. No UFs were applied to the LOEC value.

Eight studies covering four different species of daphnids represent the data used to develop a Tier II AL for zooplankton. The lowest measured and bounded NOEC value of 0.00053 mg/L for the most sensitive species in the chronic reproduction study (*Ceriodaphnia dubia*) was used to develop a Tier II AL. No UFs were applied to the NOEC value.

Seven studies covering six different species represent the data used to develop a Tier II AL for fish. The lowest measured LC_1 value of 0.0001 mg/L for the most sensitive species in the study

(*Oncorhynchus mykiss*) was used to develop a Tier II AL. The LC_1 value was divided by a UF of 5 to extrapolate from a sub-chronic to chronic duration, resulting in a Tier II AL of 0.00002 mg/L.

3.12 VANADIUM

Based on the literature review, Tier II ALs were developed for mammals, birds and zooplankton.

Although a literature review was conducted for mammals, the EcoSSL TRV of 4.2 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 450 mg/kg (lemming) to 900 mg/kg (weasel).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 0.34 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 25 mg/kg (ptarmigan) to 110 mg/kg (owl), and 9.3 mg/L for the loon ingesting fish.

One study on vanadium’s toxicity to *Daphnia* represents data considered in developing Tier II ALs for zooplankton. Three EC_{10} values were identified in this study, all of which were the same concentration. These EC_{10} values were used to develop a Tier II AL of 1.7 mg/L for zooplankton. No UF was incorporated because EC_{10} concentrations were used.

3.13 ZINC

Based on the literature review, Tier II ALs were developed for mammals, birds, plants, zooplankton, and fish.

Although a literature review was conducted for mammals, the EcoSSL TRV of 75 mg/kg-day was used to develop Tier II ALs, as discussed in Section 7 of the main document. This yields Tier II ALs ranging from 720 mg/kg (shrew) to 18,000 mg/kg (weasel).

A literature review was also conducted for birds, but as discussed above the EcoSSL TRV of 66 mg/kg-day was used to develop Tier II ALs. This yields Tier II ALs ranging from 1,300 mg/kg (Lapland longspur) to 23,000 mg/kg (owl), and 0.29 mg/L for the loon ingesting fish.

For terrestrial plants, three studies on grasses, wheat, and oats focusing on germination, growth, and yield were considered in Tier II AL development. A chronic (161-day) NOEC was identified in one study, which was used to develop a Tier II AL for terrestrial plants of 3,000 mg/kg. No UF was incorporated since a chronic NOEC was used.

For aquatic organisms, five studies on three species of zooplankton were considered in Tier II AL development. A reproductive LOEC was identified for a 7-day *Ceriodaphnia* study, which was used as the basis for the Tier II AL for zooplankton of 0.075 mg/L. No UF was incorporated since a reproduction LOEC was used.

Three studies on two species of fish were considered in developing ALs. A 4-day NOEC based on survival was identified for fish in one study, which was directly used to identify a Tier II AL for fish of 12.9 mg/L. No UF was incorporated since a NOEC was used.

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4 INORGANICS

4.1 CYANIDE

Based on the literature review, Tier II ALs for cyanide were developed for mammals, algae, zooplankton, and fish.

Two rat ingestion studies examining reproduction, growth, and mortality represent the data considered to develop a Tier II AL for mammals. Excluding mortality, only two NOAELs were identified. The lowest of these NOAELs of 125 mg/kg-day for reproduction was used as the basis for the TRV. Since a reproduction endpoint was measured, no duration-based UF was necessary. This NOAEL value was then divided by taxonomic-based UFs of 2 and 4 for the lemming, and the shrew and weasel, respectively, resulting in TRVs of 31.3 mg/kg-day for the shrew and weasel, and 62.5 mg/kg-day for the lemming. This yields Tier II ALs ranging from 22 mg/kg (lemming) to 9,700 mg/kg (weasel).

Three growth studies on algae were considered for developing a Tier II AL for algae and other phytoplankton. The measured EC_{10} value of 0.158 mg/L from the study that used a sealed container was used as the basis for a Tier II AL. No UFs were applied to the EC_{10} value.

A single short-term mortality study was considered for developing a Tier II AL for zooplankton. A 2-day EC_{50} of 2.52 mg/L for *Ceriodaphnia dubia* mortality was used to develop a Tier II AL. The EC_{50} value was divided by a UF of 10 to extrapolate from an EC_{50} to a LOEC, resulting in a Tier II AL of 0.252 mg/L.

Four studies on nine different species (*Oncorhynchus mykiss, Rinichthys atratulus, Semotilus atromaculatus, Lepomis macrochirus, Perca favescens, Salvelinus fontinalis, Pomoxis nigromaculatus, Micropterus salmoides and Pimephales promelas*) represent the data used to develop a Tier II AL for fish. The lowest measured and bounded NOEC value of 0.0052 mg/L was used as the basis of a Tier II AL as it was from a longer duration reproduction study. No UFs were applied to the NOEC value.

APPENDIX C

TIER II SITE-SPECIFIC ACTION LEVEL SPREADSHEETS

Table C-1
Acetone TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Specific Effect	Reference	Test Sp. Body Weight (BWt) (kg)	Ingestion Rate (IRt)	Notes
MAMMALS												
Acetone	Acetone2	Rat	depressed body weight	14	ingestion	20000 ppm	50000 ppm		Dietz et al., 1991	0.336 (males) 0.210 (females)	2559-4312mg/kg/d (males) 2328-4350mg/kg/d (females)	*No mortality. Water consumption was reduced by 50-78% in 2-week study and 40-73% in 13-week study groups containing 50000ppm in the drinking water.*
Acetone	Acetone2	Mice	depressed body weight	14	ingestion	50000 ppm	100000 ppm (males)	did not affect females despite depressed fluid consumption	Dietz et al., 1991	0.0277 (females)	6348-10314mg/kg/d (males) 8804-12725mg/kg/d (females)	
Acetone	Acetone2	Rat	organ weight	91	ingestion	10000 ppm	20000 ppm		Dietz et al., 1991	0.336 (males) 0.210 (females)	900-1700mg/kg/d (males) 1200-1600mg/kg/d (females)	
Acetone	Acetone2	Mice	organ weight	91	ingestion	20000 ppm	50000 ppm	females only	Dietz et al., 1991	0.0277 (females)	5945-11298mg/kg/d (females)	
Acetone	Acetone2	Rat	hematology	91	ingestion	5000 ppm (males) 20000 ppm (females)	10000 ppm (males) 50000 ppm (females)	mild lymphocytosis	Dietz et al., 1991	0.336 (males) 0.210 (females)	400-900mg/kg/d (males) 1600-3100mg/kg/d (females)	
Acetone	Acetone2	Mice	hematology	91	ingestion	20000 ppm (males) 50000 ppm (females)	-	no consistent effects other than marginal increases in hematocrit and hemoglobin	Dietz et al., 1991	0.0277 (females)	4858mg/kg/d (males) 11298mg/kg/d (females)	
Acetone	Acetone2	Mice	histopathology	14	ingestion	10000 ppm (males) 20000 ppm (females)	20000 ppm (males) 50000 ppm (females)	centrilobular hepatocellular hypertrophy	Dietz et al., 1991	0.0277 (females)	2258-4858 (males) 5945-11298 (females)	
Acetone	Acetone2	Rat	histopathology	14	ingestion	50000 ppm	100000 ppm	bone marrow hypoplasia in males only	Dietz et al., 1991	0.336 (males) 0.210 (females)	4312-6942 (males)	
Acetone	Acetone2	Rat	histopathology	91	ingestion	-	20000 ppm	increased severity of nephropathy and splenic pigmentation in males	Dietz et al., 1991	0.336 (males) 0.210 (females)	1700 (males)	
Acetone	Acetone2	Mice	histopathology	91	ingestion		50000 ppm	minimal hepatocellular hypertrophy in 2/10 females	Dietz et al., 1991	0.0277 (females)	11298 (females)	
Acetone	Acetone2	Rats & Mice	reproduction	91	ingestion	10000 ppm	50000 ppm	depressed sperm motility, cauda epididymal weight, increased abnormal sperm. No changes in vaginal cytology	Dietz et al., 1991		1050 mg/kg-d (rats); 3207 mg/kg-d (mice)	

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	1050	20	**53**
Lemming	1050	10	**105**
Weasel	1050	20	**53**

Rationale:

Used lowest NOAEL (for rats) from reproductive study. Paired LOAEL available.
Divided by UF of 5 to extrapolate from subchronic to chronic.
Taxonomic UF for shrew and weasel of 4 represents different Order, same Class
Taxonomic UF for lemming of 2 represents different Family, same Order

Table C-2
Acetone TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (ppm)	LOAEL (ppm)	Specific Effect	Reference	Ingestion Rate (IRt)	Notes
BIRDS											
Snow Goose											
Acetone	Acetone1	Mallard embryo	embryo development	3 or 8	immersion	100000	1,000,000	decrease in survival rate, embyonic weight, embryonic length, increase in abnormalities in surviving embryos	Hoffman & Eastin, 1981	30sec/d	*Other toxins tested as well.*

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Ptarmigan	100000	20	5000
Goose	100000	5	20000
Loon	100000	20	5000
Lapland longspur	100000	20	5000
Snowy owl	100000	20	5000

Rationale:

Only one study; used NOEC for developmental effects. Asssumed 100% bioavailability so concentration assumed equal to dose.
Due to lack of other studies, divided by a UF of 5.

Taxonomic UF of 4 different Order, same Class
Taxonomic UF of 4 different Order, same Class
Taxonomic UF of 4 different Order, same Class

Table C-3
Acetone AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
acetone	Daphnia magna	death	2	water			10		Dowden and Bennett, 1965	*oldest study - outlier. Nominal concentrations.*
acetone	Daphnia magna	death	2	water			6900		Cowgill, 1987	*nominal concentrations.*
acetone	Daphnia magna	death	2	water			7.6		Pawlisz and Peters, 1995	*Converted from 131 mmol/L using MW of 58.08. outlier*
acetone	Daphnia magna	death	0.75	water			7800		Bowman et al., 1981	*nominal concentrations.*
acetone	Daphnia magna	death	3	water			>100		Ewell et al., 1986	*nominal concentrations.*
acetone	Daphnia magna	death	2	water	8500				Slooff et al., 1983	*nominal concentrations.*
acetone	Daphnia pulex	death	2	water	5800		7635		Slooff et al., 1983	*nominal concentrations.*
acetone	Daphnia magna	death	2	water			23500		Ziegenfuss et al., 1986	*nominal concentrations. (kepone concentrations measured)*
acetone	Daphnia magna	death	2	water			39		Leblanc, 1980	*outlier; nominal concentrations*
acetone	Daphnia magna	death	2	water	<403		4068		Cowgill and Milazzo, 1991	*nominal concentrations.*
acetone	Ceriodaphnia dubia	death	10	water	1866		6693		Cowgill and Milazzo, 1991	*nominal concentrations.*
acetone	Ceriodaphnia dubia	reproduction	10	water	5184		5908		Cowgill and Milazzo, 1991	*nominal concentrations.*
acetone	Daphnia magna	reproduction	10	water	3110		6369		Cowgill and Milazzo, 1991	*nominal concentrations.*
acetone	P. putida	density	0.25		1700				Slooff et al., 1983	*nominal concentrations.*
acetone	M. aeruginosa	density	0.25		530				Slooff et al., 1983	*nominal concentrations.*
acetone	E. sulcatum	immobility	3		72				Slooff et al., 1983	*nominal concentrations.*
acetone	U. parduczi	immobility	3		1710				Slooff et al., 1983	*nominal concentrations.*
acetone	C. paramecium	immobility	3		3520				Slooff et al., 1983	*nominal concentrations.*
Algae										
acetone	Chlorella pyrenoidosa	growth	8		3400				Slooff et al., 1983	*nominal concentrations.*
acetone	Scenedesmus pannonicus	growth	8		7500				Slooff et al., 1983	*nominal concentrations.*
acetone	Selenastrum capricornatum	growth	8		7000				Slooff et al., 1983	*nominal concentrations.*
acetone	Chlamydomonas eugametos	population growth	2		5000	10000			Hess, 1980	*nominal concentrations.*
Fish										
acetone	Pimephales promelas	death	3				8120		Brooke, et al. 1984	*great lakes water. Measured concentrations.*
acetone	Pimephales promelas	growth	3				6880		Brooke, et al. 1984	*great lakes water. Measured concentrations.*
acetone	Pimephales promelas	death	3				6210		Brooke, et al. 1984	*great lakes water. Measured concentrations.*
acetone	Pimephales promelas	death	2		12000				Slooff et al., 1983	*nominal concentrations.*
acetone	Salmo gairdneri	death	2		5700				Slooff et al., 1983	*nominal concentrations.*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Algae	3400	NOEC - growth	1	**3400**	Selected lowest NOEC across four species. No UF needed since NOEC used.
Zooplankton	484	NOEC reproduction/ growth/mortality	1	**484**	Used 10th percentile of NOECs. No UF needed since NOEC used.
Fishes	6210	LOEC	10	**621**	Used lowest LOEC since fewer than 10 values. Did not use NOECs since shorter duration studies. Divided by a UF of 10 to convert from LC50 to LOEC.

Table C-4
Acrolein TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Doses Studied	Notes
MAMMALS												
Acrolein	mouse	Growth	18 months	gavage	2.0 mg/kg-d	4.5 mg/kg-d		decreased weight gain	Parent et al., 1991		0.5/2.0/4.5 mg/kg/day	*Statistically significant for males only.*
Acrolein	mouse	Survival	18 months	gavage	2.0 mg/kg-d	4.5 mg/kg-d		reduced survival among males	Parent et al., 1991		0.5/2.0/4.5 mg/kg/day	*Increased mortality was only seen in males in the high dose group.*
Acrolein	rat (female)	Reproduction	93-94 days (males), 96-130 days (female)	gavage	3 mg/kg-d	6 mg/kg-d		Reduced pup weight in F1 generation	Parent et al., 1992a	278-375 g (males), 187-251 g (females)	1/3/6 mg/kg/day	*Exposure durations:* *F0 generation: males 93-94 days, females 96-130 days.* *F1 generation: males 106-125 days, females 104-149 days.* *F2 generation: not directly exposed (only in utero).*
Acrolein	rat	Growth	93-94 days (males), 96-130 days (female)	gavage	1 mg/kg-d	3 mg/kg-d		Reduced weight gain in F0 and F1 high dose male pups.	Parent et al., 1992a	278-375 g (males), 187-251 g (females)	1/3/6 mg/kg/day	*Reduced weight gain trends were observed in 3 mg/kg dose males, but were not statistically significant. Statistically significant reduced weight gain in 3 mg/kg group reported in abstract and discussion, though it's not clear from the results section in which group this was observed.*
Acrolein	rat	Reproduction	93-94 days (males), 96-130 days (female)	gavage	6 mg/kg-d			mating/fertility	Parent et al., 1992a	278-375 g (males), 187-251 g (females)	1/3/6 mg/kg-d	*The maximum dose did not affect mating or fertility of F0 or F1 generations, or the viability and morphology of their offspring.*
Acrolein	rat	Survival	93-94 days (males), 96-130 days (female)	gavage	3 mg/kg-d	6 mg/kg-d		Increased mortality in F0 and F1 generation females, and F1 males.	Parent et al., 1992a	278-375 g (males), 187-251 g (females)	1/3/6 mg/kg-d	*Increased mortality was observed in the F1 mid-dose animals and low-dose females, but was not statistically significant.*
Acrolein	rat	Survival	102 weeks	gavage		2.5 mg/kg-d		Increased mortality in both males and females.	Parent et al., 1992b		0.05/0.5/2.5 mg/kg-d	*Increased mortality in males only observed through the first year, but not significant through the second year, while reduced mortality in females was significant through the duration of the study. Statistical significance only discussed for 2.5 mg/kg group. Effects in 0.5 dose group were stated to be "marginally significant," therefore not considered to be a LOEL.*
Acrolein	New Zealand white rabbit	Growth	13 days (gestation)	gavage	0.75 mg/kg-d	2.0 mg/kg-d		Reduced maternal weight gain during first three days of dosing	Parent et al., 1993		0.1/0.75/2.0 mg/kg-d	*Effect disappears when looked at over the duration of the dosing period. Not considering as a chronic effect, as it did not persist.*
Acrolein	New Zealand white rabbit	Reproduction	13 days (gestation)	gavage		0.1 mg/kg-d		Increased fetal weight	Parent et al., 1993		0.1/0.75/2.0 mg/kg-d	*Effect attributed to a "rebound effect" of maternal weight gain. Was observed in males only at 0.1 mg/kg, and in both males and females at 2.0 mg/kg.*
Acrolein	New Zealand white rabbit	Reproduction	13 days (gestation)	gavage	2.0 mg/kg-d			Fetal skeletal malformations and gross external and soft tissue alterations.	Parent et al., 1993		0.1/0.75/2.0 mg/kg-d	*No significant effects observed.*
Acrolein	mouse	Reproduction	11 days (gestation)	gastric intubation		4 mg/kg-d		Fetotoxicity: dilated renal pelves, delayed ossification of sternebrae, metacarpals or metatarsals, subcutaneous edema, 14th rib.	King and Salinas, 1982		4/6.3/10 mg/kg-d	*Fetotoxicity was observed in all dosed maternal groups, so a NOEL was not established. Data obtained from summary memorandum (BSC_1982_Summary), not the original paper.*
Acrolein	mouse	Growth	11 days (gestation)	gastric intubation		4 mg/kg-d		depressed body weight	King and Salinas, 1982		4/6.3/10 mg/kg-d	*Depressed weight was observed in all dosed maternal groups, so a NOEL was not established. Data obtained from summary memorandum (BSC_1982_Summary), not the original paper.*

Table C-4
Acrolein TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Doses Studied	Notes
MAMMALS												
Acrolein	rat	Growth	13 days (gestation)	gastric intubation	3.6 mg/kg-d	6.0 mg/kg-d		depressed body weight	King and Crowell, 1982		3.6/6/10 mg/kg-d	*Data obtained from summary memorandum (BSC_1982_Summary), not the original paper.*
Acrolein	rat	Survival	13 days (gestation)	gastric intubation	3.6 mg/kg-d	6.0 mg/kg-d		increased mortality	King and Crowell, 1982		3.6/6/10 mg/kg-d	*Data obtained from summary memorandum (BSC_1982_Summary), not the original paper.*
Acrolein	rat	Reproduction	13 days (gestation)	gastric intubation	6 mg/kg-d	10 mg/kg-d		delayed ossification, fetal runts	King and Crowell, 1982		3.6/6/10 mg/kg-d	*Data obtained from summary memorandum (BSC_1982_Summary), not the original paper.*
Acrolein	rat	Growth	14 weeks (5 days/wk)	gavage	5 mg/kg-d	10 mg/kg-d		depressed body weight	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg-d	*5 mg/kg 5 days a week: 3.57mg/kg-day* *10 mg/kd 5 days a week: 7.14 mg/kg-day*
Acrolein	rat	Growth	42 days	intraperitoneal injection				7-10% lower body weight, chemical peritonitis	Cohen et al., 1992	73±1 g at start of study	2 mg/kg twice weekly	*Dicard due to exposure route.*
Acrolein	rat			ingestion					Lijinsky and Reuber, 1987		80 ml of soln, 5 days/week	*Discard due to lack of statistically significant results, group sizes were small (20 animals), and no stability was reported for the solution. Also, Parent et al. claim that study is inaccurate.*
Acrolein	Syrian hamster			gavage					Lijinsky and Reuber, 1987		80 ml of soln, 5 days/week	*Discard due to lack of statistically significant results, group sizes were small (20 animals), and no stability was reported for the solution. Also, Parent et al. claim that study is inaccurate.*
Acrolein	rat	Growth	77 days	inhalation		0.53 ppm		depressed body weight	Bouley et al., 1976		0.53-0.56 ppm	*Other effects included reduced liver weight and serum levels of acid phosphates, a higher suscepibility to airborne Salmonella enteritidis infection, and irritation of the upper respiratory tract, however these effects disappeared due to adaptation after 3-4 weeks.*
Acrolein	rat	Lesions	93-94 (males), 96-130 (female)	gavage	1 mg/kg	3 mg/kg		stomach lesions	Parent et al., 1992a	278-375 g (males), 187-251 g (females)	1/3/6 mg/kg/day	*Observed in both parental generations (F0 and F1).*
Acrolein	rat	Enzyme activity	102 weeks	gavage	0.05 mg/kg-d	0.5 mg/kg-d		Reduced creatinine phosphokinase (CPK) levels.	Parent et al., 1992b		0.05/0.5/2.5 mg/kg-d	
Acrolein	rat	Survival	14 weeks	gavage				increased mortality	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg	*Statistical significance of this effect not addressed*
Acrolein	rat	Hematology	14 weeks	gavage		2.5 mg/kg		Various hematology and clinical chemistry effects observed at 2.5 mg/kg and up.	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg	
Acrolein	rat (female)	Liver/Heart	14 weeks	gavage	2.5 mg/kg	5 mg/kg		high absolute and relative liver weight, and low absolute heart weight in females.	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg	
Acrolein	rat (female)	Thymus	14 weeks	gavage	5 mg/kg	10 mg/kg		low absolute and relative thymus weight in females.	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg	
Acrolein	rat (male)	Lesions	14 weeks	gavage	2.5 mg/kg	5 mg/kg		increased incidences of squamous hyperplasia of the forestomach epithelium in males.	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg	
Acrolein	rat (female)	Lesions	14 weeks	gavage	1.25 mg/kg	2.5 mg/kg		increased incidences of squamous hyperplasia of the forestomach epithelium in females.	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg	

Table C-4
Acrolein TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Doses Studied	Notes
MAMMALS												
Acrolein	rat	Lesions	14 weeks	gavage	5 mg/kg	10 mg/kg		increased incidences of hyperplasia in bone marrow, lymphoid follicular cell depletion in the spleen, and inflammation in the nose (male and female), and thymacyte necrosis (males).	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg	
Acrolein	rat	Lesions	14 weeks	gavage	5 mg/kg	10 mg/kg		increased incidences of glandular stomach hemorrhage.	NTP, 2006		0.75/1.25/2.5/5/10 mg/kg	
Acrolein	mouse	Survival	14 weeks	gavage				increased mortality	NTP, 2006		1.25/2.5/5/10/20 mg/kg	*Statistical significance of this effect not addressed*
Acrolein	mouse	Hematology	14 weeks	gavage	5 mg/kg	10 mg/kg		increased platelet counts.	NTP, 2006		1.25/2.5/5/10/20 mg/kg	
Acrolein	mouse (male)	Liver	14 weeks	gavage	5 mg/kg	10 mg/kg		high liver weight in males.	NTP, 2006		1.25/2.5/5/10/20 mg/kg	
Acrolein	mouse	Lesions	14 weeks	gavage	1.25 mg/kg	2.5 mg/kg		increased incidences of squamous epithalial hyperplasia in the forestomach.	NTP, 2006		1.25/2.5/5/10/20 mg/kg	
Acrolein	mouse	Lesions	14 weeks	gavage	10 mg/kg	20 mg/kg		increased incidences of glandular stomach hemorrhage.	NTP, 2006		1.25/2.5/5/10/20 mg/kg	
Acrolein	mouse	Necrosis	14 weeks	gavage	10 mg/kg	20 mg/kg		increased incidences of necrosis in the mandibular and mesenteric lymph nodes, depletion of the lymphoid follicle in the spleen, and necrosis in the thymus.	NTP, 2006		1.25/2.5/5/10/20 mg/kg	

🟪 = eliminated from TRV development; non-target endpoint. 🟨 = value used for AL development. 🟥 = eliminated from TRV development; no data or inappropriate route of administration.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

		Value (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	rat	2.8	4	0.7
Lemming	rat	2.8	2	1.4
Weasel	rat	2.8	4	0.7

Rationale: Geometric mean for chronic growth and reproduction bounded NOAELs is 2.8 mg/kg. This is lower than the lowest relevant paired LOAEL. Apply the following taxonomic UFs:
UF of 4 applied for same class, different order.
UF of 2 applied for same order, different family.

Table C-5
Acrolein TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Value (mg/kg-d)	Test Sp. Body Weight (BWt)	Doses Studied	Notes
BIRDS													
Acrolein	mallard duck	Survival	Single dose	oral			LD50 (mg/kg) = 9.11, 95% CL = (6.32-13.1)	mortality	Hudson et al., 1984				Document is *Handbook of Toxicity of Pesticides to Wildlife.* Information on acrolein is limited. Mentions sub-lethal effects included imbalance, wing tremors, running and falling, etc. Sample purity was 92%. Acute study.
Acrolein	leghorn chick embryos	Teratogenic effects	single injection at 48 or 72 hours of incubation	injection into air sacs of eggs		0.001 mg		gross malformations: abnormal limbs, abnormal necks, everted viscera, body hemorrhage, heart hemorrhage, microphthalimia	Chhibber and Gilani, 1984			0.001/0.004/0.007/ 0.01/0.05/0.1 mg per egg	Both 48 hr and 72 hr groups showed higher overall incidences of abnormal embryos versus controls. The overall incidences did not vary in a dose-dependent way.
Acrolein	leghorn chick embryos	Survival	single injection at 48 or 72 hours of incubation	injection into air sacs of eggs	0.004 mg	0.007 mg	LD50 = 0.01 mg per egg	mortality	Chhibber and Gilani, 1984			0.001/0.004/0.007/ 0.01/0.05/0.1 mg per egg	No significant increase in mortality for embryos injected after 72 hours. Acute study, invalid exposure route.
Acrolein	mallard duck	Survival						mortality	EPA, 2008				Document is an EPA Reregistration Eligibility Decision for Acrolein. All data are calculated based on the above Hudson et al. study and rat studies.

🟪 = eliminated from TRV development; non-target endpoint.

🟥 Shaded rows contain documents that were not usable

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	UF	TRV (mg/kg-day)
Ptarmigan			NA
Goose			NA
Loon			NA
Lapland longspur			NA
Snowy owl			NA

Rationale: Insufficient data.

Table C-6
Acrolein AL Derivation for Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (days)	Route	NOAEL	LOAEL	Other Endpoint	Specific Effect	Reference	Notes
TERRESTRIAL PLANTS										
Growth										
Acrolein	Seeds of Wheat	Viabilty	8 days	Fumigated for 24-hrs		24-hr EC: 50 mg/L			Pourmirza, 2007	All dosages used in this study are expressed as commercial formulations (95% Active Ingredient stabilzed with ~5% water and 300 ppm hydroquinone); Substrate: filter paper
	Silage Corn	Yield	35+ days	irrigation water			Yield (not significant) = 8.99 @180 ppm 9.71 @120 ppm 10.32 @ 60 ppm 10.57 @ 0 ppm		Yeo, 1959	Nominal concentrations; Short synopsis - not full study report (reference in Ferguson et al., 1961)
	Corn (Wisconsin 642)	Yield Leaf Damage Mortality	6+ months	irrigation water (furrow)		160 ppm	240 ppm = 5% mortality (143.9 bushels) 160 ppm = 3% mortality (147.3 bushels) 80 ppm = 0% mortality (133.9 bushels) None = 0% mortality (145.0 bushels)		U.S. Dept. of Agriculture, 1964	Substrate: Sagemoor very fine sandy loam (Washington); Concentrations: 80, 160, 240 ppm (1958)
						150 ppm	20 ppm = Minor injury, no reduction in yield 60 ppm = slight/moderate injury, no reduction in yield 150 ppm = severe injury, 3% mortality, yields not reduced measurably			Substrate: Sagemoor very fine sandy loam (Washington); Concentrations: 20, 60, 150 ppm (1959)
	Silage Corn			irrigation water (furrow)	180 ppm		0 ppm = 10.6 tons/acre 60 ppm = 10.3 tons/acre 120 ppm = 9.7 tons/acre 180 ppm =9.0 tons/acre			Substrate: Pryor silty clay (Montana); Concentrations: 0, 60, 120, 180 ppm (1958); No trace of acrolein found in plant/seed tissues
	Silage Corn						0 ppm = 19.7 tons/acre 15 ppm = 19.8 tons/acre 30 ppm = 19.8 tons/acre 60 ppm =20.0 tons/acre			Substrate: Pryor silty clay (Montana); Concentrations: 0, 15, 30, 60 ppm (1959)
	Yellow Nutsedge		1 month	Soil			≥200 mgs/kg soil = 100% mortality		Rodriguez-Kabana et al., 2003	Nominal concentration
Damage/Death										
Acrolein	Avena sp. (oats)	Leaf Damage	4-9 hrs	Air, constant rate	4.5-hr: 1.2 ppm		—		Haagen-Smit et al., 1952	Measured concentrations; Substrate: 1:1 pea gravel/vermiculite - watered with Hoagland's solution
	corn, cotton, milo, squash, castor beans, tomatoes			irrigation water	80 ppm				Ferguson et al., 1961	Not part of study - just reference
	Beans, Clover, Corn	Damage Mortality		irrigation water			No Effect		Unrau et al., 1965	Nominal concentration

II. Calculate AL

Endpoint	Conc (mg/L)	UF	Tier II AL
			NA

Rationale:

Because no values were given for actual soil concentration no Tier II values could be derived.

🟨 = value used for AL development.

Table C-7
Acrolein AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
Acrolein	Ceriodaphnia dubia	Mortality	1 day	aqueous solution (fresh water)	0.1	0.2	LC_{50} = 0.43 (0.35-0.53)		Union Carbide Corporation, 1997	Static-renewal test; Nominal concentrations; dilution water 50:50 mixture of 20% Perrier and filtered Kanawha River water
			2 days				LC_{50} = 0.40 (0.32-0.50)			
			3-7 days				LC_{50} = 0.30 (0.27-0.35)			
			7 days				ChV = 0.14			
	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.057 (0.02-0.099)		Macek et al., 1976	Static and intermittent-Flow water system; Nominal and measured concentrations reported; Chronic three generation reproduction study data point are measured concentration values.
		Reproduction	64 days		>0.0169	<0.0336	—			
	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	0.034	—	LC_{50} = 0.083 (0.070-0.10)		LeBlanc, 1980	Static system; Nominal concentrations
	Daphnia magna	Mortality	4 days	aqueous solution (fresh water)	<26	—	LC_{50} = 100 (92-110)		Turner, 1982	Static system; Nominal concentrations
	Daphnia magna	Immobile	2 days	aqueous solution (fresh water)	—	—	EC_{50} = 0.051 (0.043-0.062)		Holcombe and Phipps, 1987	Toxicological values were reference from EPA ECOTOX: Aquatic Report, Reference Number 12665; Flow-through system; Measured concentrations reported
Fishes										
Acrolein	Pimephales promelas	Mortality	6 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.084 (0.054-0.130)		Macek et al., 1976	Intermittent-Flow water system; Both nominal and measured concentrations reported
		Reproduction	245 days		>0.0114	<0.0417	—			
	Oncorhynchus kisutch	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.068		Lorz et al., 1979	Static system, nominal concentrations reported
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	0.073	—	LC_{50} = 0.15 (0.1-0.20)		Turner, 1982	Static system; Nominal concentrations
	Jordanella floridae	General Growth	32 days	aqueous solution (fresh water)	0.016	0.042	—		Spehar, 1989	Flow-through system; Measured concentrations reported
	Jordanella floridae (1-day old)	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.060 (0.043-0.097)			
	Jordanella floridae (30-day old)	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.051 (0.035-0.074)			
	Pimephales promelas	Mortality	32 days	aqueous solution (fresh water)	0.014	0.035	—			
	Pimephales promelas (1-day old &30-day old)	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.027 (0.024-0.030)			

Table C-7
Acrolein AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Acrolein	Oncorhynchus mykiss	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.016 (0.014-0.019)		Holcombe and Phipps, 1987	Toxicological values were reference from EPA ECOTOX: Aquatic Report, Reference Number 12665; Flow-through system; Measured concentrations reported
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.014 (0.008-0.025)			
	Catostomus commersoni	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.014 (0.008-0.025)			
	Lepomis macrochirus	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.033 (0.027-0.040)			

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Zooplankton	0.0169	NOEC	1	**0.017**	Used the lowest bounded and measured NOEC value from the chronic reproduction study with a longer duration that used a flow-through system. No UF applied to the NOEC value.
Fish	0.0114	NOEC	1	**0.011**	Used the lowest bounded and measured NOEC value from the chronic reproduction study with a longer duration that used a flow-through system. No UF applied to the NOEC value.

🟨 = value used for AL development.

Table C-8
Benzene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Other (as specified)	Specific Effect	Reference	Test Sp. Body Weight (BWt) (kg)	Ingestion Rate (IRt) (g/g-day)	Notes
MAMMALS													
Benzene	B1	Mice	Reproductive	10 days	Gavage	nr	.3 ml/kg-d	nr	Fetal weight	Nawrot and Staples, 1979	nr		*Abstract only* *Females days 6 - 15 or 12 - 15 of gestation* *Maternal toxicity occurred at higher doses.*
Benzene	B2	Rats (F344/N)	Hematological Histological Morphology	2 years	Gavage	nr	1	nr	various	National Toxicology Program Tech. Report Series (No 289)	258 g	0.039	*Studies conducted at 25, 50, 100 and 200 mg/kg.* *BW at end - BW at start / 2 (both sexes)*
Benzene	B2	Mice (B6C3F)	Hematological Histological Morphology	2 years	Gavage	nr	5	nr	various	National Toxicology Program Tech. Report Series (No 289)	32.75 g	0.2	*Studies conducted at 25, 50, and 200 mg/kg.* *BW at end - BW at start / 2 (both sexes)*
Benzene	B3	Rats	Mortality	Acute (single dose)	Stomach tube	nr	nr	LC50 = 5.6 mg/kg	Death	Wolf et al., 1956	nr		
Benzene	B3	Rats	Organ Histopathology and Growth	187 days (132 feedings)	Stomach tube	1	10	-	Leucopenia	Wolf et al., 1956	nr		*Dose regime = 1, 10 , 50 and 100 mg/kg/d* *No. of feedings = 132*
Benzene	B3	Rabbits	Skin Irritation	2 - 4 wks	Direct application to ear and abdomen	nr	nr	nr	Erythema Exfoliation Edema/superficial necrosis	Wolf et al., 1956	nr		*Effects not quantified; slight to moderate irritation and moderate necrosis noted*
Benzene	B3	Rabbits	Conjuctival Irritation Corneal Injury	Acute	Direct application of 2 drops	nr	nr	nr	Irritation Inflammation/swelling Necorsis (cornea)	Wolf et al., 1956	nr		*Effects not quantifitied; moderate conjunctival irritation and very slight, transient corneal injury noted*
Benzene	B3	Rat	Organ Weight Organ/Blood Histopathology Mortality	204 days + *various*	Vapour exposure chamber	nr	88 ppm	nr	Spleen weight Blood histopathology	Wolf et al., 1956	nr		*Exposures for 7 -8 hours a day, 5 days a week for up to 6 months*
Benzene	B3	Guinea Pig	Organ Weight Organ/Blood Histopathology Mortality	32 days	Vapour exposure chamber	nr	88 ppm	nr	Kidney weight Blood histopathology	Wolf et al., 1956	nr		*Exposures for 7 -8 hours a day, 5 days a week for up to 6 months*
Benzene	B3	Rabbits	Organ Weight Organ/Blood Histopathology Mortality	243 d	Vapour exposure chamber	nr	80 ppm	nr	Kidney histopathology Testes histopathology Blood histopathyology	Wolf et al., 1956	nr		*Exposures for 7 -8 hours a day, 5 days a week for up to 6 months*
						🟨	= Value used in identifying TRV						*rat ingestion rate of 10 g/d from zinc studies.*

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	1.0	4	**0.25**
Lemming	1.0	2	**0.50**
Weasel	1.0	4	**0.25**

Rationale:

Selected only NOAEL; chronic rat study with growth endpoint and LOAEL.
No toxicity-based UF needed since chronic NOAEL.

Taxonomic UF represents different Order, same Class
Taxonomic UF represents different Family, same Order
Taxonomic UF represents different Order, same Class

Table C-9
Benzene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes
AQUATIC											
Algae											
Benzene	Chlorella pyrenoidosa	Growth	48 hr	aqueous solution	-	-	-	nr	Slooff et al., 1983		*nominal concentrations.*
Benzene	Chlamydomonas angulosa	Photosynthesis Inhibition	3 hr	aqueous solution	-	-	EC_{50} = 312.4 mg/L	$^{14}CO_2$ uptake	Hutchinson et al., 1980		*"three to four day exponential phase cells" used; assume nominal concentrations*
Benzene	Chlorella vulgaris	Photosynthesis Inhibition	3 hr	aqueous solution	-	-	EC_{50} = 460.8 mg/L	$^{14}CO_2$ uptake	Hutchinson et al., 1980		*"three to four day exponential phase cells" used; assume nominal concentrations*
Benzene	Selenastrum capricornutum	Growth	72 hr	aqueous solution		-	LC50 = 29 mg/L	nr	Galassi et al., 1988		*Authors maintained steady concentration throughout study; measured concentrations*
Benzene	Scenedesmus pannonicus	Growth	48 hr	aqueous solution	> 1400 mg/L	-	-	nr	Slooff et al., 1983		*nominal concentrations.*
Benzene	Scenedesmus pannonicus	Growth	192 hr	aqueous solution	-	-	-	Cell multiplication	Slooff et al., 1983		*Tox info cited from Bringmann and Kuhn, 1978 (german journal. assume nominal concentrations.*
Benzene	Selenastrum capricornutum	Growth	96 hr	aqueous solution	600 mg/L	-	-	nr	Slooff et al., 1983		*nominal concentrations.*
Zooplankton											
Benzene	Entosiphon sulcatum	Cell multiplication	72 hr	aqueous solution	>1400 mg/L	-	-	nr	Slooff et al., 1983		*Tox info cited from Bringmann 1978 (german journal. assume nominal concentrations.*
Benzene	Uronema parduczi	Cell multiplication	20 hr	aqueous solution	490 mg/L	-	-	nr	Slooff et al., 1983		*Tox info cited from Bringmann and Kuhn, 1980 (german journal. assume nominal concentrations.*
Benzene	Chilomonas paramaecium	Cell multiplication	48 hr	aqueous solution	440 mg/L	-	-	nr	Slooff et al., 1983		*Tox info cited from Bringmann et al, 1980 (Water Res. 14: 231-241); assume nominal concentrations.*
Benzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 31.2 mg/L	Mortality	Bobra et al, 1983		*closed syste; assume nominal concentrations*
Benzene	Daphnia magna	Body burden	48 hr	aqueous solution	-	-	33.6 mg/L ***		Pawlisz and Peters, 1993		*This was not a toxicological study. The authors were interested in body burdens of radiolabels at LC $_{50}$ concentrations determined in other studies. (***LC50 value from Konemann, H. Toxicology. 1981:19, 209-221.)*

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I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes
AQUATIC											
Benzene	Daphnia magna	Body burden	48 hr	aqueous solution	-	-	2.73 mg/L***		Pawlisz and Peters, 1995		*Investigation into the effect of sublethal vs lethal exposures compared to body burdens. LC50 used were obtained from other studies. (*** no reference given for LC50 value)*
Benzene	Daphnia magna	Mortality	48 hr	aqueous solution	NOEC = 240 mg/L	-	LC50 = 400 mg/L	Mortality	Slooff et al., 1983		*Tox info cited from Canton and Adema 1978 (Hydrobiologia 2: 135-140); assume nominal concentrations.*
Benzene	Daphnia magna	Mortality	24	aqueous solution	NOEC = <13 mg/L	-	LC50 = 250 mg/L	Mortality	LeBlanc, 1980		*no details on NOEC concentration; nominal concentrations*
Benzene	Daphnia magna	Mortality	48	aqueous solution	NOEC = <13 mg/L	-	LC50 = 200 mg/L	Mortality	LeBlanc, 1980		*no details on NOEC concentration; nominal concentrations*
Benzene	Daphnia pulex	Mortality	48 hr	aqueous solution	NOEC = 196 mg/L	-	LC50 = 305 mg/L	Mortality	Slooff et al., 1983		*Tox info cited from Canton and Adema 1978 (Hydrobiologia 2: 135-140. assume nominal concentrations.*
Benzene	Daphnia magna	Immobilization	24 hr	aqueous solution	-	-	LC50 = 18 mg/L		Galassi et al., 1988		*Closed system; measured concentrations*
Benzene	Daphnia cucculata	Mortality	48 hr	aqueous solution	-	-	LC50 = 373 mg/L	Mortality	Slooff et al., 1983		*Tox info cited from Canton and Adema 1978 (Hydrobiologia 2: 135-140). assume nominal concentrations.*
Benzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 682 mg/L	Mortality	Eastmond et al., 1984		*LC50 calculated using probit analysis by SAS program; nominal concentrations*
Benzene	Ceriodaphnia dubia (<24 hr)	Mortality	24 hr	aqueous solution	-	-	LC50 = 18.4 mg/L	Mortality	Marchini et al., 1993		*static system* *LC50 calculated using trimmed Spearman-Karber method; measured concentrations*

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I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes
AQUATIC											
Benzene	Daphnia pulex	Diversity	24 d	aqueous solution	-	-	-		Lay et al., 1985		*Good population study but no ECx's identified; measured concentrations*
Benzene	Daphnia magna	nzymatic Inhibiti	1 hr	aqueous solution	-	-	6.3 mg/L	Fluorescence	Janssen and Persoone, 1993		*nominal concentrations*
Benzene	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	10 mg/L	Mobility	Janssen and Persoone, 1993		*nominal concentrations*
Benzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	10 mg/L	Mobility	Janssen and Persoone, 1993		*nominal concentrations*
Benzene	C. cf. dubia (Australian species)	Mortality	48 hr	aqueous solution	-	-	EC50 = 130 mg/L	Immobilization	Rose et al., 1998		*EC50 calculated using trimmed Spearman-Karber method; measured concentrations*
Benzene	Tigriopus californicus	Mortality	7 days	aqueous solution	-	-	nc	-	Barnett and Kontogiannis, 1970		*Study did not calculate NOEC/LOEC/LC50s; assume nominal concentrations*
Benzene	Daphnia pulex	Mortality	96 hr	aqueous solution	-	-	LC50 = 15 mg/L	Mortality	Trucco et al., 1983		*measured concentrations*
Benzene	Hydra oligactis	Mortality	48 hr	aqueous solution	NOEC = 24 mg/L	-	LC50 = 34 mg/L	Mortality	Slooff et al., 1983		*nominal concentrations.*
Fish											
Benzene	Carassius auratus (goldfish)	Mortality	24 hr	Soft water	-	-	34.42 mg/L	Mortality	Pickering and Henderson, 1966		
Benzene	Carassius auratus (goldfish)	Mortality	48 hr	Soft water	-	-	34.42 mg/L	Mortality	Pickering and Henderson, 1966		
Benzene	Carassius auratus (goldfish)	Mortality	96 hr	Soft water	-	-	34.42 mg/L	Mortality	Pickering and Henderson, 1966		
Benzene	Lebistes reticularus (guppies)	Mortality	24 hr	Soft water	-	-	36.6 mg/L	Mortality	Pickering and Henderson, 1966		
Benzene	Lebistes reticularus (guppies)	Mortality	48 hr	Soft water	-	-	36.6 mg/L	Mortality	Pickering and Henderson, 1966		
Benzene	Lebistes reticularus (guppies)	Mortality	96 hr	Soft water	-	-	36.6 mg/L	Mortality	Pickering and Henderson, 1966		
Benzene	Lepomis macrochirus (Bluegill)	Mortality	24 hr	Soft water	-	-	22.49 mg/L	Mortality	Pickering and Henderson, 1966		

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I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes
AQUATIC											
Benzene	Lepomis macrochirus (Bluegill)	Mortality	48 hr	Soft water	-	-	22.49 mg/L	Mortality	Pickering and Henderson, 1966		
Benzene	Lepomis macrochirus (Bluegill)	Mortality	96 hr	Soft water	-	-	22.49 mg/L	Mortality	Pickering and Henderson, 1966		
Benzene	Leuciscus idus (Orfe)	Mortality	48 hr	aqueous solution	-	-	LC 50 = 132 mg/L	Mortality	Slooff et al., 1983		*Tox info cited from Juhnke and Ludemann 1978 (german journal) assume nominal concentrations.*
Benzene	Oryzias latipes (Japanese killifish)	Mortality	48 hr	aqueous solution	NOEC = 126 mg/L	-	LC50 = 250 mg/L	Mortality	Slooff et al., 1983		*nominal concentrations.*
Benzene	Pimephales promelas	Mortality	48 hr	aqueous solution	NOEC = 54 mg/L	-	LC50 = 84 mg/L	Mortality	Slooff et al., 1983		*nominal concentrations.*
Benzene	Pimephales promelas	Mortality	24 hr	Soft water	-	-	35.56 mg/L	Mortality	Pickering and Henderson, 1966		*Endpoint concentrations = median tolerable concentrations (calculated from mortalities in difference test concentrations causing 50% mortality during time interval. (straight line graphical interpolation from percent survival and lot concentrations of chemicals); assume nominal concentrations*
Benzene	Pimephales promelas	Mortality	48 hr	Soft water	-	-	35.08 mg/L	Mortality	Pickering and Henderson, 1966	126	*assume nominal concentrations*
Benzene	Pimephales promelas	Mortality	96 hr	Soft water	-	-	33.47 mg/L	Mortality	Pickering and Henderson, 1966	54	*assume nominal concentrations*
Benzene	Pimephales promelas	Mortality	24 hr	Hard water	-	-	34.42 mg/L	Mortality	Pickering and Henderson, 1966	2.9	*assume nominal concentrations*
Benzene	Pimephales promelas	Mortality	48 hr	Hard water	-	-	32.0 mg/L	Mortality	Pickering and Henderson, 1966	10.2	*assume nominal concentrations*
Benzene	Pimephales promelas	Mortality	96 hr	Hard water	-	-	32 mg/L	Mortality	Pickering and Henderson, 1966	40	*assume nominal concentrations*
Benzene	Pimephales promelas (fry)	Mortality	96 hr	aqueous solution	-	-	LC30 = 15.1 mg/L	Mortality	DeGraeve et al., 1982	24.05273648	*Flow through* *LC50 calculated using graphical methods described in Am. Public Health Assoc. 1975; measured concentrations*
Benzene	Pimephales promelas (juveniles = 28 -	Mortality	96 hr	aqueous solution	-	-	LC50 = 24.6 mg/L	Mortality	Marchini et al., 1992		*LC50 based on personal communication by the author; measured concentrations*

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I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes
AQUATIC											
Benzene	Pimephales promelas (juveniles = 28 - 33 d)	Survival	ELS (32 - 33 day)	aqueous solution	10.0 mg/L	23.4 mg/L	-	Mortality	Marchini et al., 1992		*NOEC/LOEC based on personal communication by the author; measured concentrations*
Benzene	Pimephales promelas (juveniles = 28 - 33 d)	Growth	ELS (32 - 33 day)	aqueous solution	2.9 mg/L	5.5 mg/L	-	Weight	Marchini et al., 1992		*NOEC/LOEC based on personal communication by the author; measured concentrations*
Benzene	Pimephales promelas (larvae = < 24 hr old)	Mortality	7 day	aqueous solution	-	-	14.01 mg/L	Mortality	Marchini et al., 1992		*Flow through test conditions LC50s calculated using trimmed Spearman-Karber technique; measured concentrations*
Benzene	Pimephales promelas (larvae = < 24 hr old)	Mortality	96 hr	aqueous solution	-	-	15.59 mg/L	Mortality	Marchini et al., 1992		*Flow through test conditions LC50s calculated using trimmed Spearman-Karber technique; measured concentrations*
Benzene	Pimephales promelas (larvae = < 24 hr old)	Growth	7 day	aqueous solution	10.2 mg/L	17.2 mg/L	-	Dry Weight	Marchini et al., 1992		*NOEC/LOEC determined by means of hypothesis testing statistics; measured concentrations*
Benzene	Pimephales promelas (larvae = < 24 hr old)	Survival	7 day	aqueous solution	10.2 mg/L	17.2 mg/L	-	Mortality	Marchini et al., 1992		*NOEC/LOEC determined by means of hypothesis testing statistics; measured concentrations*
Benzene	Pimephales promelas (larvae = < 24 hr old)	Growth	7 day	aqueous solution	-	-	IC25 = 13.5 mg/L	Dry Weight # Survivors	Marchini et al., 1992		*ICs estimated by point estimation technique using monotone smoothing and linear interpolation procedure ; measured concentrations*
Benzene	Pimephales promelas (larvae = < 24 hr old)	Growth	7 day	aqueous solution	-	-	IC50 = 20.48 mg/L	Dry Weight # Survivors	Marchini et al., 1992		*ICs estimated by point estimation technique using monotone smoothing and linear interpolation procedure ; measured concentrations*
Benzene	Pimephales promelas (larvae = < 24 hr old)	Biomass	7 day	aqueous solution	-	-	IC25 = 10.57 mg/L	Dry Weight # Original	Marchini et al., 1992		*ICs estimated by point estimation technique using monotone smoothing and linear interpolation procedure ; measured concentrations*

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Benzene AL Derivation for Aquatic Receptors
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Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes
AQUATIC											
Benzene	Pimephales promelas (larvae = < 24 hr old)	Biomass	7 day	aqueous solution	-	-	IC50 = 13.38 mg/L	Dry Weight # Original	Marchini et al., 1992		*ICs estimated by point estimation technique using monotone smoothing and linear interpolation procedure ; measured concentrations*
Benzene	Rainbow Trout (juveniles)	Mortality	96 hr	aqueous solution	-	-	LC50 = 5.3 mg/L	Mortality	DeGraeve et al., 1982		*Flow through; LC50 calculated using graphical methods described in Am. Public Health Assoc. 1975; measured concentrations*
Benzene	Salmo gairdneri	Mortality	48 hr	aqueous solution	NOEC = 40 mg/L	-	LC50 = 56 mg/L	Mortality	Slooff et al., 1983		*nominal concentrations.*
Benzene	Salmo gairdneri	Mortality	96 hr	aqueous solution	-	-	LC50 = 5.9 mg/L	Mortality	Galassi et al., 1988		*Test solution renewed at 48 hrs; measured concentrations*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale:
Algae	29	LC50	10	**2.9**	Used lowest LC50 associated with measured study; fewer than ten studies available. Divided by UF of 10 to convert LC50 to LOEC.
Zooplankton	15	LC50	10	**1.5**	Used lowest LC50 of measured studies; fewer than ten studies available. Divided by UF of 10 to convert LC50 to LOEC.
Fish	5.3	LC50	10	**0.53**	Five LC50 values available from measured studies; used lowest LC50 since fewer than ten. Divided by UF of 10 to convert LC50 to LOEC.

Table C-10
2-Butanone TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Specific Effect	Reference	Notes	BW (kg)	Water IR (l/d)	IR (mg/d)	Dose (mg/kg-d)
MAMMALS													
2-Butanone	Rats	reproduction	12 weeks	oral (drinking water)	1,201	2,815	pup growth, fetus weights, retarded skeletal development	Cox et al., 1975					
2-Butanone	Rats	kidney effects	12 weeks	oral (drinking water)	1,201	2,815	tubular degeneration, tubular casts, foci of tubular regeneration, renal papilla microcysts	Cox et al., 1975					

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	1,201	20	**60**
Lemming	1,201	10	**120**
Weasel	1,201	20	**60**

Rationale:

Used reproductive NOAEL.

Divided by UF of 5 to extrapolate from subchronic to chronic.
Taxonomic UF for shrew and weasel of 4 represents different Order, same Class
Taxonomic UF for lemming of 2 represents different Family, same Order

Density = 0.8 g/cm3
800 g/L
800000 mg/L

16000 mg 2-Butanone in 1 liter of 2% solution

8000 mg 2-Butanone in 1 liter of 1% solution

F1 generation: 2% group 2.651 L total fluid intake over 11 weeks
average per day fluid intake = 0.0344 L/d

1% group 2.726 L total fluid intake over 11 weeks
average per day fluid intake = 0.0354 L/d
body weight average for 2% group = 195.71 g
0.196 kg
body weight average for 1% group = 235.86 g
0.236 kg

Dose 2% group = 2815 mg/kg-d
1% group = 1201 mg/kg-d

(note these are different from the study "estimates" of 2500/1500 mg/kg-day.)

Table C-11
Carbon tetrachloride TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	NOAEL (mg/m^3)	Inhalation Rate (m3/d)	NOAEL (mg/kg-day)	Hours/day Factor	Days/week Factor	Adjusted NOAEL (mg/kg-day)
MAMMALS																	
Carbon tetrachloride	Rat (male and female)	Growth	2 yr	ingestion (fumigated mash)	10-18 mg/kg-d			weight gain, food consumption	Alumot et al., 1976a		*No effects observed at highest concentration tested (out of 2 dose levels plus control). Concentration calculated based on fumigated feed consumption and body weight; amount of fumigant lost and % of dose consumed were also measured. Authors recommend 10 mg/kg-d as an acceptable daily intake.*						
Carbon tetrachloride	Rat (male and female)	Reproduction	2 yr	ingestion (fumigated mash)	10-18 mg/kg-d			litter size and weight, # mated, pregnant, and with litters, mortality of young, male fertility	Alumot et al., 1976a		*Fatty livers observed during preliminary 13-week study at higher concentration (but liver and kidney functions not affected after 2 yr).*						
Carbon tetrachloride	Rat (male and female)	Survival	2 yr	ingestion (fumigated mash)	10-18 mg/kg-d			mortality	Alumot et al., 1976a	0.037 (males), 0.030 (females)							
Carbon tetrachloride	Mouse	Survival	90 days	ingestion (gavage with corn oil)	1200 mg/kg-d			mortality	Hayes et al., 1986a	0.03	*Body weights are terminal weight average for naive and vehicle control groups.*						
Carbon tetrachloride	Mouse	Growth	90 days	ingestion (gavage with corn oil)	1200 mg/kg-d			body weight	Hayes et al., 1986a	0.03	*Some changes to body weight noted, but not consistent and observed at intermediate but not highest doses.*						
Carbon tetrachloride	Rat (male)	Growth	12 weeks	ingestion (gavage with corn oil)	10 mg/kg-d	33 mg/kg-d		body weight	Bruckner et al., 1986	0.2-0.25	*Persisted after discontinuation of dosing (at least 13 days)*						
Carbon tetrachloride	Rat	Mortality	173-205 days	inhalation (7 hrs/d, 5 days/wk)	100 ppm (0.63 mg/L)	200 ppm (1.26 mg/L)		survival	Adams et al., 1952	0.329 (males), 0.207 (females)	*At 200 ppm only 6 male and 9 females survivors out of 15 each initially.*						
Carbon tetrachloride	Rat	Growth	173-205 days	inhalation (7 hrs/d, 5 days/wk)	100 ppm (0.63 mg/L)	200 ppm (1.26 mg/L)		body weight	Adams et al., 1952	0.329 (males), 0.207 (females)	*Reduced growth observed only in males at 200 ppm (only 6 male and 9 females survivors out of 15 each initially). "Slight depression of growth in the males" also noted at 50 ppm.*						
Carbon tetrachloride	Rat	Reproduction	173-205 days	inhalation (7 hrs/d, 5 days/wk)	100 ppm (0.63 mg/L)	200 ppm (1.26 mg/L)		complete atrophy of germinal elements of testes tubules	Adams et al., 1952	0.329 (males), 0.207 (females)	*Assume no effects observed at 50 or 100 ppm, since not discussed as such in the paper.*	629	0.32	614	0.29	0.71	128
Carbon tetrachloride	Rat (female)	Reproduction	10 days (days 6-15 of gestation)	inhalation (7 hrs/d)	1,000 ppm			fetal resorptions, gross fetal anomalies, maternal conception rate, number of implantations, litter size	Schwetz et al., 1974	0.25	*Weight given as approximation, presumably at beginning of study. Nominal concentrations of 300 and 1,000 ppm. Analytical concentrations also measured by infrared spectrometry, mean of 3 measurements on each of 10 days of exposure (334 and 1004 ppm average).*	6291	0.26	6454	0.29	1	1882
Carbon tetrachloride	Rat (female)	Reproduction	10 days (days 6-15 of gestation)	inhalation (7 hrs/d)			300 ppm	decreased fetal body weight and crown-rump length, maternal body weight and food consumption	Schwetz et al., 1974	0.25	*Significantly different from controls at both concentrations tested.*						
Carbon tetrachloride	Rat (female)	Reproduction	10 days (days 6-15 of gestation)	inhalation (7 hrs/d)	300 ppm	1,000 ppm		incidence of sternebral anomalies	Schwetz et al., 1974	0.25		1887	0.26	1936	0.29	0.71	403
Carbon tetrachloride	Rat	Growth	90 days	inhalation (continuous)	6.1 mg/m^3	61 mg/m^3		depressed growth curve/reduced body weight gain	Prendergast et al., 1967	0.304	*Nominal input data correlated with analytical chemical measurements, also continuous automated analytical monitoring. Weight gain not reduced at 6.1 mg/m^3, but reduced growth curve at 61 mg/m^3. Body weight is average of control group at beginning and end of 90 day study.*						

Table C-11
Carbon tetrachloride TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	NOAEL (mg/m^3)	Inhalation Rate (m3/d)	NOAEL (mg/kg-day)	Hours/day Factor	Days/week Factor	Adjusted NOAEL (mg/kg-day)
MAMMALS																	
Carbon tetrachloride	Rat	Survival	90 days	inhalation (continuous)	61 mg/m^3			mortality	Prendergast et al., 1967	0.304							
Carbon tetrachloride	Rat	Growth	6 weeks	inhalation (8 hr/d, 5 d/wk)	515 mg/m^3			body weight	Prendergast et al., 1967	0.304	*Only concentration tested. Weight was reduced in all other test species at this concentration.*						
Carbon tetrachloride	Rat	Survival	6 weeks	inhalation (8 hr/d, 5 d/wk)	515 mg/m^3			mortality	Prendergast et al., 1967	0.304	*Only concentration tested.*						
Carbon tetrachloride	Rat	Growth	10.5 months	inhalation (8 hrs/d, 5 days/wk)	200 ppm	400 ppm		weight gain	Smyth et al., 1936	not reported	*Weight gain was 70% of controls in this group; statistical significance not discussed. Other groups (50, 100, and 200 ppm) had similar or increased weight gain compared to controls. Used average male rat weight (0.47) for chronic study to calculate dose.*	1258	0.43	1153	0.33	0.71	274
Carbon tetrachloride	Rat	Reproduction	10.5 months	inhalation (8 hrs/d, 5 days/wk)	100 ppm	200 ppm		total offspring and litters per female	Smyth et al., 1936	not reported	*Values provided and compared to controls; statistical significance not discussed.*	629	0.43	576	0.33	0.71	137
Carbon tetrachloride	Rat	Mortality	10.5 months	inhalation (8 hrs/d, 5 days/wk)	400 ppm			survival	Smyth et al., 1936	not reported	*Two (out of 19) rats died in this group.*						
Carbon tetrachloride	Rat (female)	Liver	10 days (days 6-15 of gestation)	inhalation (7 hrs/d)			300 ppm	increased SGPT, pale, mottled livers, increased relative liver weight	Schwetz et al., 1974	0.25	*Significantly different from controls at both concentrations tested. Effects (SGPT and liver appearance) no longer observed after 6 day recovery period.*						
Carbon tetrachloride	Mouse	Liver/spleen/thymus	90 days	ingestion (gavage with corn oil)		12 mg/kg		organ weights (absolute and/or relative), liver necrosis, hepatitis, numerous other liver effects	Hayes et al., 1986a	0.03	*Dose-dependent increase in liver and spleen weights, thymus at 2 highest doses.*						
Carbon tetrachloride	Mouse	Enzymes	90 days	ingestion (gavage with corn oil)		12 mg/kg		serum enzyme chemistry	Hayes et al., 1986a	0.03							
Carbon tetrachloride	Rat (male)	Clinical chemistry	12 weeks	ingestion (gavage with corn oil)	10 mg/kg	33 mg/kg		SDH, OCT, GPT elevated	Bruckner et al., 1986	0.2-0.25	*Authors note that SDH increase 2-3 fold at most points at 10 mg/kg but results were "not always sufficient to be statistically significant". Assuming nominal concentrations.GPT and SDH in 33 mg/kg group returned to normal after 13 days of discontinuation.*						
Carbon tetrachloride	Rat (male)	Liver	12 weeks	ingestion (gavage with corn oil)	10 mg/kg	33 mg/kg		liver weights (relative), degenerative lesions	Bruckner et al., 1986	0.2-0.25							
Carbon tetrachloride	Rat	Liver	173-205 days	inhalation (7 hrs/d, 5 days/wk)	5 ppm (0.032 mg/L)	10 ppm (0.063 mg/L)		increased liver weight and fatty degeneration, increased total lipid, neutral fat, and esterified chloesterol	Adams et al., 1952	0.329 (males), 0.207 (females)	*Vapor concentrations measured; always within 10% of target. Body weights are average of final control body weights. 5 ppm is identified by the authors as the concentration at which rats were not affected adversely.*						329
Carbon tetrachloride	Rat	Kidney	173-205 days	inhalation (7 hrs/d, 5 days/wk)	25 ppm (0.16 mg/L)	50 ppm (0.32 mg/L)		cloudy swelling of tubular epithelium, increased kidney weight	Adams et al., 1952	0.329 (males), 0.207 (females)							
Carbon tetrachloride	Rat	Blood	173-205 days	inhalation (7 hrs/d, 5 days/wk)	50 ppm (0.32 mg/L)	100 ppm (0.63 mg/L)		increased plasma prothrombin clotting time	Adams et al., 1952	0.329 (males), 0.207 (females)	*Blood nonprotein nitrogen and blood urea nitrogen also increased at 200 ppm.*						
Carbon tetrachloride	Rat	Liver	90 days	inhalation (continuous)	6.1 mg/m^3	61 mg/m^3		enlarged and discolored livers, histopathology	Prendergast et al., 1967	0.304							
Carbon tetrachloride	Rat	Lung	90 days	inhalation (continuous)			6.1 mg/m^3	nonspecific inflammatory changes	Prendergast et al., 1967	0.304	*Effect observed at this concentration, not mentioned at higher concentration.*						

Table C-11
Carbon tetrachloride TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	NOAEL (mg/m^3)	Inhalation Rate (m3/d)	NOAEL (mg/kg-day)	Hours/day Factor	Days/week Factor	Adjusted NOAEL (mg/kg-day)
MAMMALS																	
Carbon tetrachloride	Rat	Blood	90 days	inhalation (continuous)	6.1 mg/m^3			serum urea nitrogen	Prendergast et al., 1967	0.304							
Carbon tetrachloride	Rat	Liver	6 weeks	inhalation (8 hr/d, 5 d/wk)			515 mg/m^3	mottled liver, histopathology, fatty changes	Prendergast et al., 1967	0.304	*Only concentration tested.*						
Carbon tetrachloride	Rat	Lung	6 weeks	inhalation (8 hr/d, 5 d/wk)			515 mg/m^3	histopathology/morphological changes, pneumonitis, interstitial inflammation	Prendergast et al., 1967	0.304	*Only concentration tested.*						
Carbon tetrachloride	Rat	Blood	10.5 months	inhalation (8 hrs/d, 5 days/wk)	200 ppm	400 ppm		high icteric index	Smyth et al., 1936	not reported	*Index returned to normal soon after exposures stopped.*						
Carbon tetrachloride	Rat	Liver	10.5 months	inhalation (8 hrs/d, 5 days/wk)	50 ppm	100 ppm		cirrhosis	Smyth et al., 1936	not reported	*Liver regenerated/healed after varying amounts of time (50-156 days reported) following end of exposure.*						
Carbon tetrachloride	Rat	Nerve degeneration	10.5 months	inhalation (8 hrs/d, 5 days/wk)		50 ppm		sciatic nerve damage	Smyth et al., 1936	not reported	*Observed at all concentrations with more exposures/time resulting in observation of effect at lower concentrations.*						
Carbon tetrachloride	Mouse	Liver	12 weeks (+3 days)	ingestion (gavage with corn oil or 1% Tween-60)	12 mg/kg	120 mg/kg		absolute and relative liver weights	Condie et al., 1986	0.041 (males) , 0.03 (females)	*Study looked at effect of gavage vehicle (corn oil or 1% Tween-60) on toxicity; this effect was observed at the same dose in all groups.*						
Carbon tetrachloride	Mouse	Liver	12 weeks (+3 days)	ingestion (gavage with corn oil or 1% Tween-60)	1.2 mg/kg	12 mg/kg		serum enzyme activities, lesions	Condie et al., 1986		*Authors identify 1.2 mg/kg as a NOEL for the corn oil vehicle group and 12 mg/kg in the Tween-60 group.*						

▨ = eliminated from TRV development; non-target endpoint.

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

Ingestion	Endpoint Species	NOAEL (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	rat & mouse	10	4	2.5
Lemming	rat & mouse	10	2	5.0
Least Weasel	rat & mouse	10	4	2.5

Rationale: Geometric mean of chronic and subchronic NOAELs for relevant endpoints is 49.3 mg/kg-day. This is greater than the lowest paired LOAEL of 33 mg/kg-day. Therefore, use the highest paired NOAEL below the lowest paired LOAEL of 10 mg/kg-day.

UF of 4 applied for same class, different order.
UF of 2 applied for same order, different family.

Table C-12
Carbon tetrachloride TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL	LOAEL	Other	Specific Effect	Reference	Value (mg/kg-d)	(IRt) g/g-d	NOAEL (mg/kg-day)
BIRDS												
Carbon tetrachloride	Chicken (Hens)	Growth	8 weeks (plus 4 week pre-treatment period)	gavage (syringe inserted into hen crop)	16 mg/bird/day			body weight	Fuller and Morris, 1962			8.9
Carbon tetrachloride	Chicken (Hens)	Reproduction	8 weeks (plus 4 week pre-treatment period)	gavage (syringe inserted into hen crop)	16 mg/bird/day			egg weight, egg production	Fuller and Morris, 1962			8.9
Carbon tetrachloride	Chicken (Hens)	Mortality	24 weeks exposure, 36 weeks total (12 weeks [plus 4 week pre-treatment period], followed by 8 week rest period, then additional 12 week treatment period)	gavage (syringe inserted into hen crop)		32 mg/bird/day		survival	Fuller and Morris, 1962			
Carbon tetrachloride	Chicken (Hens)	Growth	24 weeks exposure, 36 weeks total (12 weeks [plus 4 week pre-treatment period], followed by 8 week rest period, then additional 12 week treatment period)	gavage (syringe inserted into hen crop)	64 mg/bird/day			Body weight	Fuller and Morris, 1962			35.6
Carbon tetrachloride	Chicken (Hens)	Reproduction	24 weeks exposure, 36 weeks total (12 weeks [plus 4 week pre-treatment period], followed by 8 week rest period, then additional 12 week treatment period)	gavage (syringe inserted into hen crop)	64 mg/bird/day			egg weight, egg production	Fuller and Morris, 1962			35.6

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	NOAEL (mg/kg-day)	UF	TRV (mg/kg-day)
Ptarmigan	chicken	35.6	10	3.6
Goose	chicken	35.6	20	1.8
Loon	chicken	35.6	20	1.8
Lapland longspur	chicken	35.6	20	1.8
Snowy owl	chicken	35.6	20	1.8

Rationale: Use lowest NOEL for reproduction in longest duration study (35.6 mg/kg/day).

Apply subchronic to chronic UF of 5.
Taxonomic UF of 2 for same family, different genus.
Taxonomic UF of 4 for same class, different order.

Table C-13
Carbon tetrachloride AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Algae and Other Phytoplankton										
Carbon Tetrachloride	Scendesmus quadricauda	Growth	~7 days	aqueous solution (fresh water)	—	>600	—	Population Growth Rate (Toxicity Threshold)	Bringmann and Kuhn, 1980	Static system; Nominal concentrations reported; study duration is unclear may have been longer.
	Chlamydomonas reinhardtii	Growth	3 days	aqueous solution (fresh water)	—	—	EC_{50} = 0.246 (0.217-0.278) EC_{10} = 0.0717 (0.0572-0.0864)	Biomass, General Population Changes	Brack and Rottler, 1994	Static system (sealed bipartite test vessel); Measured concentrations reported with 95% confidence intervals in parentheses.
Zooplankton										
Carbon Tetrachloride	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	7.7	—	LC_{50} = 35 (25-47)		LeBlanc, 1980	Static system; Nominal concentrations reported with 95% confidence intervals in parentheses.
	Daphnia magna	Immobilization	1 day	aqueous solution (fresh water)	—	—	EC_{50} = 0.484 mM (74.459 mg/L)		Lilius et al., 1994	Static system; Nominal concentrations reported in mM.
	Daphnia magna	Immobilization	1 day	aqueous solution (fresh water)	—	—	EC_{50} = 135,000 µmol/L (20.8 mg/L)		Calleja et al., 1994	Static system; Nominal concentrations reported in µmol/L.
	Tetrahymena pyriformis	Growth	1 day	aqueous solution (fresh water)	—	—	EC_{50} = 830 mg/L (5,000 µmol/L [mol. Wt. = 154])	Population Growth Rate	Yoshioka et al., 1985	Static system; Nominal concentrations reported in µmol/L and mg/L; Organism is a free-living ciliate protozoa.
	Monina macrocopa	Mortality	3 hours	aqueous solution (fresh water)	—	—	Log LC_{50} = 2.3		Yoshioka et al., 1986	Static system; Nominal concentrations reported in logarithmic values.
Fishes										
Carbon Tetrachloride	Lepomis macrochirus	Mortality	1 day 4 days	aqueous solution (fresh water)	—	—	LC_{50} = 38 LC_{50} = 27 (23-33)		Buccafusco et al., 1981	Static system (capped jars); Nominal concentrations reported with 95% confidence intervals in parentheses.
	Lepomis macrochirus	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 125		Dawson et al., 1976	Static system (jars without lids; aerated as necessary, but never for 24- hrs); Nominal concentrations reported.
	Oncorhynchus mykiss	Hepatoxic Effects	14 days	aqueous solution (fresh water)	80	—	—		Statham et al., 1978	Static system; Nominal concentrations reported; "Carbon tetrachloride (1 ml/kg, ip) produced 5- to l0-fold increases in serum GOT, GPT, and ICD activities, whereas exposure of trout to Ccl, in the tank water (l-80 mg/liter) produced neither mortality nor significant changes in enzyme activities"
	Orizias latipes	Mortality	2 days	aqueous solution (fresh water)	—	—	Log LC_{50} = 2.0		Yoshioka et al., 1986	Static system; Nominal concentrations reported in logarithmic values.

🟨 = value used for AL development.

🟪 = eliminated from AL development; non-target endpoint.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Algae	0.0171	EC_{10} - Growth	1	**0.017**	Used lowest, measured EC_{10} value that used a sealed container. No UF was applied to the EC_{10} value.
Zooplankton	7.7	NOEC - Mortality	5	**1.54**	Used single NOEC value from the longer duration study. The NOEC value was divided by an UF of 5 to extrapolate a sub-chronic to chronic duration.
Fish	27	LC_{50} - Mortality	10	**2.70**	Used lowest LC50 value from the longer duration study. The LC50 value was divided by UF of 10 to extrapolate to LOEC value.

Table C-14
Chlorobenzene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Specific Effect	Reference	Test Sp. Body Weight (BWt) (kg)	Ingestion Rate (IRt)	Notes
MAMMALS												
Chlorobenzene	MCB1	Rat	embryotoxicity, teratogenic potential	6hr/day	inhalation	210ppm	590ppm	high liver weight, decrease body weight & feed consumption	John et al., 1984	start = 0.196	75, 210, 590 ppm	*Exposed during days 6-15 of gestation; converts to NOAEL of 967 mg/m3*
Chlorobenzene	MCB1	White rabbit	embryotoxicity, teratogenic potential	6hr/day	inhalation	210ppm	590ppm	high liver weight	John et al., 1984	mean fetus start = 0.03567 mean end = 0.03758	75, 210, 590 ppm	*Exposed during days 6-18 of gestation; converts to NOAEL of 967 mg/m3*
Chlorobenzene	MCB2	Rat	growth, consumption, fertility, pup mortality, histopathology	10 weeks	inhalation	450 ppm	none	Hepatocellular hypertrophy and renal changes in male rats @ 150 and 450ppm	Nair et al., 1987	male = 0.129-.233 female = 0.131-0.162	50, 150, 450 ppm	*no adverse effects observed*
Chlorobenzene	MCB3	Rat	mortality	103 weeks	gavage	120 mg/kg	N/A	multiple systems evaluated	NTP, 1985b	male start = 0.205 male end = 0.451 female start = 0.135 female end = 0.291	4.8 g/day	*2 dose groups; converts to 17.8 mg/kg-day with a BW of 270 g (calculated as average of sex-specific start and end weights)*
Chlorobenzene	MCB3	Mice	mortality	103 weeks	gavage	60 mg/kg	none	multiple systems evaluated	NTP, 1985b	male start = 0.023 male end = 0.039 female start = 0.017 female end = 0.105	12 g/day	*2 dose groups; converts to 261 mg/kg-day with a BW of 46 g (calculated as average of sex-specific start and end weights)*

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
MCB1	253	--	
MCB3	17.8	--	
MCB3	261	--	
Geomean	**105**	**1**	**105**
Shrew	105	**4**	**26**
Lemming	105	**2**	**53**
Weasel	105	**4**	**26**

Rationale:

Used three NOAELs based on reproduction and teratogenicity.
Calculated geomean of three NOAELs.
Chronic NOAEL and reproductive studies available; no toxicity-based UF necessary.

Taxonomic UF represents different Order, same Class
Taxonomic UF represents different Family, same Order
Taxonomic UF represents different Order, same Class

NOAEL (mg/m3)	Body Weight (kg)	Inhalation Rate (m3/d)	NOAEL (mg/kg/day)	Hour per week adjustment	Day per week adjustment	Adjusted NOAEL (mg/kg/day)
967.00	0.225	0.235	1010.96	0.250	1.00	252.741

Table C-15
Chlorobenzene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/L)	LOAEL (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
chlorobenzene	Daphnia magna	death	1	water			140		LeBlanc, 1980	*nominal concentrations*
chlorobenzene	Daphnia magna	death	2	water			86		LeBlanc, 1980	*nominal concentrations*
chlorobenzene	Daphnia magna	death	2	water			5.2 mmole/m3		Bobra et al., 1985	*static test; nominal concentrations*
chlorobenzene	Daphnia magna	death	1	water			4.3		Calamari et al., 1983	*nominal concentrations used for LC50 (however, concentrations were measured throughout studies and were within 10% of nominal, except for fertility tests)*
chlorobenzene	Daphnia magna	reproduction	14	water			2.5	EC50 inhibition	Calamari et al., 1983	*nominal concentartions (see above)*
chlorobenzene	Daphnia magna	death	1	water			14		Gersich et al., 1986	*nominal concentrations*
chlorobenzene	Daphnia magna	death	2	water			12.9		Gersich et al., 1986	*nominal concentrations*
chlorobenzene	Daphnia magna	death	2	water			230 umole/L		Rose et al., 1998	*25.9 mg/L; measured concentrations used (did not change by more than 20% within 2d study period)*
chlorobenzene	Ceriodaphnia dubia	death	2	water			47 umole/L		Rose et al., 1998	*5.3 mg/L; measured concentrations used (did not change by more than 20% within 2d study period)*
chlorobenzene	Daphnia magna	death	2	water					Marchini et al., 1993	*stock solutions were measured and exposure concentrations were extrapolated*
chlorobenzene	Ceriodaphnia dubia	death	1	water			7.6		Marchini et al., 1993	*stock solutions were measured and exposure concentrations were extrapolated*
chlorobenzene	Daphnia magna	death	2	water			51.6 mmole/m3		Abernethy et al., 1986	*5.8 mg/L; nominal concentrations*
chlorobenzene	Daphnia magna	death	10	water	<1.4		31		Cowgill and Milazzo, 1991	*3-brood test; nominal concentrations*
chlorobenzene	Ceriodaphnia dubia	death	10	water	3.89		47		Cowgill and Milazzo, 1991	*3-brood test; nominal concentrations*
chlorobenzene	Daphnia magna	reproduction	10	water	12		14	EC50	Cowgill and Milazzo, 1991	*3-brood test; nominal concentrations*
chlorobenzene	Ceriodaphnia dubia	reproduction	10	water	6.5		15	EC50	Cowgill and Milazzo, 1991	*3-brood test; nominal concentrations*
chlorobenzene	Daphnia magna	death	2	water			12.9		Cowgill et al., 1985	*static test; nominal concentrations*
chlorobenzene	Ceriodaphnia dubia	death	2	water			7.9		Cowgill et al., 1985	*static test; nominal concentrations*
Fish										
chlorobenzene	Pimephales promelas	death	3	water			25.9		Mayes et al., 1983	*nominal concentrations*
chlorobenzene	Salmo gairdneri	death	2	water			4.1		Calamari et al., 1983	*nominal concentrations*
chlorobenzene	Pimephales promelas	death	3	water			33.93		Pickering and Henderson, 1966	*nominal concentrations*
chlorobenzene	Pimephales promelas	death	3	water			7.7		Marchini et al., 1993	*stock solutions were measured and exposure concentrations were extrapolated*

Table C-15
Chlorobenzene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/L)	LOAEL (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Algae										
chlorobenzene	Selenastrum capricornutum	death	3	water			12.5	EC50 growth	Calamari et al., 1983	*nominal concentrations used for LC50 (however, concentrations were measured throughout studies and were within 10% of nominal, except for daphnia fertility tests)*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	**Rationale**
Zooplankton	5.3	LC50	10	**0.53**	Three available LC50 values from measured studies. Used lowest LC50. Divided by UF of 10 to convert from LC50 to LOEC.
Fish	7.7	LC50	10	**0.77**	Used single measured LC50 value. Divided by UF of 10 to convert from LC50 to LOEC.
Algae	12.5	EC50	10	**1.25**	Only 1 value; used this. Divided by UF of 10 to convert from EC50 to LOEC.

Table C-16
Chloroform TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Exposure Levels	Notes
INGESTION												
Chloroform	CD-1 mouse	Survival	14 days	gavage	50 mg/kg			increased mortality (males)	EHRT, 1988	**Control:** Males = 33.04 g (0 day) 34.14 g (14 days) Females = 26.26 g (0 day) 26.17 g (14 day)	25/50/100/250/500 mg/kg	Dose finding study
Chloroform	CD-1 mouse	Reproduction	18 weeks	gavage	41.2 mg/kg-d			litter size, number of live pups.	EHRT, 1988		6.6/15.9/41.2 mg/kg	RACB Protocol - had no adverse effect on mouse reproductive endpoints at doses that were hepatotoxic; Measured concentrations.
Chloroform	Sprague Dawley rat	Growth	10 days (gestation)	intubation	79 mg/kg-d	126 mg/kg-d		depressed maternal weight	Thompson et al., 1974	181-224 g	79/126/300/316/516 mg/kg/day	Range finding study. Value excluded from TRV calculation because the growth effect is observed in the mother and toxicity occurs at lower levels in offspring.
Chloroform	Sprague Dawley rat	Reproduction	10 days (gestation)	intubation	50 mg/kg-d	126 mg/kg-d		reduced fetal body weight	Thompson et al., 1974	181-224 g	20/50/126 mg/kg/day	
Chloroform	Rabbit	Mortality	13 days (gestation)	intubation		100 mg/kg-d			Thompson et al., 1974	1.7-2.2 kg	25/63/100/159/251/398 mg/kg/day	Range finding study - statistical significance of this effect not discussed.
Chloroform	Rabbit	Growth	13 days (gestation)	intubation		20 mg/kg-d		reduced fetal body weight	Thompson et al., 1974	1.7-2.2 kg	20/35/50 mg/kg/day	Observed at 20 and 50 mg/kg/day, but not significant at 35.
Chloroform	Sprague Dawley rat	Growth	95 weeks, 6 days/week	gavage		60 mg/kg-d		depressed body weight	Palmer et al., 1979	180-240 g (males) and 130-175 g (females).	60 mg/kg/d	Experiment II - only one concetration tested
Chloroform	Sprague Dawley rat	Growth	10 days (gestation)	oral intubation		100 mg/kg		reduced maternal weight gain	Ruddick, et al., 1983	150-175 g	100/200/400 mg/kg	Observed at all concentrations.
Chloroform	Sprague Dawley rat	Reproduction	10 days (gestation)	oral intubation	200 mg/kg-d	400 mg/kg-d		depressed fetal weight	Ruddick, et al., 1983	150-175 g	100/200/400 mg/kg	
INHALATION												
Chloroform	Sprague Dawley rat	Reproduction	10 days, 7hr/day	inhalation	100 ppm	300 ppm		fewer fetuses per litter, reduced fetal body weight	Schwetz et al., 1974	250 g	30/100/300 ppm	
Chloroform	Sprague Dawley rat	Reproduction	10 days, 7hr/day	inhalation		30 ppm		fetal anomalies: delayed ossification of skull, wavy ribs.	Schwetz et al., 1974	250 g	30/100/300 ppm	
Chloroform	Sprague Dawley rat	Growth	10 days, 7hr/day	inhalation	30 ppm	100 ppm		maternal body weight	Schwetz et al., 1974	250 g	30/100/300 ppm	effect was observed in 30 ppm group mid study, but was no longer significant by the end.
Chloroform	Wistar rat	Growth	7hr/day, 10 days	inhalation		30 ppm		body weight development	Baeder & Hoffman, 1988	**Control (Females):** 184 ±5 g (0 day) 315 ±18 g (21 day)	30/100/300 ppm	Effects observed at all exposure levels.
Chloroform	Wistar rat	Reproduction	7hr/day, 10 days	inhalation		30 ppm		pregnancy and interuterine development of fetuses	Baeder & Hoffman, 1988	**Control (Females):** 184 ±5 g (0 day) 315 ±18 g (21 day)	30/100/300 ppm	Effects observed at all exposure levels.
Chloroform	Wistar rat	Growth	7hr/day, 10 days	inhalation	3 ppm	10 ppm		reatarded feed consumption and body weight development	Baeder & Hoffman, 1991	195 ± 9 g	3/10/30 ppm	
Chloroform	Wistar rat	Reproduction	7hr/day, 10 days	inhalation	10 ppm	30 ppm		pregnancy and interuterine development of fetuses - reduced fetal body weight	Baeder & Hoffman, 1991	195 ± 9 g	3/10/30 ppm	Results in original article are ammended in Baeder and Hoffman, 1993. Embryotoxicity NOEL changed from 3 to 10 ppm.

Table C-16
Chloroform TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Exposure Levels	Notes
Chloroform	Sprague Dawley rat	Mortality	single dose	oral injection					Kimura et al., 1971			LD50s are reported for 3 different age groups. Eliminated from consideration because exposure is acute.
Chloroform	Rat	Kidney effects	2 years	gavage				renal toxicity	Hard et al., 2000		200/400/900/1800 mg/L	
Chloroform	Sprague Dawley rat	Respiratory and kidney disease	52 weeks, 6 days/week	gavage					Palmer et al., 1979	180-240 g (males) and 130-175 g (females).	15/75/165 mg/kg/d	Experiment I

🟪 = eliminated from TRV development; non-target endpoint.

🟨 = value used for AL development.

🟥 = eliminated from TRV development; no data or inappropriate route of administration.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	Value (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	rat&mouse	74.4	4	18.6
Lemming	rat&mouse	74.4	2	37.2
Weasel	rat&mouse	74.4	4	18.6

Rationale: Geometric mean for chronic reproduction NOAELs is 74.4 mg/kg/day, which is lower than the lowest paired LOAEL, so select it as the TRV.

UF of 4 applied for same class, different order.
UF of 2 applied for same order, different family.

Table C-17
Chloroform AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Algae and Other Phytoplankton										
Chloroform	Skeletonema costatum	Growth	5 days	aqueous solution (fresh water)	216	–	EC_{50} = 437 (440-829) [cell volume] EC_{50} = 477 (75-878) [cell count]	Biomass, General Population Changes	Cowgill et al., 1989	Static system covered with Parafilm; Nominal concentrations reported with 95% confidence intervals in parentheses.
	Chlamydomonas reinhardtii	Growth	3 days	aqueous solution (fresh water)	—	–	EC_{10} = 3.61 (2.55-4.72)	Biomass, General Population Changes	Brack and Rottler, 1994	Static system (sealed bipartite test vessel); Measured concentrations reported with 95% confidence intervals in parentheses.
							EC_{50} = 13.3 (11.00-15.77)			
	Scendesmus quadricauda	Growth	~7 days	aqueous solution (fresh water)	—	1,100	–	Population Growth Rate	Bringmann and Kuhn, 1980	Static system; Nominal concentrations reported; study duration is unclear may have been longer.
Zooplankton										
Chloroform	Daphnia magna	Immobilization	1 day	aqueous solution (fresh water)	—	–	EC_{50} = 4.80 mM (573.02 mg)		Lilius et al., 1994	Static system; Nominal concentrations reported in mM; Capped test vessels
	Daphnia magna	Immobilization	1 day	aqueous solution (fresh water)	—	–	EC_{50} = 2,660 µmol/L (310.4 mg/L)		Calleja et al., 1994	Static system; Nominal concentrations reported in µmol/L
	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	<7.8	–	LC_{50} = 29 (19-47)		LeBlanc, 1980	Static system; Nominal concentrations with 95% confidence intervals in parentheses.
	Daphnia magna	Reproduction	1 day	aqueous solution (fresh water)	—	–	EC_{50} = 79		Kuhn et al., 1989b	Semi-static system; Nominal values calculated on the basis of chemical quantification of stock concentrations; Closed test vessel
							EC_0 = 48			
			21 day		13 (average	–	–			
					6.3 (minimum	–	–			
	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	—	–	LC_{50} = 353 (200-512)	Mortality	Cowgill and Milazzo, 1991a	Toxicological values were reference from EPA ECOTOX: Aquatic Report, Reference Number 212; Static and Static-Renewal systems; Nominal concentrations reported with 95% confidence intervals in parentheses.
			9 days		120		LC_{50} = 290 (200-512)			
		Reproduction	9-11 days		120	–	EC_{50} = 288 (89-487)	Mean Brood Size		
							EC_{50} = 295 (79-510)	Progeny Mutations		
							EC_{50} = 336 (83-589)	No. of Broods		
	Ceriodaphnia dubia	Mortality	2 days		—	–	LC_{50} = 290 (200-512)	Mortality		
			9 days		200		LC_{50} = 235 (179-315)			
		Reproduction	7-10 days		200	–	EC_{50} = 311 (0-777)	Mean Brood Size		
							EC_{50} = 343 (0-867)	No. of Broods		
							EC_{50} = 368 (0-967)	Progeny Mutations		

Table C-17
Chloroform AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Fishes										
Chloroform	Micropterus salmoides	Mortality	4 days	aqueous solution (fresh water)	—	—	LC$_{50}$ = 51 (45.4-56.2) [mean of 6 toxicity tests]		Anderson and Lusty, 1980	Flow-through system, Measured concentrations reported with 95% confidence intervals in parentheses.
	Ictalurus punctatus						LC$_{50}$ = 75 [mean of 3 toxicity tests]			
	Lepomis macrochirus						LC$_{50}$ = 18 (13.-24.4) [mean of 6 toxicity tests]			
	Salmo gairdneri						LC$_{50}$ = 18 (15.1-37.1) [mean of 5 toxicity tests]			
Chloroform	Salmo gairdneri	Mortality	23-27 days	aqueous solution (fresh water)	—	—	LC$_{50}$ = 1.24 (0.62-2.16) [Hard Water]		Birge et al., 1979	Continuous flow, closed test system used in Early Life Stage Test; Measured concentrations reported with 95% confidence intervals in parentheses.
							LC$_{50}$ = 2.03 (0.95-3.75) [Soft Water]			
							LC$_{1}$ = 0.0049 (0.0003-0.0225) [Hard Water]			
							LC$_{1}$ = 0.0062 (0.0002-0.0349) [Soft Water]			
	Oryzias latipes	Fish histopathology	9 months	aqueous solution (fresh water)	—	1.463	96-hr NOEL = 21-26 mg/L (previous study)		Toussaint et al., 2001	Flow-through system, Measured concentrations reported; prolonged study (over 9 months) - gender specific
	Oncorhynchus mykiss	Mortality	4 days	aqueous solution (fresh water)	42	—	LC$_{50}$ = 66.8 (54.8-81.4) [Soft Water]		Bentley et al., 1979	Static system; Nominal concentrations reported with 95% confidence intervals in parentheses.
					24		LC$_{50}$ = 43.8 (36.1-53.2) [Hard Water]			
	Lepomis macrochirus				100		LC$_{50}$ = 115 (96-138) [Soft Water]			
					75		LC$_{50}$ = 100 (72-140) [Hard Water]			

🟨 = value used for AL development.

🟪 = eliminated from TRV development; non-target endpoint.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Algae	3.61	EC$_{10}$ - Growth	1	**3.61**	Used lowest measured EC$_{10}$ value that used a sealed test system. No UF applied to the EC$_{10}$ value.
Zooplankton	6.3	NOEC - Reproduction	1	**6.30**	Used the lowest NOEC value from a chronic reproduction study that used a closed test vessel. No UF was applied to the NOEC value.
Fish	0.0049	LC1 - Mortality	1	**0.005**	Used the LC1 from measured Early Life Stage study for hard water. Hard water has the closes similarities to the North Slope water quality characteristics based on background values from the Consolidated Background Report (Feb 2012). No UF was applied to the NOEC value.

Table C-18
1,2-Dibromoethane TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	NOAEL (mg/m3)	Inhalation Rate (m3/d)	Dose (NOEL) (mg/kg-day)	Hours/day Factor	Days/week Factor	Converted NOAEL (mg/kg-day)	LOAEL (mg/m3)	Dose (LOEL) (mg/kg-day)	Converted LOAEL (mg/kg-day)
MAMMALS																				
1,2-Dibromoethane	Rat (male)	Reproduction	10 weeks exposure, 2 weeks mating	inhalation (7 hr/d, 5 d/wk)	39 ppm	89 ppm		# impregnating females, # of females impregnated, testes weight, serum testosterone, atrophy of testis, epididymis, prostate, and seminal vesicles	Short et al., 1979	0.404	*BWt is average of averages for control group across 10 weeks of study. Concentrations measured (monitored 3x daily, TWA). Authors note chemical exposure may not be directly responsible for reproductive effects due to other effects on weight gain, etc. but there is some basis for attributing effects to 1,2-DBA.*	300	0.38	282	0.29	0.71	59	683.83	643.65	134.09
1,2-Dibromoethane	Rat (male)	Growth	10 weeks	inhalation (7 hr/d, 5 d/wk)	19 ppm	39 ppm		reduced body weight, food consumption	Short et al., 1979	0.404	*Effect observed in parents and is therefore not a chronic effect.*	146	0.38	137	0.29	0.71	29	299.65	282.05	58.76
1,2-Dibromoethane	Rat (male)	Survival	10 weeks	inhalation (7 hr/d, 5 d/wk)	39 ppm	89 ppm		mortality	Short et al., 1979	0.404	*21% of males died*		0.38		0.29	0.71		683.83	643.65	134.09
1,2-Dibromoethane	Rat (female)	Reproduction	3 weeks exposure, 10-day mating	inhalation (7 hr/d, 7 d/wk)	39 ppm	80 ppm		# mated, # pregnant (after 10 days), diestrus	Short et al., 1979	0.221										
1,2-Dibromoethane	Rat (female)	Growth	3 weeks	inhalation (7 hr/d, 7 d/wk)	39 ppm	80 ppm		reduced body weight, food consumption	Short et al., 1979	0.221										
1,2-Dibromoethane	Rat (female)	Survival	3 weeks	inhalation (7 hr/d, 7 d/wk)	39 ppm	80 ppm		mortality	Short et al., 1979	0.221	*20% of females died*									
1,2-Dibromoethane	CD Rat (female)	Survival	10 days (Days 6 - 15 of gestation), 2-4 days post-exposure	inhalation (23 hr/d)	38 ppm	80 ppm		mortality	Short et al., 1977		*BWt not reported (only weight change). Concentrations measured (monitored 3x daily, TWA). 50% mortality rate (so could call this LD50 as well).*									
1,2-Dibromoethane	CD Rat (female)	Growth	10 days (Days 6 - 15 of gestation), 2-4 days post-exposure	inhalation (23 hr/d)	20 ppm	38 ppm		weight loss/reduced weight gain	Short et al., 1977	0.24	*Weights increased after exposure in 38 ppm group, weight gain was still reduced in 80 ppm group. Feed consumption decreased in all groups but remained so after exposure only in 80 ppm group.* *Effect was observed in parent, and is therefore not chronic.* *Reproductive effects including reduced fetal weight, # of implants, viable fetuses, and complete resorptions were also observed but not summarized separately because authors note reproductive effects may be due to maternally toxic effects such as reduced food consumption and maternal weight.*	154	0.25	159	0.96	1	152	292	302	289
1,2-Dibromoethane	CD-1 Mouse (female)	Survival	10 days (Days 6 - 15 of gestation), 2-4 days post-exposure	inhalation (23 hr/d)	20 ppm	38 ppm		mortality	Short et al., 1977		*35% of mice died at 38 ppm, 100% died at 80 ppm.*									
1,2-Dibromoethane	CD-1 Mouse (female)	Growth	10 days (Days 6 - 15 of gestation), 2-4 days post-exposure	inhalation (23 hr/d)		20 ppm		reduced weight gain	Short et al., 1977		*Weight gain increased after exposure in 20 ppm group, but was still reduced in 38 ppm group. Feed consumption decreased in all groups but remained so after exposure only in 38 ppm group (all 80 ppm animals died).* *Reproductive effects including reduced fetal weight, late resorptions, skeletal abnormalities, (20 ppm), # of viable fetuses, complete resorptions, fetuses/dam, increased % male fetuses, and runts (38 ppm) were also observed but not summarized separately because authors note reproductive effects may be due to maternally toxic effects such as reduced food consumption and maternal weight.* *This study is different task of same study as Short et al., 1976.*									
1,2-Dibromoethane	CDF (F344) Rat (male)	Growth	13 weeks	inhalation (6 hr/d, 5 d/wk)	10 ppm	40 ppm		body weight	Nitschke et al., 1981	0.21	*Effect was observed in 10 ppm group after but not before recovery period. Identified as NOEL based on statement in study that "Male rats inhaling 3 or 10 ppm EDB or female rats inhaling concentrations of EDB as high as 40 ppm did not exhibit a significant decrease in body weight throughout the exposure period". Body weight based on first week average (Table 2).*	77	0.22	82	0.25	0.71	15	307.34	326.72	58.34

Table C-18
1,2-Dibromoethane TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	NOAEL (mg/m3)	Inhalation Rate (m3/d)	Dose (NOEL) (mg/kg-day)	Hours/day Factor	Days/week Factor	Converted NOAEL (mg/kg-day)	LOAEL (mg/m3)	Dose (LOEL) (mg/kg-day)	Converted LOAEL (mg/kg-day)
MAMMALS																				
1,2-Dibromoethane	Rat	Growth	Days 3 to 19-20 of gestation maternal exposure	inhalation (4 hr/d, 3 d/wk)	0.42 ppm	6.79-66 ppm		maternal weight gain during gestation	Smith and Goldman, 1983	0.344	*Dose-response relationship observed for decreasing maternal weight gain with higher dose. Paper states that this effect was statistically significant, but do not state at which (or all) levels. Doses were 0, 0.42, 6.79, and 66 ppm (mean measured concentrations). Body weights not provided.% increases in body weight were 63 (control), 62.8 (low), 56.4 (medium), 49.6 (high). Assume medium (6.79 ppm) is likely LOEL and low (0.42 ppm) is likely NOEL based on judgement. Subchronic effect since effect on mother not offspring.*	3	0.33	3	0.17	0.43	0.22	52.17	50.54	3.61
1,2-Dibromoethane	Rat	Reproduction	Days 3 to 19-20 of gestation maternal exposure	inhalation (4 hr/d, 3 d/wk)	66 ppm			number of females delivering litters, average number of pups in litter,weanling body weight (not persisting into adulthood), behavioral performance of offspring	Smith and Goldman, 1983	0.344	*Weanling body weight decreased initially but did not persist into adulthood. Higher dose offspring performed better than controls in behavioral tests. Assumed recommended chronic female body weight from EPA (1988), based on assumption that adult rats were used in the study.*	507	0.33	491	0.17	0.43	35.09			
1,2-Dibromoethane	F344 Rat (male and female)	Growth	103 weeks (low dose), 88-91 weeks (high dose for males and females, respectively) exposure, 0-1 week observation	inhalation (6 hr/d, 5 d/wk)	10 ppm	39 ppm		body weight	National Toxicology Program, 1982	0.25	*Body weights not reported but based on figure control group for males appears to average around 250 g, and 200 g for females. Subchronic (90-day) study reports averages (beginning and end weight averaged) of 249 g for males and 144 g for females. Study does not report if difference observed in high dose group was statistically significant. Measured chemical concentrations (means). Subchronic (90-day) component of study used different concentrations, both chronic and subchronic also report pathology (cancer studies); those are not summarized here. Use approximate average male body weight.*	77	0.26	79	0.25	0.71	14	299.65	307.41	54.89
1,2-Dibromoethane	F344 Rat (male and female)	Survival	103 weeks (low dose), 88-91 weeks (high dose for males and females, respectively) exposure, 0-1 week observation	inhalation (6 hr/d, 5 d/wk)	10 ppm	39 ppm		mortality	National Toxicology Program, 1982		*Males 90% mortality at 89 weeks, females 84% mortality at 91 weeks.*									
1,2-Dibromoethane	B6C3F1 Mouse (male and female)	Growth	78 weeks (males) and 90 or 103 weeks (females in high and low dose groups, respectively) exposure, 0-1 week observation	inhalation (6 hr/d, 5 d/wk)	10 ppm	39 ppm		body weight	National Toxicology Program, 1982	0.03	*Body weights not reported but based on figure control group for males appears to average around 30-35 g, and 30 g for females. Subchronic (90-day) study reports averages (beginning and end weight averaged) of 25 g for males and 21 g for females. Study does not report if difference observed in high dose group was statistically significant.*	77	0.05	115	0.25	0.71	21			
1,2-Dibromoethane	Rat	Survival	10 days (days 6-15 of gestation)	inhalation (23 hr/d)	30 ppm			mortality	Short et al., 1976		*Chamber concentrations monitored with GC and flame ionization detector. Average concentration was 31.6 ppm. Only concentration tested.*									
1,2-Dibromoethane	Rat	Growth	10 days (days 6-15 of gestation)	inhalation (23 hr/d)			30 ppm	weight gain	Short et al., 1976		*Animals consumed less food and gained less weight than controls, resumed consumption and weight gain when exposure stopped. Same effect observed in feed restricted control group.*									
1,2-Dibromoethane	Rat	Reproduction	10 days (days 6-15 of gestation)	inhalation (23 hr/d)		30 ppm		reduced litter size, fetal abnormalities	Short et al., 1976		*Only concentration tested. Effects not observed in feed-restricted control group.*									
1,2-Dibromoethane	Mouse	Survival	10 days (days 6-15 of gestation)	inhalation (23 hr/d)	30 ppm			mortality	Short et al., 1976		*Chamber concentrations monitored with GC and flame ionization detector. Average concentration was 31.6 ppm. Only concentration tested.*									
1,2-Dibromoethane	Mouse	Growth	10 days (days 6-15 of gestation)	inhalation (23 hr/d)			30 ppm	weight gain	Short et al., 1976		*Animals consumed less food and gained less weight than controls, resumed consumption and weight gain when exposure stopped. Same effect observed in feed restricted control group.*									

Table C-18
1,2-Dibromoethane TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	NOAEL (mg/m3)	Inhalation Rate (m3/d)	Dose (NOEL) (mg/kg-day)	Hours/day Factor	Days/week Factor	Converted NOAEL (mg/kg-day)	LOAEL (mg/m3)	Dose (LOEL) (mg/kg-day)	Converted LOAEL (mg/kg-day)
MAMMALS																				
1,2-Dibromoethane	Mouse	Reproduction	10 days (days 6-15 of gestation)	inhalation (23 hr/d)			30 ppm	reduced fetal weight, fetal abnormalities	Short et al., 1976		*Reduced fetal weight and anomalies also observed in feed-restricted control group, likely due to malnourishment rather than chemical effect.*									
1,2-Dibromoethane	Rat	Mortality	91 days (50 ppm) - 213 days (25 ppm)	inhalation (7 hrs/d, 5 days/wk)			25 ppm (0.19 mg/L)	survival	Rowe et al., 1952	0.327 (males), 0.209 (females)	*50% of males died in both 25 and 50 ppm groups, due chiefly to pneumonia and infections of the upper respiratory tract.*									
1,2-Dibromoethane	B6C3F1 Mouse (male and female)	Survival	78 weeks (males) and 90 or 103 weeks (females in high and low dose groups, respectively) exposure, 0-1 week observation	inhalation (6 hr/d, 5 d/wk)	10 ppm (females)	10 ppm (males), 39 ppm (females)		mortality	National Toxicology Program, 1982		*Study notes that survival was significantly lower for males in the low-dose group, but survival was 22% vs 26% in controls, and higher in the high dose group. Female survival was 14% at 91 weeks in the high dose group vs 80% survival to end of study in the control group.* *Not included in TRV evaluation, as control and dosed mice all had poor survival due to an infection that was unrelated to compound administration.*									
1,2-Dibromoethane	Rat (female)	Reproduction	3 weeks exposure, 10-day mating	inhalation (7 hr/d, 7 d/wk)	80 ppm			implants/resorptions in pregnant females at midgestation	Short et al., 1979	0.221	*Lower but not statistically significant at 80 ppm*									
1,2-Dibromoethane	Rat	Growth	91 days (50 ppm) - 213 days (25 ppm)	inhalation (7 hrs/d, 5 days/wk)	50 ppm (0.38 mg/L)			body weight	Rowe et al., 1952	0.327 (males), 0.209 (females)	*Reduced growth observed at 50 ppm but not statistically significant.*									
1,2-Dibromoethane	Rat (female/male)	Liver/kidney	13 weeks	inhalation (6 hr/d, 5 d/wk)	3 ppm	10 ppm		relative liver/kidney weights	Nitschke et al., 1981		*Only observed in males at 40 ppm. Authors note effects most likely due to exposure and accompanying decrease in body weight, and not observed after recovery period (except relative liver weights for 40 ppm males).*									
1,2-Dibromoethane	Rat (female/male)	Histopathology	13 weeks	inhalation (6 hr/d, 5 d/wk)	3 ppm	10 ppm		nasal/respiratory epithelium	Nitschke et al., 1981		*Hyperplasia, lesions, essentially completely reversible following recovery period.*									
1,2-Dibromoethane	Rat	Organ weights	91 days (50 ppm) - 213 days (25 ppm)	inhalation (7 hrs/d, 5 days/wk)	25 ppm (0.19 mg/L)	50 ppm (0.38 mg/L)		liver, lung, kidney weight increase; testis, spleen weight decrease	Rowe et al., 1952	0.327 (males), 0.209 (females)	*Vapor concentrations measured with a continuously recording analyzer; always within 10% of desired concentration. Body weights are average of final control body weights. 25 ppm is identified by the authors as the concentration at which rats were not affected adversely. Study also included single inhalation and oral exposures and repeated exposures to 100 ppm for 9 days, and looked at guinea pigs, rabbits, and monkeys as well; results of those study components not summarized here.*									
1,2-Dibromoethane	Rat	Blood/liver	91 days (50 ppm) - 213 days (25 ppm)	inhalation (7 hrs/d, 5 days/wk)	50 ppm (0.32 mg/L)			blood urea nitrogen, liver total lipid, and hematological values	Rowe et al., 1952	0.327 (males), 0.209 (females)										

🟪 = eliminated from TRV development; non-target endpoint.
🟥 = result was not statistically significant.
🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	Geometric Mean (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	mouse&rat	27.80	4	6.95
Lemming	mouse&rat	27.80	2	13.9
Least Weasel	mouse&rat	27.80	4	6.95

Rationale: Geometric mean of chronic growth and reproduction NOELs is 27.8 mg/kg-d. This is lower than the lowest paired LOAEL for mortality, reproduction, or growth from chronic studies (55 mg/kg-d) and was therefore used as the TRV.

UF of 4 applied for same class, different order (shrew and least weasel).
UF of 2 applied for same order, different family (lemming).

Table C-19
1,2-Dibromoethane TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL	LOAEL	Other	Specific Effect	Reference	Value (mg/kg-d)	(IRt) g/g-d	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)
BIRDS													
1,2-Dibromoethane	Quail (Japanese)	Growth	7 days	Intubation, 2x/day	3.7 mg total/day			Body weight	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Growth	21 days	Intubation, 2x/day	3.7 mg total/day			Body weight	Westlake et al., 1981			35.5	
1,2-Dibromoethane	Quail (Japanese)	Behavior	7 days	Intubation, 2x/day	3.7 mg total/day			Food consumption	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Behavior	21 days	Intubation, 2x/day	3.7 mg total/day			Food consumption	Westlake et al., 1981				
1,2-Dibromoethane	Chicken (Hens)	Mortality	8 weeks (plus 4 week pre-treatment period)	gavage (syringe inserted into hen crop)			20 mg/bird/day	survival	Fuller and Morris, 1962				
1,2-Dibromoethane	Chicken (Hens)	Growth	8 weeks (plus 4 week pre-treatment period)	gavage (syringe inserted into hen crop)	4 mg/bird/day	20 mg/bird/day		body weight	Fuller and Morris, 1962			2.2	11.1
1,2-Dibromoethane	Chicken (Hens)	Reproduction	8 weeks (plus 4 week pre-treatment period)	gavage (syringe inserted into hen crop)	1 mg/bird/day	2 mg/bird/day		egg weight, egg production	Fuller and Morris, 1962			0.56	1.1
1,2-Dibromoethane	Chicken (Hens)	Mortality	12 weeks (plus 4 week pre-treatment period), followed by 8 week rest period, then additional 12 week treatment period	gavage (syringe inserted into hen crop)	8 mg/bird/day			survival	Fuller and Morris, 1962				
1,2-Dibromoethane	Chicken (Hens)	Growth	12 weeks (plus 4 week pre-treatment period), followed by 8 week rest period, then additional 12 week treatment period	gavage (syringe inserted into hen crop)	8 mg/bird/day			Body weight	Fuller and Morris, 1962			4.4	
1,2-Dibromoethane	Chicken (Hens)	Reproduction	12 weeks (plus 4 week pre-treatment period), followed by 8 week rest period, then additional 12 week treatment period	gavage (syringe inserted into hen crop)	4 mg/bird/day	8 mg/bird/day		egg production	Fuller and Morris, 1962			2.2	4.4
1,2-Dibromoethane	Chicken (Hens)	Reproduction	12 weeks (plus 4 week pre-treatment period), followed by 8 week rest period, then additional 12 week treatment period	gavage (syringe inserted into hen crop)	0.5 mg/bird/day	1 mg/bird/day		egg weight	Fuller and Morris, 1962			0.28	0.56

Table C-19
1,2-Dibromoethane TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL	LOAEL	Other	Specific Effect	Reference	Value (mg/kg-d)	(IRt) g/g-d	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)
BIRDS													
1,2-Dibromoethane	Chicken (Leghorn)	Reproduction	9 weeks	Ingestion (fumigated feed)				reduced egg weight, # of eggs laid	Bondi et al., 1955				
1,2-Dibromoethane	Chicken (Leghorn)	Reproduction	9 weeks	Ingestion (fumigated feed)		180-220 ppm (~10 mg daily)		irreversible cessation of egg-laying	Bondi et al., 1955				
1,2-Dibromoethane	Chicken (Leghorn)	Reproduction	16 weeks	Ingestion (fumigated feed)		10 ppm	10-15 ppm	reduced egg weight	Bondi et al., 1955				
1,2-Dibromoethane	Quail (Japanese)	Plasma enzyme and constituent contents	7 days	Intubation, 2x/day			3.7 mg total/day	Total lipid, haematocrit, haemoglobin	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Plasma enzyme and total constituents	21 days	Intubation, 2x/day			3.7 mg total/day	ChE, AT, haematocrit, haemoglobin	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Liver	7 days	Intubation, 2x/day			3.7 mg total/day	Relative liver weight increase	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Liver	21 days	Intubation, 2x/day			3.7 mg total/day	Relative liver weight increase	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Liver	7 days	Intubation, 2x/day			3.7 mg total/day	Hepatic enzymes and constituent contents	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Liver	21 days	Intubation, 2x/day			3.7 mg total/day	Hepatic enzymes and constituent contents	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Enzyme levels	7 days	Intubation, 2x/day	3.7 mg total/day			Brain acetylcholinesterase	Westlake et al., 1981				
1,2-Dibromoethane	Quail (Japanese)	Enzyme levels	21 days	Intubation, 2x/day			3.7 mg total/day	Brain acetylcholinesterase	Westlake et al., 1981				

▨ = eliminated from TRV development; non-target endpoint.

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	NOEL (mg/kg-day)	UF	TRV (mg/kg-day)
Ptarmigan	chicken&quail	0.28	2	0.14
Goose	chicken&quail	0.28	4	0.070
Loon	chicken&quail	0.28	4	0.070
Lapland longspur	chicken&quail	0.28	4	0.070
Snowy owl	chicken&quail	0.28	4	0.070

Rationale: Geometric mean of statistically significant chronic and subchronic growth and reproduction NOAELs is 3.5 mg/kg-day. After applying a subchronic to chronic UF of 5, this is 0.70. This is higher than the lowest paired LOAEL for reproduction (chronic), which is 0.56 mg/kg-day. Therefore, used the highest paired NOAEL below the lowest paired LOAEL which is 0.28 mg/kg-day.

Taxonomic UF of 2 for same family, different genus (ptarmigan)

Taxonomic UF of 4 for same class, different order (all other bird species)

Table C-20
1,2-Dibromoethane AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
1,2-Dibromoethane	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	–	–	LC_{50} = 6.5		Kszos et al., 2003	Static (Teflon-lined polypropylene closures) system; Measured concentrations reported
	Ceriodaphnia dubia						LC_{50} = 3.61 (3.26-3.99)			
Fishes										
1,2-Dibromoethane	Oryzias latipes (Japanese Medaka)	Mortality	4-28 days	aqueous solution (fresh water)	–	–	LC_{50} = 32.1 (27.6-37.4)		Holcombe et al., 1995	Continuous-flow mini-diluter water system; Measured concentrations reported
		Growth			5.81	9.62	–			
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	–	–	LC_{50} = 4.30 (4.01-4.62)		Kszos et al., 2003	Static (Teflon-lined polypropylene closures) system; Measured concentrations reported
	Cyprinodon variegatus	Mortality	2 days	aqueous solution (fresh water)	–	–	LC_{50} = 4.8		Landau and Tucker, 1984	Static system; Nominal concentrations reported

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Zooplankton	3.61	LC_{50} - Mortality	10	**0.36**	Used lowest measured LC_{50} value from the more sensitive species in the study. The LC_{50} value was divided by UF of 10 to extrapolate to a LOEC value.
Fish	5.81	NOEC - Growth	1	**5.81**	Used lowest bounded, measured NOEC - Growth value from a longer duration study that used a continuous flow system. No UF was applied to the NOEC value.

Table C-21
1,2-Dichlorobenzene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	LOAEL (mg/kg-d)	Specific Effect	Reference	Notes
MAMMALS								
1,2-Dichlorobenzene	Rats (F344/N) Mice (B6C3F)	Hematological Histological Morphology	2 years	Gavage	🟨 60	Kidney tubular degeneration	National Toxicology Program Tech. Report Series (No 255)	*Cancer studies conducted at 125, 250 and 500 mg/kg.* *No NOEC, LOEC or ECx values calculated*

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	LOAEL (mg/kg-d)	UF	(mg/kg-day)
Shrew	60	20	**3.0**
Lemming	60	10	**6.0**
Weasel	60	20	**3.0**

Rationale:

Only one study; chronic LOAEL. Divided by 5 to convert to NOAEL.

Taxonomic UF represents different Order, same Class

Taxonomic UF represents different Family, same Order

Taxonomic UF represents different Order, same Class

Table C-22
1,2-Dichlorobenzene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/L)	LOAEL (mg/L)	Other	Specific Effect	Reference	Notes
AQUATIC										
Algae										
1,2-Dichlorobenzene	Scenedesmus pannonicus	Growth	nr	aqueous solution	-	-	EC50 = 17 mg/L		Slooff et al., 1983	*no information provided re: time frame. Assume nominal data.*
Zooplankton										
1,2-Dichlorobenzene	Daphnia magna	Mortality	24 hr	aqueous solution	EC0 = 1.0 mg/L	-	EC50 = 1.7 mg/L	Mortality	Kuhn et al., 1989b	*Nominal concentrations.*
1,2-Dichlorobenzene	Daphnia magna	Reproduction	21 d	aqueous solution	NOEC = 0.63 mg/L	-	-	# offspring	Kuhn et al., 1989b	*Nominal concentrations.*
1,2-Dichlorobenzene	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	LC50 = 2.4 mg/L	Mortality	Leblanc, 1980	*Nominal concentrations.*
1,2-Dichlorobenzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 2.4 mg/L	Mortality	Leblanc, 1980	*Nominal concentrations.*
1,2-Dichlorobenzene	Daphnia magna	Mortality	24 / 48 hr	aqueous solution	NOEC = 0.36 mg/l	-	-	Mortality	Leblanc, 1980	*no information on exposure duration. Nominal concentrations.*
1,2-Dichlorobenzene	Ceriodaphnia dubpia	Mortality	48 hr	aqueous solution	-	-	EC50 = 0.66 mg/L	Immobility	Rose et al., 1998	*static system*
1,2-Dichlorobenzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 0.13 mg/L		Pawlisz and Peters, 1995	*organisms moved to a new test solution at 24 hours*
1,2-Dichlorobenzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 3.3 mg/L	Immobility	Canton et al., 1985	
1,2-Dichlorobenzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	EC50 = 0.74 mg/L	Immobility	Canton et al., 1985	*no information on how LC50 and EC50 differed……*
1,2-Dichlorobenzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 2.35 mg/L	Mortality	Bobra et al., 1985	*closed system; nominal concentrations.*
1,2-Dichlorobenzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 2.35 mg/L	Mortality	Abernethy et al., 1986	*static system; nominal concentrations.*
1,2-Dichlorobenzene	Artemia nauplii	Mortality	24 hr	aqueous solution	-	-	LC50 = 14.99 mg/L	Mortality	Abernethy et al., 1986	*static system; nominal concentrations.*
Fishes										
1,2-Dichlorobenzene	Pimephalus promelas	Mortality	48 hr	aqueous solution	-	-	LC50 = 76.3 mg/L	Mortality	Curtis et al., 1979	*Nominal concentrations.*
1,2-Dichlorobenzene	Pimephalus promelas	Mortality	96 hr	aqueous solution	-	-	LC50 = 57 mg/L	Mortality	Curtis et al., 1979	*Nominal concentrations.*
1,2-Dichlorobenzene	Pimephalus promelas	Mortality	96 hr	aqueous solution	-	-	LC50 = 57 mg/L	Mortality	Curtis et al., 1979	*Nominal concentrations.*
1,2-Dichlorobenzene	Poecillia reticulata (guppies)	Mortality	96 hr	aqueous solution	-	-	LC50 = 4.79 mg/l	Mortality	Sijm et al., 1993	*semistatic system; measured concentrations.*
1,2-Dichlorobenzene	Pimephalus promelas	Mortality	96 hr	aqueous solution	-	-	LC50 = 6.03 mg/L	Mortality	Sijm et al., 1993	*semistatic system; measured concentrations.*
1,2-Dichlorobenzene	Pimephalus promelas							Mortality	Van Wesel et al., 1995	
1,2-Dichlorobenzene	Pimephalus promelas							Mortality	Van Wesel et al., 1996	*Study focused on Lethal Body Burden not test concentration*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Zooplankton	0.36	48-hr NOEC	1	**0.36**	Used lowest NOEC; longer duration study had higher NOEC. No UF needed since NOEC.
Algae	17	EC50	10	**1.7**	Used single LC50 value. Divided by UF of 10 to convert to LOEC.
Fish	4.79	LC50	10	**0.48**	Used lowest LC50 from measured studies. Used UF of 10 to convert to LOEC.

Table C-23
1,1-Dichloroethane AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Notes
AQUATIC										
Fish										
1,1-Dichloroethane	Pimephales pimephales	LC50	24 hr	water	100	500		death	GLEC, 2005	*nominal concentrations*
					🟨	= value used for AL development.				

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	**Rationale**
Fish	100	24-hr NOEC	5	**20**	Used NOEC from single study. UF of 5 used to convert to chronic duration.

Table C-24
1,2-Dichloroethane TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg)	Other (mg/kg)	Specific Effect	Reference	Test Sp. Body Weight (BWt) (kg)	Ingestion Rate (IRt)	Notes
MAMMALS											
1,2-Dichloroethane	Rat	hepatic	5-7 wks	Oral (fumigated mash)	600	1600	15% liver fat increase	Alumot et al., 1976a			*effect not observed in 2-year study*
1,2-Dichloroethane	Rat	growth	2 yr	Oral (fumigated mash)	500		growth, feed consumption and efficiency	Alumot et al., 1976a	0.221	0.02	*NOAEL (mg/kg-d) = 500 mg/kg * 0.002 kg/kg-d / .221 kg =45.25*
1,2-Dichloroethane	Rat	reproduction	2 yr	Oral (fumigated mash)	500		litter size and weight, pup mortality, male fertility	Alumot et al., 1976a	0.221	0.02	*NOAEL (mg/kg-d) = 500 mg/kg * 0.002 kg/kg-d / .221 kg =45.25*
1,2-Dichloroethane	Rat	hepatic, renal	2 yr	Oral (fumigated mash)	500		liver, kidney function	Alumot et al., 1976a	0.221	0.02	*NOAEL (mg/kg-d) = 500 mg/kg * 0.002 kg/kg-d / .221 kg =45.25*
1,2-Dichloroethane	Mouse	reproduction	3 generations	Oral (drinking water)	50 mg/kg-d		pup weight, viability and lactation indices, dominant lethal and teratology	Lane et al., 1982	0.035	6 ml/d	*NOAEL (mg/kg-d) = 0.29 mg/ml * 6 ml/d / 0.035 kg = 50*

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	50	4	**13**
Lemming	50	2	**25**
Weasel	50	4	**13**

Rationale: se lowest chronic NOAEL for reproduction.

Taxonomic UF represents different Order, same Class
Taxonomic UF represents different Family, same Order
Taxonomic UF represents different Order, same Class

Table C-25
1,2-Dichloroethane TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration	Route	NOAEL (mg/kg)	LOAEL (mg/kg)	Other (mg/kg)	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Ingestion Rate (IRt)	Notes
BIRDS													
Ptarmigan													
1,2-Dichloroethane		leghorn chicken	hepatic		Oral (fumigated mash)	500			liver function and general health	Alumot et al., 1976b			
1,2-Dichloroethane		leghorn chicken	Nutrition	2 yr	Oral (fumigated mash)		500		feed intake	Alumot et al., 1976b			
1,2-Dichloroethane		leghorn chicken	reproduction	2 yr	Oral (fumigated mash)		250		decreased egg weights	Alumot et al., 1976b	2	0.1	_LOAEL = 250 mg/kg * 0.1 kg/d / 2 kg = 12.5 mg/kg-day * .7 = 8.75 mg/kg-d_
1,2-Dichloroethane		leghorn chicken	reproduction	2 yr	Oral (fumigated mash)		500		decreased egg production (and egg weights)	Alumot et al., 1976b	2	0.1	_(multiplied dose by 70% to account for actual % of dose consumed, due to desorption of residues during eating period)_
1,2-Dichloroethane		leghorn chicken	reproduction	2 yr	Oral (fumigated mash)	500			fertilization rate	Alumot et al., 1976b	2	0.1	_NOAEL = 500 mg/kg * 0.1 kg/d / 2 kg = 25 mg/kg-day * .7 = 17.5 mg/kg-d_

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	LOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Ptarmigan	8.75	5	1.75
Goose	8.75	20	0.44
Loon	8.75	20	0.44
Lapland longspur	8.75	20	0.44
Snowy owl	8.75	20	0.44

Rationale:

Selected lowest LOAEL for reproduction since lower than NOAELs.
Divide chronic LOAEL by UF of 5 to convert to NOAEL.
Taxonomic UF of 4 represents different Order, same Class
Taxonomic UF of 4 represents different Order, same Class
Taxonomic UF of 4 represents different Order, same Class
Taxonomic UF of 4 represents different Order, same Class

Table C-26
1,2-Dichloroethane AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Fish										
1,2-Dichloroethane	Pimephales pimephales	reproduction	24 hr	water	29	59		reduced offspring and lower growth	Benoit et al., 1982	*Measured concentrations*
1,2-Dichloroethane	Pimephales pimephales	survival	96 hr	water			116	death	Walbridge et al., 1983	*Nominal concentrations*
Zooplankton										
1,2-Dichloroethane	Daphnia magna	lethality	48 hr	water	186		383	NOEC = LC0	Kuhn et al., 1989b	*Nominal concentrations*
1,2-Dichloroethane	Daphnia magna	lethality	24 hr	water			250		LeBlanc, 1980	*Nominal concentrations*
1,2-Dichloroethane	Daphnia magna	lethality	48 hr	water			220		LeBlanc, 1980	*Nominal concentrations*
1,2-Dichloroethane	Daphnia magna	lethality	24 hr	water			270		Richter et al., 1983	*Nominal concentrations*
1,2-Dichloroethane	Daphnia magna	reproduction	28 day	water	11	21		number of offspring	Richter et al., 1983	*Measured concentrations*
1,2-Dichloroethane	Daphnia magna	growth	28 day	water	42	72		length	Richter et al., 1983	*Measured concentrations*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	Rationale
Fish	29	reproductive NOEC	5	**5.8**	Used low end of range of measured NOEC from single study. UF of 5 to convert to chronic duration.
Zooplankton	11	reproductive NOEC	1	**11**	Used NOEC from single study. No UF needed since reproductive NOEC.

Table C-27
1,1-Dichloroethene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL	LOAEL	Specific Effect	Reference	Notes	NOAEL (mg/m3)	LOAEL (mg/m3)	Body Weight (kg)	Inhalation Rate (m3/d)	Water Ingestion Rate (L/d)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Hour/day adjustment	Day/Week adjustment	Adjusted NOAEL (mg/kg/day)	Adjusted LOAEL (mg/kg/day)
MAMMALS																				
1,1-Dichloroethene	Sprague-Dawley Rats	Maternal effects (growth)	21 days (exposure = 7 hours/day, days 6 - 15 of gestation)	Inhalation	>683 mg/m3		Maternal weight gain	Murray et al., 1979	*concentrations used include 20, 80 and 160 ppm (85, 340, 683 mg/m3)* *effects between days 6 and 9 for 80 and 160 ppm, but not between days 10 and 15 or days 16 and 20.*	683		0.523	0.47		613.78		0.29	1.00	179.02	
1,1-Dichloroethene	Sprague-Dawley Rats	Maternal effects	21 days (exposure = 7 hours/day, days 6 - 15 of gestation)	Inhalation	340 mg/m3	683 mg/m3	maternal relative liver weight	Murray et al., 1979	*concentrations used include 20, 80 and 160 ppm (85, 340, 683 mg/m3)*	340	683	0.523	0.47		305.54	613.78	0.29	1.00	89.12	179.02
1,1-Dichloroethene	Sprague-Dawley Rats	Maternal effects (growth, survival, reproduction)	21 days (exposure = days 6 - 15 of gestation)	Drinking water	200 mg/L		Weight/weight gain, liver weight, death, % Pregnancy	Murray et al., 1979	*one concentration investigated = 200 ppm*	200		0.523		0.04	14.75	0.00				
1,1-Dichloroethene	Sprague-Dawley Rats	Maternal/fetal effects	21 days (maternal exposure = 7 hours/day, days 6 - 15 of gestation)	Inhalation	> 683 mg/m3		No. of litters, corpora lutea/dam, implantation sites/dam, pregnancy wastage, live fetuses/litter, resorptions/litter, fetal sex ratio, fetal body weight, fetal length	Murray et al., 1979		683		0.523	0.47		613.78		0.29	1.00	179.02	
1,1-Dichloroethene	Sprague-Dawley Rats	Maternal/fetal effects	21 days (exposure = days 6 - 15 of gestation)	Drinking water		200 mg/L	corpora lutea/dam fetal length	Murray et al., 1979			200	0.523		0.04		14.75				
1,1-Dichloroethene	Sprague-Dawley Rats	Fetal alterations	21 days (maternal exposure = 7 hours/day, days 6 - 15 of gestation)	Inhalation	85 mg/m3	340 mg/m3	wavy ribs	Murray et al., 1979		85	340	0.523	0.47		76.39	305.54	0.29	1.00	22.28	89.12
1,1-Dichloroethene	Sprague-Dawley Rats	Fetal alterations	21 days (exposure = days 6 - 15 of gestation)	Drinking water	> 200 mg/L		external and skeletal examination soft tissue examination cleft palate	Murray et al., 1979		200		0.523		0.04	14.75					
1,1-Dichloroethene	New Zealand White Rabbits	Maternal toxicity	7 h/d, 28 days (exposure = days 6 - 18 of gestation)	Inhalation		340 mg/m3	body weight gain liver absolute weight liver relative weight	Murray et al., 1979	*concentrations examined = 80 and 160 ppm (340 and 683 mg/m3)* *LOAEL = 340 mg/m3*		340	3.93	1.43			124.05	0.29	1.00		36.18
1,1-Dichloroethene	New Zealand White Rabbits	Maternal/fetal effects	7 h/d, 28 days (exposure = days 6 - 18 of gestation)	Inhalation		683 mg/m3	resorptions/litter	Murray et al., 1979	*LOAEL = 683 mg/m3*		683	3.93	1.43			249.20	0.29	2.00		145.37
1,1-Dichloroethene	New Zealand White Rabbits	Fetal alterations	7 h/d, 28 days (exposure = days 6 - 18 of gestation)	Inhalation	340 mg/m3	683 mg/m3	external and skeletal examination soft tissue examination cleft palate	Murray et al., 1979		340	683	3.93	2.46		212.78	427.44	0.29	1.00	62.06	124.67
1,1-Dichloroethene	Sprague-Dawley Rats	Clinical observations	three generations	Drinking water	> 200 mg/L		Physical appearance of f0, f1, f2 and f3 body weight and water consumption of f1, f2 and f3	Nitschke et al., 1983	*rats given dosed drinking water for all generations (f0, f1a, f1b, f2, f3, f3a, f3b)* *drinking water dosed at 50, 100 and 200 ppm (mg/L)*	200		0.523		0.04	14.75					
1,1-Dichloroethene	Sprague-Dawley Rats	Fertility	three generations	Drinking water	> 200 mg/L		fertility index	Nitschke et al., 1983	*data do not indicate trend (inc or dec) with increasing concentration*	200		0.523		0.04	14.75					
1,1-Dichloroethene	Sprague-Dawley Rats	Litter size and survival	three generations	Drinking water		50 mg/L***	post natal survival	Nitschke et al., 1983	*** effects seen in F2 and F3a generations only (no effects in f1a, f1b, f3b or f3c)*		50	0.523		0.04		3.69				
1,1-Dichloroethene	Sprague-Dawley Rats	Growth, Biochemical	2 years	Drinking water	19.3 (male) and 25.6 (female) mg/kg/day		body weight, food/water consumption, clinical chemistry, hematology, urinalysis, mortality	Rampy et al., 1977	*test concentrations 0, 60, 100 and 200 ppm (worked out by authors to be 0, 5.9, 10 and 19.3 mg/kg/day for the males and 0, 7.5, 12.6 and 25.6 mg/kg/day for females)*											

Table C-27
1,1-Dichloroethene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL	LOAEL	Specific Effect	Reference	Notes	NOAEL (mg/m3)	LOAEL (mg/m3)	Body Weight (kg)	Inhalation Rate (m3/d)	Water Ingestion Rate (L/d)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Hour/day adjustment	Day/Week adjustment	Adjusted NOAEL (mg/kg/day)	Adjusted LOAEL (mg/kg/day)
MAMMALS																				
1,1-Dichloroethene	Sprague-Dawley Rats	Growth, Biochemical	2 years	Inhalation	298 mg/m3		body weight, food/water consumption, clinical chemistry, hematology, urinalysis, mortality	Rampy et al., 1977	*Test concentrations 10 ppm and 40 ppm up until 5 weeks of study then 25 and 75 ppm for 5 weeks - 2 years* *Worked out by authors to be 40 and 159 mg/m3 then 99 and 298 mg/m3)*	298		0.523	0.47		267.80		0.29	1.00	78.11	
1,1-Dichloroethene	Sprague-Dawley Rats	Reproductive/Developmental	2 months prepregnancy + 20 days of pregnancy	Drinking water	110 mg/L		% live births, # implants, # resorptions, congenital abnormalities (excl cardiac)	Dawson et al., 1993	*test concentrations 0.15 and 110 ppm* *Test group receiving 0.15 ppm = 76 days* *Test group receiving 110 ppm = 68 days*	110		0.523		0.04	8.11					
1,1-Dichloroethene	Sprague-Dawley Rats	Developmental	2 months prepregnancy + 20 days of pregnancy	Drinking water		0.15 mg/L	% abnormal hearts	Dawson et al., 1993			0.15	0.523		0.04		0.01				
1,1-Dichloroethene	Sprague-Dawley Rats	Liver (hepatic changes)	2 years	Drinking water				Quast et al., 1983	*50 ppm dose in dw, calculated in paper to be 7 mg/kg-d for males and 9 mg/kg-d for females based on drinking water mean analyzed concentrations. No effects observed at this level for males, but effects observed in females at all dose levels (this was lowest)*							9				
1,1-Dichloroethene	Beagle dogs	Growth, Biochemical	97 days	Oral (gelatin capsule)			organ/body weight, food consumption, clinical chemistry, hematology, urinalysis	Quast et al., 1983							25					

🟦 = drinking water rather than inhalation study and highlighted drinking water ingestion rates used.
🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
	4.3	--	
	22.28	--	
	62.06	--	
	8.11	--	
Geometric mean	14.8	1	**14.8**
Shrew	14.8	4	**3.7**
Lemming	14.8	2	**7.4**
Weasel	14.8	4	**3.7**

Rationale:

4 reproductive-based NOAELs from yellow highlighted studies.
Calculated geomean to develop TRV.
No toxicity-based UF needed since multiple generation studies had higher NOAELs.

Taxonomic UF represents different Order, same Class
Taxonomic UF represents different Family, same Order
Taxonomic UF represents different Order, same Class

Table C-28
1,2-Dichloroethene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	TRV (mg/kg-day)	Specific Effect	Reference	Notes
MAMMALS								
1,2-Dichloroethene (cis and trans)	mouse	various	90 d	oral (water)	45.2	body and organ weight, blood chemistry, hepatic function	Sample et al., 1996	*subchronic NOAEL converted to chronic NOAEL using UF of 10; note reduced glutathione levels and aniline hydroxylase activity were observed in males and females, respectively, at the highest dose and at all doses, respectively.*

Table C-29

1,2-Dichloroethene AL Derivation for Aquatic Receptors

Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels

Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC											
Fish											
1,2-DCE	cis	Pimephales pimephales	mortality	24 hr	water	100 mg/L			death	GLEC, 2005	*nominal concentrations*
Zooplankton											
1,2-DCE	trans	Daphnia magna	mortality	48 hr	water			220 mg/L	death	LeBlanc, 1980	*nominal concentrations*

Note: Applies to both cis- and trans- isomers.

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	Rationale
Fish	100	24-hr NOEC	5	**20**	Used NOEC from single study. Divided by UF of 5 to convert from short-term to chronic duration.
Zooplankton	220	LC50	10	**22**	Used LC50 as only available study Divided by UF of 10 to convert from LC50 to LOEC.

Table C-30
Diethyl ether TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	NOAEL (mg/m3)	LOAEL (mg/m3)	Inhalation Rate m3/day	Dose (mg/kg-day)	Hours/day Factor	Days/week Factor	Adjusted NOAEL (mg/kg-day)	Adjusted LOAEL (mg/kg-day)
MAMMALS																			
Diethyl ether	Rat	Growth/Haematology	7 weeks	inhalation (7 hr/d, 5 d/wk)	2000 ppm			terminal body weight, organ/body weight ratios (lung, heart, liver, spleen, kidneys, testes), SGOT and SGPT levels	Chenoweth et al., 1970	0.360 (male), 0.221 (female)	*Nominal concentrations. Mean chamber atmosphere of 1908 ppm diethyl ether reported. Note that a significant difference in testes weight ratio was observed in guinea pigs, but authors note that no consistent trends were observed and effects may not be compound-related. Statistical tests not stated, p value = 0.01 considered significant. Rat body weights are means of control group terminal body weights. Used rat inhalation rate equation from EPA (1988): 0.8*BW^0.8206.*	6063		0.35	5826	0.29	0.71	1214	
Diethyl ether	(C57B1/C3H) F1 Mouse	Reproduction	5 day exposure, 28 days post-exposure	inhalation (4 hr/d, 5 d total)	1.6%			morphological epididymal spermatozoa abnormalities	Land et al., 1981	0.0316	*Concentrations monitored and within 5 percent of intended concentrations. Exposures initiated when mice were 11 weeks old. Concentrations reported in MAC and volume percent of exposure atmosphere. 1.6% corresponds to 0.5 MAC, and 0.32 % corresponding to 0.1 MAC was also tested.* *Used subchronic exposure weight of B6C3F1 male mouse (0.0316 kg; BW not reported in study). Only reproductive effect studied was morphologic changes in spermatozoa.* *Used mouse inhalation rate from EPA (1988): 1.99*BW^1.0496.*	48504		0.05	81323	0.17	0.71	9681	
Diethyl ether	Sprague Dawley rats	Growth	5 weeks	inhalation (continuous exposure implied)	1%			body weight decrease	Stevens et al., 1975	0.2125	*Reported weights were 0.15-0.275 kg. Use average of 0.2125 kg.*	30315		0.22	32020	1	1	32020	
Diethyl ether	Mouse	Growth	5 weeks	inhalation (continuous exposure implied)		0.1%		body weight decrease	Stevens et al., 1975	0.018-0.020	*Body weights are from beginning of study prior to exposure. Concentrations measured automatically at 4 hour intervals by GC.*		3031	0.03	4956	1	1		4956
Diethyl ether	Mouse	Mortality	5 weeks	inhalation (continuous exposure implied)		1%		survival	Stevens et al., 1975	0.018-0.020	*Mice sacrificed after 20 days because 25% had died. Same was done for guinea pigs in this dose group; rats all survived.*		30315	0.03	49561	1	1		49561
Diethyl ether	Guinea pig	Mortality	5 weeks	inhalation (continuous exposure implied)		1%		survival	Stevens et al., 1975	0.25-0.35	*Mice sacrificed after 20 days because 25% had died. Same was done for guinea pigs in this dose group; rats all survived.* *Used guinea pig inhalation rate equation from EPA (1988): 0.44*BW^0.5156.*		30315	0.24	23900	1	1		23900
Diethyl ether	Mouse	Liver	5 weeks	inhalation (continuous exposure implied)		0.1%		liver/body weight ratio	Stevens et al., 1975	0.018-0.020	*Males only significant at this concentration; males and females both significant at 1%.*								

▨ = eliminated from TRV development; non-target endpoint.

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	Geometric Mean (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	rat	7219	4	1805
Lemming	rat	7219	2	3610
Least Weasel	rat	7219	4	1805

Rationale: Use the geometric mean of growth and reproductive NOAELs (7219 mg/kg-day). Mean includes chronic reproductive study, so do not apply subchronic to chronic UF.
UF of 4 applied for same class, different order.
UF of 2 applied for same order, different family.

Table C-31
Diethyl ether TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	FIR (mg/day)	BW (kg)	Dose (mg/kg-day)
MAMMALS														
Diethyl ether	Chicken (Fertile Eggs)	Mortality	5-6 hours exposure, 10-18 days of incubation	Vapors in incubator			9%	survival	Smith et al., 1967	not reported	*9% vapor on day 4 of incubation caused 50% deaths, statistically significant (versus 10% ether on day 3 only 9.2% deaths, increased sensitivity). No body weights (embryos exposed directly) but blood and yolk concentrations at various time intervals are provided.*			
Diethyl ether	Chicken (Fertile Eggs)	Teratogenicity	5-6 hours exposure, 10-18 days of incubation	Vapors in incubator			9%	abnormal survivors (brain, eye, neak, extremity, or body anomalies)	Smith et al., 1967	not reported	*Text states that rate of abnormal survivors was statistically significant in six groups of experiments on days 3 and 4 of incubation, gives p-value range but does not state which 6 groups were significant. Based on results in table, it is inferred that results were signfiicant down to the lowest exposure level (9% ether vapor).*			

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	UF	TRV (mg/kg-day)
Ptarmigan			NA
Goose			NA
Loon			NA
Lapland longspur			NA
Snowy owl			NA

Rationale: Insufficient data to develop TRV.

Table C-32
Diethyl ether AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOAEL (mg/L)	LOAEL (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Fishes										
Diethyl Ether	Lepomis macrochirus	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = >10,000		Dawson et al., 1976	Static system (Aerated as necessary, but never for 24-hrs); Nominal concentrations reported; Never reached mortality in highest test concentration.
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	🟨 LC_{50} = 2560		Geiger et al., 1986	Flow-through mini-diluter system; Measured concentrations reported.
		Behavior					EC_{50} = 2260	loss of equilibrium - swim upright		
	Leuciscus idus ssp. melanotus	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_0 = 2130 LC_{50} = 2840 LC_{100} = 3600		Juhnke and Ludemann, 1978	Toxicological values were reference from EPA ECOTOX: Aquatic Report, Reference Number 547; Static system (Aerated as necessary, but never for 24-hrs); Nominal concentrations reported.

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)
Fish	2560	EC50	10	**256**

Rationale

Used lowest measured LC_{50} from the longer duration study that used a flow-through test system. The LC_{50} was divided by an UF of 10 to extrapolate to a LOEC value.

Table C-33
1,4-Dioxane TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Specific Effect	Reference	Notes
MAMMALS										
1,4-Dioxane	D1	Rat	Liver, kidney	716	oral, water	17	94	necrosis	Kociba et al., 1974	
1,4-Dioxane	D2	Sprague-Dawley Rats	Reproduction	days 6-15 of pregnancy	oral (gavage)	500	1,000	developmental retardation (sternum), fetal weight	Giavini et al., 1985	NOAEL and LOAEL = 0.5 and 1 ml/kg-d, respectively; density is 1.032 g/mL, so can assume 1 mL = 1 g

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	500	20	25
Lemming	500	10	50
Weasel	500	20	25

Rationale:

Only one relevant study, but reproductive NOAEL. Add UF of 5 for subchronic to chronic extrapolation.

Table C-34
Ethylbenzene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Other (as specified)	Specific Effect	Reference	Notes
MAMMALS											
Ethylbenzene	E1	Rats	Mortality	Acute (single dose)	Stomach tube	nr	nr	LC50 = 3.5 mg/kg	Mortality	Wolf et al., 1956	
Ethylbenzene	E1	Rats	Organ Histopathology and Growth	182 days (130 feedings)	Stomach tube	136	408	-	Liver/Kidney weight Liver/Kidney histopathology	Wolf et al., 1956	*Dose regime = 13.6, 136, 408 and 680 mg/kg/d* *No of feedings = 130*
Ethylbenzene	E1	Rabbits	Skin Irritation	2 - 4 wks	Direct application to ear and abdomen	nr	nr	-	Erythema Exfoliation Edema/superficial necrosis	Wolf et al., 1956	*Effects not quantified; Moderate irritation and moderate necrosis noted*
Ethylbenzene	E1	Rabbits	Conjuctival Irritation Corneal Injury	Acute	Direct application of 2 drops	nr	nr	-	Irritation Inflammation/swelling Necorsis (cornea)	Wolf et al., 1956	*Effects not quantified; slight conjunctival irritation and no coneral injury noted*
Ethylbenzene	E1	Rat	Organ Weight Organ/Blood Histopathology Mortality	186 days *+ various*	Vapour exposure chamber	nr	400 ppm	-	Liver weight Kidney weight	Wolf et al., 1956	*Exposures for 7-8 hours a day, 5 days a week for up to 6 months* *Data are not clearly presented for various durations. Did not use study due to inadequate documentation.*
Ethylbenzene	E1	Guinea Pig	Organ Weight Organ/Blood Histopathology Mortality	186 days + various	Vapour exposure chamber	400 ppm	600 ppm	-	Liver weight	Wolf et al., 1956	*Exposures for 7-8 hours a day, 5 days a week for up to 6 months* *Data are not clearly presented for various durations. Did not use study due to inadequate documentation.*
Ethylbenzene	E1	Rabbits	Organ Weight Organ/Blood Histopathology Mortality	186 days + various	Vapour exposure chamber	400 ppm	600 ppm	-	Testes histopathology	Wolf et al., 1956	*Exposures for 7-8 hours a day, 5 days a week for up to 6 months* *Data are not clearly presented for various durations. Did not use study due to inadequate documentation.*
Ethylbenzene	E1	Rhesus monkey	Organ Weight Organ/Blood Histopathology Mortality	186 days + various	Vapour exposure chamber	400 ppm	600 ppm	-	Liver weight Testes histopathology	Wolf et al., 1956	*Exposures for 7-8 hours a day, 5 days a week for up to 6 months* *Data are not clearly presented for various durations. Did not use study due to inadequate documentation.*

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	136	4	34
Lemming	136	2	68
Weasel	136	4	34

Rationale:

Selected study with lowest NOAEL since no directly relevant endpoints.

Other NOAELs are suspect based on inadequate documentation.
No toxicity-based UF needed since chronic NOAEL.

Taxonomic UF represents different Order, same Class

Taxonomic UF represents different Family, same Order

Taxonomic UF represents different Order, same Class

Table C-35
Ethylbenzene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other Endpoint (mg/L)	Specific Effect	Reference	Weight (BWt) (kg)	Notes
AQUATIC											
Algae											
Ethylbenzene	Chlorella vulgaris	Photosynthesis Inhibition	3 hr	aqueous solution	-	-	EC50 = 50.98 mg/L	$^{14}CO_2$ uptake	Hutchinson et al., 1980	-	*three to four day exponential phase cells used, assume nominal concentrations*
Ethylbenzene	Chlamydomonas angulosa	Photosynthesis Inhibition	3 hr	aqueous solution	-	-	EC50 = 62.66 mg/L	$^{14}CO_2$ uptake	Hutchinson et al., 1980	-	*three to four day exponential phase cells used; assume nominal concentrations*
Ethylbenzene	Chlamydomonas reinhardtii (green algae)	Enzymatic Activity	2 hr	aqueous solution	-	-	EC50 = 12 mg/L	ATP inhibition (indirect measurement)	Brack and Frank, 1998	-	*Toxicity threshold for most sensitive parameter; headspace concentrations were measured to determine effective concentrations in test cultures*
Ethylbenzene	Selenastrum capricornutum	Growth	72 hr	aqueous solution	-	-	EC50 = 4.6 mg/L	Cell numbers	Galassi et al., 1988		*Authors maintained steady concentration throughout study; measured concentrations*
Zooplankton											
Ethylbenzene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC$_{50}$ = 2.12 mg/L	Immobility	Bobra et al, 1983	-	*closed system (static test), 4 -6 day old at start, Log concentration-mortality curve; nominal concentrations*
Ethylbenzene	Daphnia magna	Mortality	24 hr	aqueous solution	6.8	-	LC50 = 77 mg/L	Immobility	LeBlanc, 1980	-	*Static test, <24 hr old at start, closed system, LC50 determined by 1) moving angle method, 2) probit, 3) binomal probability; nominal concentrations*
Ethylbenzene	Daphnia magna	Mortality	48 hr	aqueous solution	6.8	-	LC50 = 75 mg/L	Immobility	LeBlanc, 1980	-	*Static test, <24 hr old at start, closed system, LC50 determined by 1) moving angle method, 2) probit, 3) binomal probability; nominal concentrations*
Ethylbenzene	Daphnia magna	Immobilization	24 hr	aqueous solution	-	-	IC50 = 2.2 mg/L	Immobility	Galassi et al., 1988		*Closed system; static; measured concentrations*
Ethylbenzene	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	LC50 = 2.37 - 2.69 mg/L	Immobility	Vigano, 1993	-	*range b/c study focused on effects of food ration on fecundity, morphology and toxicity, < 24 hr old at start, probit regression; measured concentrations were used when the deviation from the nominal concentrations was greater than 20%*
Ethylbenzene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 1.81 - 2.38 mg/L	Immobility	Vigano, 1993	-	*range b/c study focused on effects of food ration on fecundity, morphology and toxicity, < 24 hr old at start, probit regression; measured concentrations were used when the deviation from the nominal concentrations was greater than 20%*
Ethylbenzene	Ceriodaphnia dubia	Mortality	24 hr	aqueous solution	-	-	LC50 = 31.3 mg/L	Immobility	Marchini et al., 1993	-	*static system. LC 50 calculated using trimmed Spearman-Krber method; stock solutions were measured and exposure concentrations were extrapolated*

Table C-35
Ethylbenzene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other Endpoint (mg/L)	Specific Effect	Reference	Weight (BWt) (kg)	Notes
AQUATIC											
Fishes											
Ethylbenzene	Lepomis macrochirus (Bluegill)	Mortality	24 hr	Soft water	-	-	LC50 = 35.08 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*nominal concentrations*
Ethylbenzene	Lepomis macrochirus (Bluegill)	Mortality	48 hr	Soft water	-	-	LC50 = 32 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*nominal concentrations*
Ethylbenzene	Lepomis macrochirus (Bluegill)	Mortality	96 hr	Soft water	-	-	LC50 = 32 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*nominal concentrations*
Ethylbenzene	Pimephales promelas	Mortality	24 hr	Soft water	-	-	LC50 = 48.51 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*Endpoint concentrations = median tolerable concentrations (calculated from mortalities in difference test concentrations causing 50% mortality during time interval. (straight line graphical interpolation from percent survival and lot concentrations of chemicals). pH = 7.5, Alkalinity = 18 mg/L, Hardness (EDTA) = 20 mg/L; nominal concentrations*
Ethylbenzene	Pimephales promelas	Mortality	48 hr	Soft water	-	-	LC50 = 48.51 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*pH = 7.5, Alkalinity = 18 mg/L, Hardness (EDTA) = 20 mg/L; nominal concentrations*
Ethylbenzene	Pimephales promelas	Mortality	96 hr	Soft water	-	-	LC50 = 48.51 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*pH = 7.5, Alkalinity = 18 mg/L, Hardness (EDTA) = 20 mg/L; nominal concentrations*
Ethylbenzene	Pimephales promelas	Mortality	24 hr	Hard water	-	-	LC50 = 42.33 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*pH = 8.2, Alkalinity = 300 mg/L, Hardness (EDTA) = 360 mg/L; nominal concentrations*
Ethylbenzene	Pimephales promelas	Mortality	48 hr	Hard water	-	-	LC50 = 42.33 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*nominal concentrations*
Ethylbenzene	Pimephales promelas	Mortality	96 hr	Hard water	-	-	LC50 = 42.33 mg/L	Mortality	Pickering and Henderson, 1966	1 - 2 g	*nominal concentrations*
Ethylbenzene	Pimephales promelas	Mortality	96 hr	aqueous solution	-	-	LC50 = 12.1 mg/L	Mortality	Geiger et al., 1986	-	*flow through, Trimmed Spearman-Karber method, 34 d old fish; measured concentrations*
Ethylbenzene	Salmo gairdneri	Mortality	96 hr	aqueous solution	-	-	LC50 = 4.2 mg/L	Mortality	Galassi et al., 1988		*Test solution renewed at 48 hrs.; measured concentrations*
Ethylbenzene	Pimephales promelas	Mortality		aqueous solution			LC50 = 9.1 mg/L	Mortality	Brooke, 1987		*Flow through test; measured concentrations*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	Rationale
Algae	4.6	EC50	10	**0.46**	Selected lowest of four available EC50 values. Divided by UF of 10 to convert from LC50 to LOEC.
Zooplankton	2.2	IC50	10	**0.22**	The only study with a NOEC appears to be an outlier; EC50 values much higher than for other studies. used lowest EC50/IC50/LC50 value among measured studies. Divided by UF of 10 to convert from LC50 to LOEC.
Fish	4.2	96 hr LC50	10	**0.42**	Only LC50 values available; used lowest measured value since fewer than 10 values (used only longest duration within a given study) Divided by UF of 10 to convert from LC50 to LOEC.

Table C-36
Formaldehyde TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Specific Effect	Reference	Notes
MAMMALS									
Formaldehyde	dog	Growth	91 days	diet	75	100	Weight	Johannsen et al., 1986	
Formaldehyde	Rat	Hematology	91 days	drinking water	>150		HCT %, Hbg, WBC	Johannsen et al., 1986	
Formaldehyde	Dog	Hematology	91 days	Diet	>150		HCT %, Hbg, WBC	Johannsen et al., 1986	
Formaldehyde	Rats	Organ Weights	24 months	drinking water	15	82	Brain Kidney	Til et al., 1989	*82 mg/kg-day is the LOAEL for males, female LOAEL is 109 mg/kg-day*
Formaldehyde	Mice	Development	treatment on days 8 to 12 of gestation	oral intubation	>540		Number of litters Ave no. of neonates/litter Neonate survival Ave. neonate weight	Seidenberg et al., 1986	*only one concentration used = 540 mg/kg/day*
Formaldehyde	Dog	Reproduction	52 days (4 days after mating until day 56)	oral (liquid solution sprayed on dog pellets)	9.4		pregnancy rate and duration, fecundity, pup weight, survival, and development, weight gain in mothers	Hurni and Ohder, 1973	*375 ppm converted to 9.4 mg/kg-d in study. Additional info not provided.*

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	subchronic NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
growth	75		
reproduction	9.4		
development	540		
Geometric mean	72.5	5	14.5
Shrew	14.5	4	3.6
Lemming	14.5	4	3.6
Weasel	14.5	2	7.2

Rationale:

Three relevant NOAELs across rodents and dogs.
Calculated geometric mean.
Divided by UF of 5 to convert from subchronic to chronic NOAEL.

Taxonomic UF of 2 represents different Family, same Order
Taxonomic UF of 4 represents different Order, same Class

Table C-37
Formaldehyde AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	EC10 (mg/L)	NOEC (mg/L)	EC50 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC											
Zooplankton											
Formaldehyde	Daphnia magna	lethality	1 hr	water			39		enzyme inhibition, fluorescence	Janssen and Persoone, 1993	*nominal concentrations*
Formaldehyde	Daphnia pulex	lethality	2	water	1.9		5.8			Tisler and Zagorc-Koncan, 1997	*nominal concentrations*
Formaldehyde	Daphnia magna	lethality	2	water			>100, <1000			Dowden and Bennett, 1965	*assume nominal concentrations*
Formaldehyde	Ceriodaphnia dubia	lethality	2	water			12.98		immobilization	Warne and Schifko, 1999	*nominal concentrations*
Formaldehyde	mixed bacteria culture	growth	5	water	14.7		34.1			Tisler and Zagorc-Koncan, 1997	*nominal concentrations*
Fish											
Formaldehyde	Oncorynchus mykiss	lethality	2	water	29.3			50		Tisler and Zagorc-Koncan, 1997	*Static test; nominal concentrations*
Algae											
Formaldehyde	Chlamydomonas reinhardtii	photosynthesis	14	water	3.7				EC5	Brack and Frank, 1998	*Static tests; headspace concentrations were measured to determine effective concentrations in test cultures*
Formaldehyde	Scenedesmus quadricauda	photosynthesis	1	water	3.6		14.7			Tisler and Zagorc-Koncan, 1997	*Static test; nominal concentrations*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	Rationale
Zooplankton	1.9	EC10	1	**1.9**	Used EC10 value since lowest; target for Tier II is EC10, so no UF needed.
Fish	29.3	LC10	1	**29**	Used EC10 value since lowest; target for Tier II is EC10, so no UF needed.
Algae	3.7	EC5	1	**3.7**	Used measured study; no UF needed since EC5.

Table C-38
Methanol TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other (as specified)	Specific Effect	Reference	Weight (BWt) (kg)	Notes
MAMMALS											
Methanol	Rats	Various	13 weeks	Gavage	500	nr	nr	Hematology, Serum Chemistry, Ophthamology Urinalysis, Necropsy, Histology, Growth	Toxicity Research Laboratories, 1986	nr	*No effects were found at the 100 or 500 mg/kg/day doses*

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	500	20	**25**
Lemming	500	10	**50**
Weasel	500	20	**25**

Rationale:
Only one study available; selected NOAEL.
Divided by UF of 5 to convert from subchronic to chronic.
Taxonomic UF of 2 represents different Family, same Order
Taxonomic UF of 4 represents different Order, same Class

Table C-39
Methanol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL (mg/L)	LOAEL (mg/L)	Other	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
Methanol	Bracionus calyciflorus (rotifer)	Mortality	24 hr	aqueous solution	-	-	LC50 = 35885 mg/L	Mortality	Calleja et al., 1994	*nominal concentrations*
Methanol	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	LC50 = 21403 mg/L	Immobility	Calleja et al., 1994	*nominal concentrations*
Methanol	Artemia salina (brine shrimp) (marine)	Mortality	24 hr	aqueous solution	-	-	LC50 = 43544 mg/L	Mortality	Calleja et al., 1994	*nominal concentrations*
Methanol	Streptocephalus proboscideus (freshwater fairy shrimp)	Mortality	24 hr	aqueous solution	-	-	LC50 = 32681 mg/L	Mortality	Calleja et al., 1994	*nominal concentrations*
Methanol	Daphnia pulex	Mortality	18 hr	aqueous solution	-	-	LC50 = 19538 mg/L	Mortality	Bowman et al., 1981	*Converted from 2.47 v/v(%) based on methanol density of 791 kg/cu.m; assume nominal concentrations*
Methanol	Hyalella azteca	Mortality	18hr	aqueous solution	-	-	LC50 = 19379.5 mg/L	Mortality	Bowman et al., 1981	*Converted from 2.45 v/v(%) based on methanol density of 791 kg/cu.m; assume nominal concentrations*
Methanol	Palaemonetes kadiakensis (glass shrimp)	Mortality	18 hr	aqueous solution	-	-	LC50 = 21910.7 mg/L	Mortality	Bowman et al., 1981	*Converted from 2.77 v/v(%) based on methanol density of 791 kg/cu.m; assume nominal concentrations*
Methanol	Daphnia magna	Mortality	96 hr	aqueous solution	-	-	LC50 = >100 mg/L	Mortality	Ewell et al., 1986	*nominal concentrations*
Methanol	Gammarus fasciatus (sideswimmer)	Mortality	96 hr	aqueous solution	-	-	LC50 = >100 mg/L	Mortality	Ewell et al., 1986	*nominal concentrations*
Methanol	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	LC50 = 4816 mg/L	Mortality	Guilhermino et al., 2000	*the LC50 values in this experiment are considerably lower than in all other experiments and may represent outliers; nominal concentrations*
Methanol	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 3286 mg/L	Mortality	Guilhermino et al., 2000	*the LC50 values in this experiment are considerably lower than in all other experiments and may represent outliers; nominal concentrations*
Methanol	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	LC50 = 20804 mg/L	Mortality	Lilius et al., 1995	*assume nominal concentrations*
Methanol	Daphnia pulex	Mortality	24 hr	aqueous solution	-	-	LC50 = 27468 mg/L	Mortality	Lilius et al., 1995	*assume nominal concentrations*
Methanol	Daphnia magna	Mortality	24 hr	aqueous solution	> 10000 mg/L	-	EC50 = >10000 mg/L	Mortality	Kuhn et al., 1989b	*nominal concentrations*
Methanol	Daphnia magna	Mortality	48 hr	aqueous solution	> 10000 mg/L	-	EC50 = >10000 mg/L	Mortality	Kuhn et al., 1989b	*nominal concentrations*
Methanol	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	LC50 = 20804 mg/L	Mortality	Lilius et al, 1994	*assume nominal concentrations*
Mollusca										
Methanol	Heisoma trivoluis (snail)	Mortality	96 hr	aqueous solution	-	-	LC50 = >100 mg/L	Mortality	Ewell et al., 1986	

Table C-39
Methanol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL (mg/L)	LOAEL (mg/L)	Other	Specific Effect	Reference	Notes
AQUATIC										
Annelida										
Methanol	Lumbriculus variegatus (segmented worm)	Mortality	96 hr	aqueous solution	-	-	LC50 = >100 mg/L	Mortality	Ewell et al., 1986	
Platyhelminthes										
Methanol	Dugesia tigrina (flatworm)	Mortality	96 hr	aqueous solution	-	-	LC50 = >100 mg/L	Mortality	Ewell et al., 1986	
Insects										
Methanol	Culex restuans	Mortality	18 hr	aqueous solution	-	-	LC50 = 20012 mg/L	Mortality	Bowman et al, 1981	*Converted from 2.53 v/v(%) based on methanol density of 791 kg/cu.m*
Fishes										
Methanol	Pimephales promelas	Mortality	96 hr	aqueous solution	-	-	LC50 = >100 mg/L	Mortality	Ewell et al., 1986	*nominal concentrations*
Methanol	Pimephales promelas	Mortality	96 hr	aqueous solution	-	-	LC50 = 28100 mg/L	Mortality	Call et al., 1983	*measured concentrations*
Methanol	Salmo gairdneri	Mortality	96 hr	aqueous solution	-	-	LC50 = 20000 mg/L	Mortality	Call et al., 1983	*measured concentrations*
Methanol	Lepomis macrochirus	Mortality	96 hr	aqueous solution	-	-	LC50 = 15500 mg/L	Mortality	Call et al., 1983	*measured concentrations*
Methanol	Oncorhynchus myskiss	Cytotoxicity	3 hr	aqueous solution	-	-	EC50 = 5364 mM	Radioactivity (rubidium leakage)	Lilius et al., 1994	*assume nominal concentrations*
Methanol	Salmo gairdneri	Mortality	24 hr	aqueous solution	-	-	LC 50 = 20300 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Salmo gairdneri	Mortality	48 hr	aqueous solution	-	-	LC50 = 20100 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Salmo gairdneri	Mortality	96 hr	aqueous solution	-	-	LC50 = 20100 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Lepomis macrochirus	Mortality	24 hr	aqueous solution	-	-	LC50 = 19100 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Lepomis macrochirus	Mortality	48 hr	aqueous solution	-	-	LC50 = 19100 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Lepomis macrochirus	Mortality	96 hr	aqueous solution	-	-	LC50 = 15400 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Pimephales promelas	Mortality	24 hr	aqueous solution	-	-	LC50 = 29700 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Pimephales promelas	Mortality	48 hr	aqueous solution	-	-	LC50 = 29700 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*

Table C-39
Methanol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL (mg/L)	LOAEL (mg/L)	Other	Specific Effect	Reference	Notes
AQUATIC										
Methanol	Pimephales promelas	Mortality	96 hr	aqueous solution	-	-	LC50 = 29400 mg/L	Mortality	Poirier et al., 1986	*flow through system; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Salmo gairdneri	Behaviour	24 hr	aqueous solution	-	-	EC50 = 13200 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Salmo gairdneri	Behaviour	48 hr	aqueous solution	-	-	EC50 = 13200 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Salmo gairdneri	Behaviour	96 hr	aqueous solution	-	-	EC50 = 13000 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Lepomis macrochirus	Behaviour	24 hr	aqueous solution	-	-	EC50 = 16100 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Lepomis macrochirus	Behaviour	48 hr	aqueous solution	-	-	EC50 = 16000 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Lepomis macrochirus	Behaviour	96 hr	aqueous solution	-	-	EC50 = 12700 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Pimephales promelas	Behaviour	24 hr	aqueous solution	-	-	EC50 = 29700 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Pimephales promelas	Behaviour	48 hr	aqueous solution	-	-	EC50 = 29700 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Pimephales promelas	Behaviour	96 hr	aqueous solution	-	-	EC50 = 28900 mg/L	Behavior, equilibrium, coloration	Poirier et al., 1986	*avoidance; assume nominal concentrations (concentrations measured indirectly with no frequency provided)*
Methanol	Pimephales promelas	Mortality	96 hr	aqueous solution	-	-	🟨 LC50 = 28200 mg/L	Mortality	Veith et al., 1983	*measured concentrations*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	**Rationale**
Zooplankton	3286	48-hr LC50	10	**329**	Fewer than 10 applicable LC50 studies, so selected lowest. Divided by UF of 10 to convert from LC50 to LOEC.
Fish	15500	96-hr EC50	10	**1550**	Selected longest duration from each study (highlighted). Lowest of four relevant LC50 values selected from measured studies. Divided by UF of 10 to convert from LC50 to LOEC.

Table C-40
Methylene chloride TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Ingestion Rate (IRt)	Notes	Water Consumption (L/d)	NOAEL (mg/kg-d)
INGESTION														
Methylene Chloride	Sprague-Dawley rats	Survival	64 weeks (4-5 days/week)	ingestion, stomach tube	100 mg/kg/day	500 mg/kg/day		Increased mortality (males)	Maltoni et al., 1988	not reported	100, 500 mg/kg/day	*Effect seen in both male and female, but statistically significant in males only. Rats were 12 weeks old at start of experiment.*		
Methylene Chloride	Sprague-Dawley rats	Growth	64 weeks (4-5 days/week)	ingestion, stomach tube	500 mg/kg/day			body weight	Maltoni et al., 1988	not reported	100, 500 mg/kg/day	*No effect seen at any concentration*		
Methylene Chloride	Swiss mice	Survival	64 weeks (4-5 days/week)	ingestion, stomach tube		100 mg/kg/day		Increased mortality	Maltoni et al., 1988	not reported	100, 500 mg/kg/day			
Methylene Chloride	F344 rats	Survival	104 weeks	ingestion	250 mg/kg/day			increased mortality	Serota et al., 1986		5, 50, 125, 250 mg/kg/day	*No treatment related trends in survival noted.*		
Methylene Chloride	F344 rats	Growth	104 weeks	ingestion		125 mg/kg/day		lower body weight and reduced weight gain	Serota et al., 1986		5, 50, 125, 250 mg/kg/day	*Effects were small, but statistically significant.*		
Methylene Chloride	rats	Reproduction	13 weeks	ingestion, drinking water	125 mg/L			fertility, litter size, survival of pups	WHO (review article), 1984	0.204	125 mg/L	*Primary source is Bornmann & Loeser, 1967. Use water consumption formula for laboratory mammals (0.1*BW^0.7377) and average body weight for female rats from EPA, 1988.*	0.03	19
Methylene Chloride	rats	Growth	13 weeks	ingestion, drinking water	125 mg/L			body weight	WHO (review article), 1984		125 mg/L	*Primary source is Bornmann & Loeser, 1967*		
Methylene Chloride	F344 rats	Growth	24 months	ingestion	52 (males), 58 (females) mg/kg/day	125 (males), 136 (females) mg/kg/day			WHO (review article), 1984		6, 52, 125, 235 (males), 6, 58, 136, 263 (females) mg/kg/day	*Primary source is National Coffee Association (NCA), 1982*		
Methylene Chloride	F344 rats	Survival	24 months	ingestion	235 (males), 263 (females) mg/kg/day			increased mortality	WHO (review article), 1984		6, 52, 125, 235 (males), 6, 58, 136, 263 (females) mg/kg/day	*Primary source is National Coffee Association (NCA), 1982*		
INHALATION														
Methylene Chloride	Sprague-Dawley rats	Survival	104 weeks (5 hr/day, 6 day/week)	inhalation	1511 ppm	3470 ppm		Increased mortality	Burek et al., 1984		510, 1511, 3470 ppm			
Methylene Chloride	Sprague-Dawley rats	Growth	104 weeks (5 hr/day, 6 day/week)	inhalation	3470 ppm			body weight	Burek et al., 1984		510, 1511, 3470 ppm	*No effect seen at any concentration*		
Methylene Chloride	Golden Syrian hamster	Growth	104 weeks (5 hr/day, 6 day/week)	inhalation	3472 ppm			body weight	Burek et al., 1984		510, 1510, 3472 ppm	*No effect seen at any concentration*		
Methylene Chloride	Sprague-Dawley rats	Growth	2 years, 6 hr/day, 5 days/week	inhalation	500 ppm			body weight	Nitschke et al., 1988a		50, 200, 500 ppm	*No effect seen at any concentration.*		
Methylene Chloride	Sprague-Dawley rats	Survival	2 years, 6 hr/day, 5 days/week	inhalation	500 ppm			mortality	Nitschke et al., 1988a		50, 200, 500 ppm	*No effect seen at any concentration.*		
Methylene Chloride	F344 rats	Reproduction	14 weeks, 6 hr/day, 5 days/week	inhalation	1500 ppm			litter size, pup body weight	Nitschke et al., 1988b		100, 500, 1500 ppm	*reproductive study- both parents exposed for 14 weeks prior to mating.* *No effect seen at any concentration.*		
Methylene Chloride	F344/N rats	Growth	102 weeks, 6 hr/day, 5 days/week	inhalation	4000 ppm			mean body weight	NTP, 1986c		1000, 2000, 4000 ppm	*No effect seen at any concentration.*		
Methylene Chloride	F344/N rats	Survival	102 weeks, 6 hr/day, 5 days/week	inhalation	2000 ppm	4000 ppm		increased mortality (females)	NTP, 1986c		1000, 2000, 4000 ppm			
Methylene Chloride	B6C3F$_1$ mice	Growth	102 weeks, 6 hr/day, 5 days/week	inhalation		4000 ppm		body weight	NTP, 1986c		2000, 4000 ppm	*Statistical significance is not discussed.*		

Table C-40
Methylene chloride TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Ingestion Rate (IRt)	Notes	Water Consumption (L/d)	NOAEL (mg/kg-d)
INHALATION														
Methylene Chloride	$B6C3F_1$ mice	Survival	102 weeks, 6 hr/day, 5 days/week	inhalation		2000 ppm		increased mortality (males)	NTP, 1986c		2000, 4000 ppm			
Methylene Chloride	$B6C3F_1$ mice	Survival	102 weeks, 6 hr/day, 5 days/week	inhalation	2000 ppm	4000 ppm		increased mortality (females)	NTP, 1986c		2000, 4000 ppm			
Methylene Chloride	Sprague-Dawley rats	Survival	104 weeks (4-7 hr/day, 5 days/week)	inhalation	100 ppm			increased mortality	Maltoni et al., 1988		100 ppm	*No effect seen at any concentration*		
Methylene Chloride	Sprague-Dawley rats	Growth	104 weeks (4-7 hr/day, 5 days/week)	inhalation	100 ppm			body weight	Maltoni et al., 1988		100 ppm			
Methylene Chloride	F344/N rats	Survival	102 weeks (6 hr/day, 5 days/week)	inhalation		4000 ppm		increased mortality (females)	Mennear et al., 1988		1000, 2000 4000 ppm	*Increased mortality was observed in both rats and mice, but statistical significance was not discussed. Effects that were analyzed for statistcal significance were neoplasms as well as some non-neoplastic changes.*		

🟥 = eliminated from TRV development; no data or inappropriate route of administration.

🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	Value (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	rat	79	4	19.8
Lemming	rat	79	2	39.5
Weasel	rat	79	4	19.8

Rationale: Geometric mean of growth and reproductive endpoints is 79 mg/kg-day. This is lower than the lowest bounded LOAEL, so use it as TRV.

UF of 4 applied for same class, different order.
UF of 2 applied for same order, different family.

Table C-41
Methylene chloride TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL (mg/kg)	LOAEL (mg/kg)	Other (mg/kg)	Specific Effect	Reference	Test Sp. Body Weight (BWt)	Ingestion Rate (IRt)	Notes
BIRDS												
Methylene chloride	Single-Comb White Leghorn chicken embryo		Eggs were treated at 2 stages of incubation: Preincubation (0 hr), and at the fourth day (96 hrs). There were 4 test conditions for each compound.	Injection (100 µg/l or less) into the yolk and through the air cell.			LD_{50}=14.13mg/egg; Test condition: Yolk sack at 0 hours.	Methylene chloride showed no teratogenic response under the four conditions of test.	Verrett et al., 1980		Highest level tested=25.00 mg/egg	This article isn't specific to methylene chloride. It is an overview of the toxicity of 80 chemicals (methylene chloride being one of them) with food additive use, and their effects on the chicken embryo. Results indicate that the chicken embryo test is capable of demonstrating the teratogenic potential of compounds. An attempt was made to use test levels that were consistent with human exposure levels. Invalid exposure route.
Dichloromethane (DCM)	White Leghorn chicken embryo			Injection through the air space and yolk sac.			Injection into the air space of of two, three, and six-day old White Leghorn chick embryos: LD_{50}>100 µmol/egg. Injection into the yolk sac of 0-h-old White Leghorn chick embryo: LC_{50}= 14 mg/egg.	Injection of DCM into the air space of two, three, and six-day old embryos induced abnormalties and death. DCM was not teratogenic following injection into the yolk sac of 0-h-old White Leghorn chick embryos.	WHO, 1986			This is a partial article and includes mammal data. Invalid exposure route.

🟥 = eliminated from TRV development; no data or inappropriate route of administration. 🟨 = value used for AL development.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	UF	TRV (mg/kg-day)
Ptarmigan	chicken		NA
Goose	chicken		NA
Loon	chicken		NA
Lapland longspur	chicken		NA
Snowy owl	chicken		NA

Rationale: Insufficient data.

Table C-42
Methylene chloride AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other Endpoint	Specific Effect	Reference	Notes
TERRESTRIAL PLANTS										
Dichloromethane (DCM)	Oat grains (*Avena sativa* L.)	Germination	7 days for germination study; 4 days for CO_2 study	Apply chemical in petri dish	-	-		Inhibited germination, reduced CO_2 evolution.	Brewer and Wilson, 1975	Germination rates and CO_2 evolution experiments indicate that DCM is not a harmless agent, and localization studies show that DCM is not capable of penetrating to the inner cells of all types of seeds. 5 ml added to petri dish. Invalid exposure route.
	Pigweed seeds (*Amaranthus retroflexus* L.)	Germination			-	-				3 ml added to petri dish. Invalid exposure route.
Dichloromethane (DCM)	Soybean seeds (*Glycine max*)--"Hill" and "Wells"	Germination	0.5, 1.5, 4, or 24 hours	Apply chemical in petri dish				Increased germination	Ellis et al., 1976	Soybean seeds treated with MBC in DCM and thiabendazole in DCM had decreased incidence of internally-borne fungi (*Phomopsis* spp.), higher germination in vitro, and emergence in vermiculite and soil than control seeds treated with DCM alone. DCM has no adverse effect on germination and appears to be somewhat antifungal. Concentrations were 25/50/100/200/400/800/1600 μg/ml. Invalid exposure route.
Dichloromethane (DCM)	Grand Rapids lettuce seeds (Lactuca sativa L.)	Dark and light germination	Seeds were incubated in the dark at 25 C for 48 hours. R and FR exposure times on germination varied by study.	Soaking in chemical	-	-		Enhanced dark germination	Rao et al., 1976	Significant promotion in dark germination was observed when Grand Rapids lettuce seeds were soaked in acetone or dichloromethane, vacuum-dried, and imbibed at 25 C. Invalid exposure route.

▨ = eliminated from AL development; no data or inappropriate route of administration.

II. Calculate AL

Conc (mg/kg)	Tier II AL
	NA

Rationale: Insufficient data for AL development.

Table C-43
Methylene chloride AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Algae										
Methylene Chloride	Selenastrum capricornutum	Growth	4 days	aqueous solution (fresh water)	56	—	EC_{50} >560	In vivo Chlorophyll A and cell count	EG&G Bionomics, 1977	Static system; Nominal concentrations reported; Use EPA-600/3-75-009 to run test but study report is incomplete.
	Chlamydomonas reinhardtii	Growth	3 days	aqueous solution (fresh water)	—	—	EC_{50} = 242 (202-286)	Biomass, General Population Changes	Brack and Rottler, 1994	Static system (sealed bipartite test vessel); Measured concentrations reported with 95% confidence intervals in parentheses.
							EC_{10} = 115 (79.1-146)			
Zooplankton										
Methylene Chloride	Streptocephalus proboscideus	Mortality	1 day	aqueous solution (fresh water)	—	—	LC_{50} = 13,800 µmol [1172 mg/L]		Calleja et al., 1994	Static system; Nominal concentrations reported in µmol.
	Daphnia magna				—	—	LC_{50} = 10,700 µmol [909 mg/L]			
	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 1599 $mmol/m^3$ [135.8 mg/L]		Abernethy et al., 1986	Static closed system [no air space]; Nominal concentrations reported in $mmol/m^3$; Toxicity affected by aqueous solubility.
	Daphnia magna	Mortality	1 day	aqueous solution (fresh water)	—	—	LC_{50} = 310		LeBlanc, 1980	Static system; Nominal concentrations reported.
			2 days		—	—	LC_{50} = 220			
	Daphnia magna	Mortality	1 day	aqueous solution (fresh water)	EC_0 = 1447	—	—		Kuhn et al., 1989a	Static system with ground-glass stoppers; Nominal concentrations reported with 95% confidence intervals in parentheses.
					—	—	EC_{50} = 1959 (1871-2050)			
					—	—	EC_{100} = 2500			
			2 days		EC_0 = 1005	—	—			
					—	—	EC_{50} = 1682 (1532-1847)			
					—	—	EC_{100} = 2500			
	Daphnia magna	Mortality	1 day	aqueous solution (fresh water)	—	—	EC_{50} = 22.86 ±0.85 mM (molecular weight = 84.93) [1941.5 mg/L]		Lilius et al., 1994	Static system with polyethene cap; Nominal concentrations reported in mM.
	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	68	—	LC_{50} = 224 (104-326)		EG&G Bionomics, 1977	Static system; Nominal concentrations reported with 95% confidence intervals in parentheses; Use EPA-600/3-75-009 to run test but study report is incomplete.
Fishes										
Methylene Chloride	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 193 (140.8 -277.8)		Alexander et al, 1978	Flowthrough system; Measured concentrations reported with 95% confidence intervals in parentheses.
					—	—	LC_{50} = 310 (262-391)			Static system; Nominal concentrations reported with 95% confidence intervals in parentheses.

Table C-43
Methylene chloride AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Methylene Chloride	Pimephales promelas	Behaviour/System Effect	1 day	aqueous solution (fresh water)	—	—	EC_{10} = 68.5 (44.2-86.7)	Loss of Equilibrium; melanization; narcosis and swollen, hemorrhaging gills	Alexander et al, 1978	The EC_{50}s are based upon loss of equilibrium manifested by the fish's inability to maintain an upright position when swimming.
					—	—	EC_{50} = 112.8 (99.8-150.8)			
					—	—	EC_{90} = 220.1 (175.1-335.4)			
			2 days		—	—	EC_{10} = 66.3 (42.6-79.7)			
					—	—	EC_{50} = 99.0 (83.2-121.5)			
					—	—	EC_{90} = 147.6 (120.5-249.7)			
			3 days		—	—	EC_{10} = 66.3 (42.6-79.7)			
					—	—	EC_{50} = 99.0 (83.2-121.5)			
					—	—	EC_{90} = 147.6 (120.5-249.7)			
			4 days		—	—	EC_{10} = 66.3 (42.6-79.7)			
					—	—	EC_{50} = 99.0 (83.2-121.5)			
					—	—	EC_{90} = 147.6 (120.5-249.7)			
	Pimephales promelas	Mortality	1 day	aqueous solution (fresh water)	—	—	LC_{10} = 122 (72.7-160.8)			Flow-through system; Measured concentrations reported with 95% confidence intervals in parentheses.
					—	—	LC_{50} = 268 (213.0-346.6)			
					—	—	LC_{90} = 589 (432.6-1077.4)			
			2 days		—	—	LC_{10} = 94 (50.7-130.4)			
					—	—	LC_{50} = 265 (202.5-369.7)			
					—	—	LC_{90} = 746.3 (494.7-1712.1)			
			3 days		—	—	LC_{10} = 67.3 (32.3-98.9)			
					—	—	LC_{50} = 232.4 (172.4-337.6)			
					—	—	LC_{90} = 802 (497.4-2132.6)			
			4 days		—	—	LC_{10} = 51.2 (22.5-78.2)			
					—	—	LC_{50} = 193 (140.8-277.8)			
					—	—	LC_{90} = 722.1 (447.4-1947.1)			
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 330 (293-372)		Geiger et al., 1986	Flowthrough system; Measured concentrations reported with 95% confidence intervals in parentheses.
		Behaviour			—	—	EC_{50} = 330 (293-372)	loss of equilibrium - swim upright		The EC_{50}s are based upon loss of equilibrium manifested by the fish's inability to maintain an upright position when swimming.

Table C-43
Methylene chloride AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Methylene Chloride	Oncorhynchus mykiss hepatocytes	Cytotoxicity	3 hr	aqueous solution (fresh water)	—	—	EC_{50} = 111.3 ±4.8 mM (molecular weight = 84.93) [9453 mg/L]	86Rb-leakage from hepatocytes	Lilius et al., 1994	Liver cells were loaded with $^{86}Rb^+$ to determine radioactivity. Rubidium leakage is expressed as percentage of tracer released in relation to the total ^{86}Rb-content.
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 502 (357-855)		Dill et al., 1987	Flow-through system and embryo-larval test; Measured concentrations reported with 95% confidence intervals in parentheses.
			8 day		—	—	LC_{50} = 471 (428-517)			
		Growth	32 days		142 ±8.38	209 ±14.1	—	Larval survival		
					82.5 ±2.5	142 ±8.38	—	Body Weight		
	Lepomis macrochirus	Mortality	4 days	aqueous solution (fresh water)	170	—	LC_{50} >220 <280		EG&G Bionomics, 1977	Static system; Nominal concentrations reported with 95% confidence intervals in parentheses; Use EPA-600/3-75-009 to run test but study report is incomplete.
	Cyprinodon variegatus				100	—	LC_{50} = 250 (211-285)			

🟨 = value used for AL development. 🟪 = eliminated from AL development; non-target endpoint.

Taxonomic Group	Conc. (mg/L)	Level	UF	Tier II AL (mg/L)	Rationale
Algae	56	NOEC - Growth	1	**56**	Used lowest NOEC from a longer duration study. No UF was applied to the NOEC value.
Zooplankton	68	NOEC - Mortality	5	**13.6**	Used the lowest bounded NOEC. The NOEC value was divided by an UF of 5 to extrapolate a subchronic to chronic duration.
Fish	51.2	LC_{10} - Mortality	5	**10.24**	Used lowest measured LC_{10} value from the longest duration in the study that used a flow-though system. The LC_{10} value was divided by UF of 5 to extrapolate a subchronic to chronic duration.

Table C-44
4-Methyl-2-pentanone TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	TRV (mg/kg-day)	Specific Effect	Reference	Notes
MAMMALS								
4-Methyl-2-pentanone	rat	Liver/kidney toxicity	13 weeks	oral (gavage)	25	Liver/kidney function	Sample et al., 1996	*subchronic NOAEL converted to chronic NOAEL using UF of 10.*

Table C-45
4-Methyl-2-pentanone AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL	LOAEL	Other	Specific Effect	Reference	Notes
AQUATIC										
Algae										
4-Methyl-2-pentanone	Chlamydomonas reinhardtii	Enyzmatic Activity	2 hr	aqueous solution	-	-	EC5 = 580 mg/L	F'_0/F_0 (rise in minimum fluorescence during illumination)	Brack and Frank, 1998	*Toxicity threshold for most sensitive parameter for MIBK*
Zooplankton										
4-Methyl-2-pentanone	Daphnia magna	Mortality	24 hr	aqueous solution	EC0 = 930 mg/L	-	EC50 = 3682 mg/L	Mortality	Khun et al., 1989	
4-Methyl-2-pentanone	Daphnia magna	Reproduction	21 day	aqueous solution	78 mg/L	-	-	Mortality of parents Reproduction rate Appearance of first offspring	Khun et al., 1989	*results presented as nominal value (the nominal concentration was calculated on the basis of the result of the chemical analysis of the stock solution.)*
4-Methyl-2-pentanone	Daphnia magna	Reproduction	21 day	aqueous solution	7.8 - 3.9 mg/L	-	-	Mortality of parents Reproduction rate Appearance of first offspring	Khun et al., 1989	*results presented as minimum value (If the chemical analysis showed a loss of the tested substance of more than 20%, then the lowest analyzed concentration (minimum value) obtained during the test was also given for the NOEC.*
Fishes										
4-Methyl-2-pentanone	Pimephales promelas	Mortality	96 hr	aqueous solution	-	-	LC50 = 550 mg/L	Mortality	Brooke et al., 1984	
4-Methyl-2-pentanone	Pimephales promelas	Behaviour	96 hr	aqueous solution	-	-	EC50 = 550 mg/L	not specified	Brooke et al., 1984	*effect not specified*
4-Methyl-2-pentanone	Pimephales promelas (juvenile)	Mortality	96 hr	aqueous solution	-	-	LC50 = 537 mg/L	Mortality	Broderius and Kahl, 1985	
4-Methyl-2-pentanone	Pimephales promelas	Reproduction	31 - 33 days	aqueous solution	57 mg/L	105 mg/L	-	Egg hatchability Incidence of dev. abnormal. Survival Growth	Call et al., 1985	

🟨 = value used for AL development.

	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Algae	580	2 hr EC5 (LOEC)	1	**580**	Used single study EC5, which is equivalent to a LOEC. No UF needed since LOEC identified.
Zooplankton	3.9	21 day NOEC	1	**3.9**	Used lowest NOEC from chronic reproduction studies. No UF needed since NOEC.
Fish	57	31 - 33 day NOEC	1	**57**	Used NOEC from chronic reproduction study. No UF needed since NOEC.

Table C-46
n-Propylbenzene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL	LOAEL	Specific Effect	Reference	Notes	Molecular Weight	Converted LOAEL (mg/kg-day)
MAMMALS											
n-Propylbenzene	Sprague-Dawley Rats	Ototoxicity	2 weeks	Gavage (Olive Oil)		8.47 mmol/kg-day	Number of missing hair cells	Gagnaire and Langlais, 2005	*No deaths occurred with n-Propylbenzene; animals were sacrificed 10 days after last treatment. Authors stated that dose level used caused no other effects.*	120.2 g/mol (equal to 120.2 mg/mmol)	1018
n-Propylbenzene	Rabbits	Liver and kidney function	6 months	Gavage	2.5 mg/kg-day		Red cell loss & protein function for liver and kidneys	National Academy of Sciences, 1977	*Red cell count/destruction and mild protein dystrophy of the liver and kidneys (all not significant). NAS (1977) presents this information as a summary from Gerarde and Ahlstrom (1966) but the citation is not provided and the corresponding article could not be identified.*		
n-Propylbenzene	Sprague-Dawley Rats	Enzyme expression	3 days	i.p. injections in corn oil		10 mmol/kg-day	Body & Liver weights and Cytochrome P450	Backes et al., 1993		120.2 g/mol (equal to 120.2 mg/mmol)	1202

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	LOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	1018	40	**25**
Lemming	1018	20	**51**
Weasel	1018	40	**25**

Rationale:

Used longest study that provided sufficient details for TRV development.

Used a UF of 10 to extrapolate to a chronic NOAEL from the subchronic LOAEL.

Taxonomic UF of 4 reflects different Order, same Class.

Taxonomic UF of 2 reflects different Family, same Order.

Taxonomic UF of 4 reflects different Order, same Class.

Table C-47
n-Propylbenzene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

Site - Related Chemical	Test Species	Endpoint	Duration	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Notes
AQUATIC										
Algae and Other Phytoplankton										
n-Propylbenzene	Chlorella vulgaris	Photosynthesis	3 hr	aqueous solution (fresh water)	—	—	EC50 = 135 mmol/m^3 (16.2 mg/L)	$^{14}CO_2$ uptake	Hutchinson et al., 1980	*three to four day exponential phase cells used, nominal concentrations*
n-Propylbenzene	Chlamydomonas angulosa	Photosynthesis	3 hr	aqueous solution (fresh water)	—	—	EC50 = 150 mmol/m^3 (18 mg/L)	$^{14}CO_2$ uptake	Hutchinson et al., 1980	*three to four day exponential phase cells used, nominal concentrations*
n-Propylbenzene	Selenastrum capricornutum	Growth	72 hr	aqueous solution (fresh water)	—	—	EC50 = 1.8 mg/L	50% growth inhibition	Galassi et al., 1988	*Measured concentrations reported*
Zooplankton										
n-Propylbenzene	Daphnia magna	Mortality	1 day	aqueous solution (fresh water)	—	—	EC50 = 2.0 (1.34-2.97) mg/L	Immobilization	Tosato et al., 1991	*Measured concentrations reported*
n-Propylbenzene	Daphnia magna	Mortality	1 day	aqueous solution (fresh water)	—	—	LC50 = 2 mg/L	Immobilization	Galassi et al., 1988	*Measured concentrations reported*
Fishes										
n-Propylbenzene	Salmo gairdneri	Mortality	4 days	aqueous solution (fresh water)	—	—	LC50 = 1.55 mg/L	Mortality	Galassi et al., 1988	*Measured concentrations reported*
n-Propylbenzene	Bryconamericus iheringii	Mortality	4 days	aqueous solution (fresh water)	—	—	LC50 = 5.63 (3.75-7.84) mg/L	Mortality	Di Marzio & Saenz, 2004	*Measured concentrations reported. Tropical species endemic to Brazil.*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Zooplankton	2	EC50	10	**0.20**	Both EC50 and LC50 values are the same; both studies based on measured concentrations. Divided by UF of 10 to convert to LOEC.
Algae	1.8	EC50	10	**0.18**	Used the measured study; this was also the longest study. Divided by UF of 10 to convert EC50 to LOEC.
Fish	1.55	LC50	10	**0.16**	Used lowest LC50 from measured studies; this was also the cold water species of the two tested. Divided by UF of 10 to convert to LOEC.

Table C-48
Tetrachloroethene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other (as specified)	Specific Effect	Reference	Notes
MAMMALS										
Tetrachloroethene	Rats (22 -30 days)	Mortality	14 days	stomach tube	-	-	Female LC50 = 3835 mg/kg	Mortality	Hayes et al., 1986b	
Tetrachloroethene	Rats (22 -30 days)	Mortality	14 days	stomach tube	-	-	Male LC50 = 3005 mg/kg	Mortality	Hayes et al., 1986b	
Tetrachloroethene	Rats (22 -30 days)	Organ weights	90 days	drinking water	14	400	-		Hayes et al., 1986b	*Results presented but not transformed to NOELs, LOELs or ECxs*
Tetrachloroethene	Mice (3-5 months)	Hepatotoxicity	6 weeks	gavage	20	100	-	Liver weight Liver G6P activity Triglyceride numbers Serum SGPT activity	Buben and O'Flaherty, 1985	*Results presented but not transformed to NOELs, LOELs or ECxs*

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	LOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	14	20	0.7
Lemming	14	10	1.4
Weasel	14	20	0.7

Rationale:

Used lowest NOAEL; subclinical effects.
No chronic study, but subclinical effects.
Divided by UF of 5 for this chemical based on nature of effects (and duration), but lack of reproduction or growth studies.
The subclinical LOAEL is 25 times higher than the NOAEL, indicating sufficient safety without additional UF.
Taxonomic UF of 4 reflects different Order, same Class.
Taxonomic UF of 2 reflects different Family, same Order.

Table C-49
Toluene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration	Route	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Other (as specified)	Specific Effect	Reference	Test Sp. Body Weight (BWt) (kg)	Ingestion Rate (IRt) (g/g-day)	Notes
MAMMALS													
Toluene	T1	Mice	Reproductive	10 days	Gavage	-	.3 ml/kg-d	-	Embryonic resorption Fetal weight Malformations	Nawrot and Staples, 1979	-		*Abstract only* *Females days 6 - 15 or 12 - 15 of gestation*
Toluene	T2	Rats	Mortality	Acute (single dose)	Stomach tube	-	-	LC50 =7.0 mg/kg	Death	Wolf et al., 1956	-		
Toluene	T2	Rats	Organ Histopathology and Growth	193 days (138 feedings)	Stomach tube	590	-	-	Liver/kidney weight and histopathology Growth	Wolf et al., 1956	-		*Dose regime = 118, 354 and 590 mg/kg/d*
Toluene	T2	Rabbits	Irritation	2 - 4 wks	Direct application to ear and abdomen	-	-	-	Erythema Exfoliation Edema/superficial necrosis	Wolf et al., 1956	-		*Effects not quantified; Slight to moderate irritation and slight necrosis noted*
Toluene	T2	Rabbits	Conjuctival Irritation Corneal Injury	Acute	Direct application of 2 drops	-	-	-	Irritation Inflammation/swelling Necrosis (cornea)	Wolf et al., 1956	-		*Effects not quantified; slight conjunctival irritation and no coneral injury noted*
Toluene	T3	Rats (F344/N)	Hematological Histological Morphology	13 wks	Gavage	12.48	25	-	increased liver and kidney weights	National Toxicology Program Tech. Report Series (No 371)	0.25	0.04	*Studies conducted at 312, 625 and 1250 mg/kg. 2-yr inhalation study not used since less relevant pathway.*
Toluene	T3	Mice (B6C3F)	Hematological Histological Morphology	13 wks	Gavage	250	500	-	neurological	National Toxicology Program Tech. Report Series (No 371)	0.023	0.2	*Studies conducted at 312, 625, 1250, 2500, and 5000 mg/kg. 2-yr inhalation study not used since less relevant pathway.*

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	subchronic NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	12.48	20	0.62
Lemming	12.48	10	1.25
Weasel	12.48	20	0.62

Rationale:

Used lowest NOAEL since geomean of three NOAELs was above the lowest paired LOAEL.

Divided by UF of 5 to convert from subchronic to chronic duration.
Taxonomic UF of 4 reflects different Order, same Class.
Taxonomic UF of 2 reflects different Family, same Order.
Taxonomic UF of 4 reflects different Order, same Class.

Table C-50
Toluene AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other Endpoint	Specific Effect	Reference	Notes
TERRESTRIAL PLANTS											
Toluene		Corn	Growth	nr	Lakeland sand	-	-	EC10 = 200 mg/kg	Yield	Overcash et al., 1982	results cited from Overcash et al. 1981, Water Resources Research Institute, Raleigh, NC. Report No 171.
Toluene		Soybean	Growth	nr	Lakeland sand	-	-	EC10 = 800 mg/kg	Yield	Overcash et al., 1982	results cited from Overcash et al. 1981, Water Resources Research Institute, Raleigh, NC. Report No 171.
Toluene		Fescue	Growth	nr	Lakeland sand	-	-	EC10 = 2000 mg/kg	Yield	Overcash et al., 1982	results cited from Overcash et al. 1981, Water Resources Research Institute, Raleigh, NC. Report No 171.

🟨 = value used for AL development.

II. Calculate AL

Endpoint	Conc (mg/kg)	Tier II AL
EC10	200	
EC10	800	684
EC10	2000	
GeoMean	**684**	

Rationale:

Select three EC10 values for growth.

Calculate geomean for three values.

Tier II AL is the geomean; no UF necessary since EC10 endpoint.

Table C-51
Toluene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other Endpoint	Specific Effect	Reference	Notes
AQUATIC											
Algae											
Toluene	T1	Chlamydomonas reinhardtii (green algae)	Enyzmatic Activity	2 hr	aqueous solution	-	-	EC10 = 13 mg/L	ATP inhibition (indirect)	Brack and Frank, 1998	*Toxicity threshold for most sensitive parameter; headspace concentrations were measured to determine effective concentrations in test cultures*
Toluene		Chlorella vulgaris	Photosynthesis Inhibition	3 hours	aqueous solution	-	-	EC$_{50}$ = 133.6 mg/L	$^{14}CO_2$ uptake	Hutchinson et al., 1980	*three to four day exponential phase cells used; assume nominal concentrations*
Toluene		Chlamydomonas angulosa	Photosynthesis Inhibition	3 hours	aqueous solution	-	-	EC$_{50}$ = 207.3 mg/L	$^{14}CO_2$ uptake	Hutchinson et al., 1980	*three to four day exponential phase cells used; assume nominal concentrations*
Toluene		Selenastrum capricornutum	Growth	72 hr	aqueous solution	-	-	EC50 = 12.5 mg/L	Cell count	Galassi et al., 1988	*Authors maintained steady concentration throughout study; measured concentrations*
Zooplankton											
Toluene		Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC$_{50}$ = 111.5 mg/L	Mortality	Bobra et al., 1983	*closed system; 4 - 6 day olds; log concentration - mortality curve; nominal concentrations*
Toluene		Daphnia magna	Mortality	24	aqueous solution	NOEC = 28 mg/L	-	LC50 = 310 mg/L	Mortality	LeBlanc, 1980	*no details on NOEC concentration; nominal concentrations*
Toluene		Daphnia magna	Mortality	48	aqueous solution	NOEC = 28 mg/L	-	LC50 = 310 mg/L	Mortality	LeBlanc, 1980	*nominal concentrations*
Toluene		Daphnia magna	Immobilization	24 hr	aqueous solution	-	-	LC50 = 7 mg/L	Immobilization	Galassi et al., 1988	*Closed system; measured concentrations*
Toluene		Daphnia magna	Enzymatic Inhibition	1 hr	aqueous solution	-	-	LC 50 = 3.6 mg/L	Fluorescence	Janssen and Persoone, 1993	*nominal concentrations*
Toluene		Daphnia magna	Mortality	24 hr	aqueous solution	-	-	LC50 = 8.0 mg/L	Mobility	Janssen and Persoone, 1993	*nominal concentrations*
Toluene		Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 6.0 mg/L	Mobility	Janssen and Persoone, 1993	*nominal concentrations*
Toluene		Daphnia magna	Reproduction	21 d	aqueous solution	2 mg/L		LC50 = 84 mg/L	death of parents more sensitive than emergence of offspring	Kuhn et al., 1989b	*water renewed 2x/wk; nominal concentration*
Toluene		Daphnia magna	Immobilization	24 hr	aqueous solution	-	-	EC50 = 7 mg/L	Immobilization	Tosato et al., 1991	*measured concentrations (start and end of study)*
Toluene		Daphnia magna	Mortality	48 hr	aqueous solution			EC50 = 19.6 mg/L	Immobilization	Pearson et al., 1979	*nominal concentrations*
Toluene		Ceriodaphnia dubia (<24 hr)	Mortality	24 hr	aqueous solution	-	-	LC50 = 9.0 mg/L	Mobility	Marchini et al., 1993	*static system; LC50 calculated using trimmed Spearman-Karber method; stock solutions were measured and exposure concentrations were extrapolated*
Fish											
Toluene	F1	Lepomis macrochirus (Bluegill)	Mortality	24 hr	Soft water	-	-	LC50 = 24 mg/L	Mortality	Pickering and Henderson, 1966	*assume nominal concentrations*
Toluene	F1	Lepomis macrochirus (Bluegill)	Mortality	48 hr	Soft water	-	-	LC50 = 24 mg/L	Mortality	Pickering and Henderson, 1966	*assume nominal concentrations*

Table C-51
Toluene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other Endpoint	Specific Effect	Reference	Notes
AQUATIC											
Toluene	F1	Lepomis macrochirus (Bluegill)	Mortality	96 hr	Soft water	-	-	LC50 = 24 mg/L	Mortality	Pickering and Henderson, 1966	*assume nominal concentrations*
Toluene	F2	Pimephales promelas	Growth	32 d	aqueous solution	4 mg/L	6 mg/L	-	Weight gain	Devlin et al., 1982	*measured tank concentrations (does not indicate frequency)*
Toluene	F1	Pimephales promelas	Mortality	24 hr	Soft water	-	-	LC50 = 46.31 mg/L	Mortality	Pickering and Henderson, 1966	*Endpoint concentrations = median tolerable concentrations (calculated from mortalities in difference test concentrations causing 50% mortality during time interval (straight line graphical interpolation from percent survival and lot concentrations of chemicals); assume nominal concentrations*
Toluene	F1	Pimephales promelas	Mortality	48 hr	Soft water	-	-	LC50 = 46.31 mg/L	Mortality	Pickering and Henderson, 1966	*assume nominal concentrations*
Toluene	F1	Pimephales promelas	Mortality	96 hr	Soft water	-	-	LC50 = 34.27 mg/L	Mortality	Pickering and Henderson, 1966	*assume nominal concentrations*
Toluene	F1	Pimephales promelas	Mortality	24 hr	Hard water	-	-	LC50 = 56 mg/L	Mortality	Pickering and Henderson, 1966	*assume nominal concentrations*
Toluene	F1	Pimephales promelas	Mortality	48 hr	Hard water	-	-	LC50 = 56 mg/L	Mortality	Pickering and Henderson, 1966	*assume nominal concentrations*
Toluene	F1	Pimephales promelas	Mortality	96 hr	Hard water	-	-	LC50 = 42.33 mg/L	Mortality	Pickering and Henderson, 1966	*assume nominal concentrations*
Toluene	F2	Pimephales promelas (embryo)	Mortality	96 hr	aqueous solution	-	-	LC50 = 55 - 72 mg/L	Mortality	Devlin et al., 1982	*range provided b/c each study conducted with 4 different dilution series; continuous flow; measured tank concentrations (does not indicate frequency)*
Toluene	F2	Pimephales promelas (protolarva)	Mortality	96 hr	aqueous solution	-	-	LC50 = 25 -36 mg/L	Mortality	Devlin et al., 1982	*range provided b/c each study conducted with 4 different dilution series; continuous flow; measured tank concentrations (does not indicate frequency)*
Toluene	F2	Pimephales promelas (30 day old)	Mortality	96 hr	aqueous solution	-	-	LC50 = 18 - 31 mg/L	Mortality	Devlin et al., 1982	*range provided b/c each study conducted with 4 different dilution series; continuous flow; measured tank concentrations (does not indicate frequency)*
Toluene	F3	Pimephales promelas (juveniles = 26 - 37 d)	Mortality	96 hr	aqueous solution	-	-	LC50 = 36.2 mg/L	Mortality	Geiger et al., 1986	*measured concentrations*
Toluene	F3	Pimephales promelas (juveniles = 26 - 37 d)	Behavior	96 hr	aqueous solution	-	-	EC50 = 14.6 mg/L	Loss of equilibrium while swimming	Geiger et al., 1986	*measured concentrations*
Toluene	F4	Pimephales promelas (juveniles = <28 d)	Mortality	96 hr	aqueous solution	-	-	LC50 = 17 mg/L	Mortality	Marchini et al., 1993	*stock solutions were measured and exposure concentrations were extrapolated*
Toluene	F4	Pimephales promelas (juveniles = 28 - 33 d)	Survival	ELS (32 - 33 day)	aqueous solution	10.8 mg/L	22.8 mg/L	-		Marchini et al., 1992	*NOEC/LOEC based on personal communication by the author; measured concentrations*

Table C-51
Toluene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other Endpoint	Specific Effect	Reference	Notes
AQUATIC											
Toluene	F4	Pimephales promelas (juveniles = 28 - 33 d)	Growth	ELS (32 - 33 day)	aqueous solution	6.9 mg/L	10.8 mg/L	-		Marchini et al., 1992	*NOEC/LOEC based on personal communication by the author ; measured concentrations*
Toluene	F4	Pimephales promelas (larvae = < 24 hr old)	Mortality	96 hr	aqueous solution	-	-	LC50 = 17.03 mg/L	Mortality	Marchini et al., 1992	*Flow through test conditions ; measured concentrations*
Toluene	F4	Pimephales promelas (larvae = < 24 hr old)	Mortality	7 day	aqueous solution	-	-	LC50 = 9.39 mg/L	Mortality	Marchini et al., 1992	*measured concentrations*
Toluene	F4	Pimephales promelas (larvae = < 24 hr old)	Survival	7 day	aqueous solution	5.4 mg/L	8.0 mg/L	-	Mortality	Marchini et al., 1992	*NOEC/LOEC determined by means of hypothesis testing statistics ; measured concentrations*
Toluene	F4	Pimephales promelas (larvae = < 24 hr old)	Growth	7 day	aqueous solution	5.4 mg/L	8.0 mg/L	-	Dry Weight	Marchini et al., 1992	*NOEC/LOEC determined by means of hypothesis testing statistics; measured concentrations*
Toluene	F4	Pimephales promelas (larvae = < 24 hr old)	Growth	7 day	aqueous solution	-	-	IC25 = 6.88 mg/L	Dry Weight # Survivors	Marchini et al., 1992	*ICs estimated by point estimation technique using monotone smoothing and linear interpolation procedure ; measured concentrations*
Toluene	F4	Pimephales promelas (larvae = < 24 hr old)	Growth	7 day	aqueous solution	-	-	IC50 = 10.16 mg/L	Dry Weight # Survivors	Marchini et al., 1992	*ICs estimated by point estimation technique using monotone smoothing and linear interpolation procedure ; measured concentrations*
Toluene	F4	Pimephales promelas (larvae = < 24 hr old)	Biomass	7 day	aqueous solution	-	-	IC25 = 6.53 mg/L	Dry Weight # Original	Marchini et al., 1992	*measured concentrations*
Toluene	F4	Pimephales promelas (larvae = < 24 hr old)	Biomass	7 day	aqueous solution	-	-	IC50 = 7.62 mg/L	Dry Weight # Original	Marchini et al., 1992	*measured concentrations*
Toluene	F5	Pimephales promelas	Development	1-5 days	aqueous solution		30-44 mg/L		reduced growth	Devlin et al., 1985	*some abnormalities in young fish; measured concentrations at start of test*
Toluene	F6	Pimephales promelas (fry)	Mortality	96 hr	aqueous solution			LC50 = 56.4 mg/L	Mortality	Mayes et al., 1983	*nominal concentrations*
Toluene	F6	Pimephales promelas (juvenile)	Mortality	96 hr	aqueous solution			LC50 = 77.4 mg/L	Mortality	Mayes et al., 1983	*nominal concentrations*
Toluene	F6	Pimephales promelas (subadult)	Mortality	96 hr	aqueous solution			LC50 = 54 mg/L	Mortality	Mayes et al., 1983	*nominal concentrations*
Toluene	F6	Pimephales promelas	Mortality	96 hr	aqueous solution			LC50 = 12.6 mg/L	Mortality	Pearson et al., 1979	*nominal concentrations*
Toluene	F7	Poecilia reticulato	Mortality	96 hr	aqueous solution	-	-	LC50 = 28.2 mg/L	Mortality	Galassi et al., 1988	*Test solution renewed at 48 hrs; measured concentrations*
Toluene	F7	Salmo gairdneri	Mortality	96 hr	aqueous solution	-	-	LC50 = 5.8 mg/L	Mortality	Galassi et al., 1988	*Test solution renewed at 48 hrs; measured concentrations*

Table C-51
Toluene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other Endpoint	Specific Effect	Reference	Notes
AQUATIC											
Toluene	F8	Daphnia magna	Body burden	48 hr	aqueous solution	-	-	21.2 mg/L ***		Pawlisz and Peters, 1993	*This was not a toxicological study. The authors were interested in body burdens of radiolabels at LC50 concentrations determined in other studies. (*** LC50 from Veith et al. In Aquatic Toxicology (book) American Society for Testing and Materials. 1980 pgs 116-129.)*
Toluene	F8	Daphnia magna	Body burden	48 hr	aqueous solution	-	-	53.1 mg/L		Pawlisz and Peters, 1995	*Investigation into the effect of sublethal vs lethal exposures compared to body burdens. LC50 used were obtained from other studies. (*** no reference given for LC50 value)*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	**Rationale:**
Algae	12.5	EC50	10	**1.25**	Used lowest EC50 of measured studies since lower than reported EC10. Divided by UF of 10 to convert from EC50 to LOEC.
Zooplankton	7	LC50	10	**0.70**	Used LC50 values from measured studies; both the same value. UF of 10 used to extrapolate from LC50 to LOEC.
Fish	4	NOEC	1	**4.0**	Six values based on measured studies; three NOECs. Used lowest NOEC of measured studies; also had longest duration. No UF needed since chronic NOEC used.

Table C-52
1,1,1-Trichloroethane TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Specific Effect	Reference	Test Sp. Body Weight (BWt) (kg)	Ingestion Rate (IRt) (g/g-d)	Notes
MAMMALS												
1,1,1-TCA	TCA1	Mouse	reproductive, developmental	3 generations	OW	1000	NA	None found	Lane et al., 1982	0.035	6 ml/d	*3 generation, 3 dose levels, continuous exposure*
1,1,1-TCA	TCA2	Rat	developmental	60-70	OW	2.6	NA	None found	George et al., 1989	NR	NR	*F1 followed through weaning, 3 dose levels*
1,1,1-TCA	TCA3	Rat	body weight	90	OF	310	600	reduced BW gain, inc. liver wt	NTP, 2000a	0.19	NR	*5 dose levels*
1,1,1-TCA	TCA3	Mouse	cancer, general	90	OF	ND	800	reduced BW gain	NTP, 2000a			

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
NOAEL	1000	--	
NOAEL	2.6	--	
NOAEL	310	--	
Geomean	93.1	1	**93.1**
Shrew	93.1	4	**23.3**
Lemming	93.1	2	**46.5**
Weasel	93.1	4	**23.3**

Rationale:

Three NOAELs for relevant endpoints (reproduction and growth).
Calculated geometric mean.
No UF needed since chronic study (3 generations) and NOAELs.

Taxonomic UF of 4 reflects different Order, same Class.
Taxonomic UF of 2 reflects different Family, same Order.
Taxonomic UF of 4 reflects different Order, same Class.

Table C-53
1,1,1-Trichloroethane AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	EC (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC											
Algae											
1,1,1-TCA	TCA2	Chlamydomonas	photosynthesis	14	Water	NA	31	NA	reduced fluorescence	Brack and Frank, 1998	*EC20; bioassay test; headspace concentrations were measured to determine effective concentrations in test cultures*
Zooplankton											
1,1,1-TCA	TCA3	Brachionis	lethality	1	Water	NA	NA	48100 uM/L	death	Calleja et al., 1994	*6,420 mg/; nominal concentrations*
1,1,1-TCA	TCA1	Daphnia	Lethality	2	Water	530	NA	NA	Lethality	LeBlanc, 1980	*nominal concentrations*
1,1,1-TCA	TCA3	Daphnia	lethality	1	Water	NA	NA	6860 uM/L	death	Calleja et al., 1994	*50 chemical; nominal concentrations*
1,1,1-TCA	TCA3	Streptocephalus	lethality	1	Water	NA	NA	9850 uM/L	death	Calleja et al., 1994	*nominal concentrations*
1,1,1-TCA	TCA5	Daphnia	death, reproduction	17	Water	1.3	NA	5.4	death	Thompson and Carmichael, 1989	*semi-static; repro LOEC = 2.4; measured concentrations at start and end of study, used mean concentration for reporting*
Fish											
1,1,1-TCA	TCA4	Pimephales	lethality	4	Water	NA	NA	52.8	death	Alexander et al., 1978	*flow through test; LC10 =30.8; measured concentrations*
1,1,1-TCA	TCA4	Pimephales	equilibrium	4	Water	NA	9/11.1	NA	loss of equilibrium, EC10/50	Alexander et al., 1978	*measured concentrations*
1,1,1-TCA	TCA6	Pimephales	lethality	4	Water	NA	NA	52.9	death	Geiger et al., 1986	*measured concentrations*
1,1,1-TCA	TCA6	Pimephales	lethality	4	Water	NA	28.8	42.3	death	Geiger et al., 1986	*EC50 for equilibrium loss; measured concentrations*
1,1,1-TCA	TCA7				Water					Cowgill, 1987	*not applicable - critical review of tests; nominal concentrations*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale:
Algae	31	EC20	1	**31**	Used single EC20 value. No UF needed since EC20 and chronic study.
Fish	9.0	EC10	1	**9.0**	Used EC10 value from measured study, which is below other EC and LC values. No UF needed since EC10.
Zooplankton	1.3	NOEC	1	**1.3**	No UF needed since NOEC.

Table C-54
Trichloroethene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	LOAEL (mg/kg-d)	Specific Effect	Reference	Test Sp. Body Weight (BWt) (kg)	Ingestion Rate (IRt) (g/g-d)	Notes
MAMMALS										
Trichloroethene	Mice (3-5 months)	Hepatotoxicity	6 weeks	gavage	100	Increased liver weights Liver G6P activity Triglyceride numbers Serum SGPT activity	Buben and O'Flaherty, 1985	NA	NA	*Results presented but not transformed to NOELs, LOELs or Ecxs*
Trichloroethene	Rats	Histopathology Renal Toxicity Morphology	2 years	Gavage	17.5	various	National Toxicology Program Tech. Report Series (No 273) 1988	285 g	3.5	*wt at end - wt. at start, average of both sexes.*
Trichloroethene	Mice	Body Weights Kidney nepropathy Pathology	2 years	Gavage	200	various	National Toxicology Program Tech. Report Series (No 243) 1990a	31 g	0.2 (estimated from literature)	*wt at end - wt. at start, average of both sexes.*
Trichloroethene	Rats	Body Weights Kidney Nephropathy Survival Pathology	2 years	Gavage	🟨 22	various	National Toxicology Program Tech. Report Series (No 243) 1990a	223 g	4.4	*wt at end - wt. at start, average of both sexes.*

🟨 = Value used in identifying TRV

rat ingestion rate of 10 g/d from zinc studies.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	LOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	22	20	**1.1**
Lemming	22	10	**2.2**
Weasel	22	20	**1.1**

Rationale:

Used lowest LOAEL that included growth as an endpoint.
Chronic LOAEL divided by UF of 5 to extrapolate to NOAEL.

Taxonomic UF of 2 reflects different Family, same Order.
Taxonomic UF of 4 reflects different Order, same Class.

Table C-55
1,2,4-Trimethylbenzene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL (ppm)	LOAEL (ppm)	Specific Effect	Reference	Notes	NOAEL (mg/m^3)	LOAEL (mg/m^3)	Body Weight (kg)	Body Weight (kg)	Inhalation Rate (m3/d)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Hour/day adjustment	Day/Week adjustment	Adjusted NOAEL (mg/kg/day)	Adjusted LOAEL (mg/kg/day)
MAMMALS																				
1,2,4-Trimethylbenzene (pseudocumene)	Sprague-Dawley Rats	Maternal effects (growth)	21 days (exposure = 7 hours/day, days 6 - 20 of gestation)	Inhalation	300	600	Maternal weight gain and food consumption	Saillenfait et al., 2005	*Concentrations used include 0, 100, 300, 600 and 1200 ppm; maternal body weights were recorded on GD 0, 6, 13, and 21.*	1474.85	2949.69	0.19	0.18 - 0.20	0.20	1589.39	3178.76	0.29	1.00	463.57	927.14
1,2,4-Trimethylbenzene (pseudocumene)	Sprague-Dawley Rats	Fetal effects	21 days (exposure = 7 hours/day, days 6 - 20 of gestation)	Inhalation	300	600	Developmental toxicity	Saillenfait et al., 2005	*Concentrations used include 0, 100, 300, 600 and 1200 ppm; females were killed on GD 21 - maternal/fetal observations/measurements were performed.*	1474.85	2949.69	0.19	0.18 - 0.20	0.20	1589.39	3178.76	0.29	1.00	463.57	927.14
1,2,4-Trimethylbenzene (pseudocumene)	Sprague-Dawley Rats	Survival	104 weeks (4 days/week, starting at 7 weeks of age)	Gavage	NA	NA	Survival	Maltoni et al., 1997	*Only one dose (800 mg/kg) administered as a solution in 1 mL of extra virgin olive oil. 100 rats (50 male, 50 female) were examined.*											
1,2,4-Trimethylbenzene (pseudocumene)	Sprague-Dawley Rats	Carcinogenicity	105 weeks (4 days/week, starting at 7 weeks of age)	Gavage	NA	NA	Carcinogenicity (Measured as Tumor Incidence)	Maltoni et al., 1997	*The survival rate may have influenced the tumor incidence. Authors state that carcinogenicity of 1,2,4-trimethylbenzene is supported by the observation of rare cancerous tumors, called neuroesthesioepitheliomas. The authors rank 1,2,4-trimethylbenzene as more carcinogenic than ethylbenzene, xylenes, and toluene (benzene).*											
1,2,4-Trimethylbenzene (pseudocumene)	rats	Neurotoxic effects (rotarod Performance Test)		Inhalation	25	100		Korsak et al. 1995	*EC50 = 954 ppm; Authors do not provide statistical analysis to indicate whether the reported effect is significant. Authors conclude: "Rotarod performance test revealed also neurotoxic effects of the compound during and 14 days after 90-day repeated exposure. Based on the respiratory tract irritation, hematopoietic and neurotoxic effects a NOAEL of 25 ppm and LOAEL of 100 ppm is proposed."*											
1,2,4-Trimethylbenzene (pseudocumene)	rats	Pathological changes to respiratory system, erythropenia, leucocytosis, and deacresed coagulation time.		Inhalation				Korsak et al. 1995	*EC50 = 954 ppm*											
1,2,4-Trimethylbenzene (pseudocumene)	mice	Sensory respiratory tract irritation		Inhalation				Korsak et al. 1995	*EC50 = 1155 ppm*											
1,2,4-Trimethylbenzene (pseudocumene)	Balb/C mice (RD50)	Respiration Rate		Inhalation				Korsak et al. 1995	*EC50 = 578 ppm*											

🟨 = Value used in identifying TRV

Saillenfait et al. reports a range of initial body weights of 0.18-0.20 kg, thus 0.19 kg was used.

Time Weighed Average Body weights were based on the weight gain of the control animals (0.131 kg over duration of experiment).

Conversion

ppm	100	300	600.00
mg/m3	491.62	1474.85	2949.69

Based on MW = 120.2

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	463.6	20	**23.2**
Lemming	463.6	10	**46.4**
Weasel	463.6	20	**23.2**

Rationale:

Used lowest NOAEL for relevant endpoint (reproduction)

Divided by UF of 5 for subchronic to chronic

Taxonomic UF represents different Order, same Class

Taxonomic UF represents different Family, same Order

Taxonomic UF represents different Order, same Class

Table C-56
1,2,4-Trimethylbenzene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Others (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
1,2,4-Trimethylbenzene	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 30 mmol/m^3 (3.61 mg/L)		Bobra et al., 1983	Static, closed system (no air space); nominal concentrations reported in mmol/m^3.
Fishes										
1,2,4-Trimethylbenzene	Oncorhynchus mykiss	No Stress Observed	1 day	aqueous solution (fresh water)	5	—	—		Applegate et al., 1957	Static system; Nominal concentrations reported.
	Petromyzon marinus									
	Tilapia zillii	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 22.4 (20.2-24.1)		El-Sayed et al., 1995	Static system; Nominal concentrations reported.
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 7.72 (7.19-8.28)		Geiger et al., 1986	Flow-through mini-diluter system; Measured concentrations reported.

🟨 = value used for AL development.

Taxonomic Group	Conc. (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	**Rationale**
Zooplankton	3.61	EC_{50} - Immobility	10	**0.36**	Used a single LC_{50} value from a study that used a closed system. The LC_{50} value was divided by an UF of 10 to extrapolate to LOEC value.
Fish	7.72	LC_{50} - Mortality	10	**0.77**	Used lowest measured LC_{50} value from a longer duration study that used a flow-though system. The LC_{50} value was divided by an UF of 10 to extrapolate to LOEC value. The NOEC value from Applegate et al., 1957 was not used in final calculation because of the following factors: 1. Study used a static test system rather than a flow-through system. 2. Toxicological values were reported as nominal concentrations. 3. Study duration was shorter than the other available studies. 4. The unbounded NOEC carries a high amount of uncertainty for the value.

Table C-57
1,3,5-Trimethylbenzene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	**Test Species**	**Endpoint**	**Duration**	**Route**	**NOAEL (ppm)**	**LOAEL (ppm)**	**Specific Effect**	**Reference**	**Notes**	NOAEL (mg/m3)	LOAEL (mg/m3)	Body Weight (kg)	Body Weight (kg)	Inhalation Rate (m3/d)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Hour/day adjustment	Day/Week adjustment	Adjusted NOAEL (mg/kg/day)	Adjusted LOAEL (mg/kg/day)
MAMMALS																				
1,3,5-Trimethylbenzene (mesitylene)	Sprague-Dawley Rats	Maternal effects (growth)	21 days (exposure = 7 hours/day, days 6 - 20 of gestation)	Inhalation	100	300	Maternal weight gain and food consumption	Saillenfait et al., 2005	*Concentrations used include 0, 100, 300, 600 and 1200 ppm;* *maternal body weights were recorded on GD 0, 6, 13, and 21.*	491.6	1474.9	0.19	0.18 - 0.20	0.03	66.2	198.7	0.29	1	19.3	57.9
1,3,5-Trimethylbenzene (mesitylene)	Sprague-Dawley Rats	Fetal effects	21 days (exposure = 7 hours/day, days 6 - 20 of gestation)	Inhalation	300 (males), 600 (females), 600 (All fetuses)	600 (males), 1200 (females), 1200 (all fetuses)	Fetal body weight	Saillenfait et al., 2005	*Concentrations used include 0, 100, 300, 600 and 1200 ppm;* *females were killed on GD 21 - maternal/fetal observations/measurements were then performed.*	1474.9	2949.7	0.19	0.18 - 0.20	0.03	198.7	397.3	0.29	1	57.9	115.9
1,3,5-Trimethylbenzene (mesitylene)	Sprague-Dawley Rats	Fetal effects	21 days (exposure = 7 hours/day, days 6 - 20 of gestation)	Inhalation	100	300	Developmental toxicity	Saillenfait et al., 2005	*Concentrations used include 0, 100, 300, 600 and 1200 ppm;* *females were killed on GD 21 - maternal/fetal observations/measurements were performed.*	491.6	1474.9	0.19	0.18 - 0.20	0.03	66.2	198.7	0.29	1	19.3	57.9

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	**19.3**	**20**	**0.97**
Lemming	**19.3**	**10**	**1.9**
Weasel	**19.3**	**20**	**0.97**

Rationale:

Used lowest NOEC; reproduction endpoint

Divided by UF of 5 for subchronic to chronic

Taxonomic UF represents different Order, same Class

Taxonomic UF represents different Family, same Order

Taxonomic UF represents different Order, same Class

Conversion

ppm	100	300	600
mg/m3	491.6	1475	2950

(Based on MW = 120.2)

Table C-58
Vinyl chloride TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL	LOAEL	Specific Effect	Reference	Notes	NOAEL (mg/m^3)	LOAEL (mg/m^3)	Body Weight (kg)	Inhalation Rate (m^3/d)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Hour per week adjustment	Week per day adjustment	Adjusted NOAEL (mg/kg/day)	Adjusted LOAEL (mg/kg/day)		GeoMean Calculation	GeoMean Calculation
MAMMALS																					(mg/m^3)	(mg/kg-d)
Vinyl Chloride	Wistar Rats	Growth	6 hr/d, 6 d/wk, 18 months	Inhalation	25.6 mg/m3	255.6 mg/m3	Body Weight	Bi et al., 1985	*concentrations = 10, 100 and 3000 ppm* *exposures 6 h/d, 6 d/week, 18 months* *NOAEL = 10ppm, LOAEL = 100 ppm*	25.60	255.6	0.462	0.425	23.52	234.86	0.250	0.857	5.041	50.328		25.6	5.041
Vinyl Chloride	Wistar Rats	Growth	6 hr/d, 6 d/wk, 18 months	Inhalation		255.6 mg/m3	Testes:Body Weight Ratio	Bi et al., 1985	*Limited results for this endpoint (I.e no 12 month or 10 ppm results)* *LOAEL = 100 ppm*		255.6	0.462	0.425		234.86	0.250	0.857		50.328		127.8	63.013
Vinyl Chloride	Wistar Rats	Growth	6 hr/d, 6 d/wk, 18 months	Inhalation	>7666 mg/m3		Relative liver, kidney, heart and spleen ratio	Bi et al., 1985	*NOAEL > 3000 ppm* *Effects seen at 3, 6 and 12 months but no significant differences at 18 months*	7666		0.462	0.425	7044.04		0.250	0.857	1509.438			2044	217.518
Vinyl Chloride	CF-1 Mouse	Maternal Effects	7 hr/day, days 6 - 15 of gestation (sacrifice on day 18)	Inhalation	127.8 mg/m3	1277.8 mg/m3	Weight gain btw d 6 and 18 of gestation Absolute Liver Weight Food consumption	John et al., 1977	*only 50 and 500 ppm concentrations tested* *NOAEL = 50 ppm, LOAEL = 500 ppm*	127.8	1278.1	0.037	0.063	216.04	2160.60	0.292	1.000	63.013	630.175		511	49.976
Vinyl Chloride	Sprague-Dawley Rats	Maternal Effects	7 hr/day, days 6 - 15 of gestation (sacrifice on day 21)	Inhalation		1277.8 mg/m3	Weight gain btw day 6 and 21 of gestation	John et al., 1977	*only 50 and 500 ppm concentrations tested* *LOAEL = 500 ppm*		1278.1	0.523	0.470		1148.57	0.292	1.000		334.998	geomean	**242**	**43.1**
Vinyl Chloride	N.Z. White Rabbits	Maternal Effects	7 hr/day, days 6 - 18 of gestation (sacrifice on day 29)	Inhalation	> 6388.5 mg/m3		Weight gain btw day 6 and 29 of gestation	John et al., 1977		6388.5		3.930	1.434	2330.91	0.00	0.292	1.000	679.850	0.000	**NOTE:** Dose from Feron et al. (1981) was based on different exposure route (oral) and could not be converted to an inhaled concentration, so was excluded from this calculation.		
Vinyl Chloride	CF-1 Mouse	Fetal effects	7 hr/day, days 6 - 15 of gestation (sacrifice on day 18)	Inhalation		127.8 mg/m3	Fetal crown-rump length	John et al., 1977	*LOAEL = 50 ppm* *Although effect seen at 50 ppm, same effect not noted at 500 ppm. Various other effects noted at 500 ppm (live fetuses/litter, implantations resorbed, fetal body weight, maternal deaths/treated dams)*		127.8	0.037	0.063		216.04	0.292	1.000		63.013			
Vinyl Chloride	Sprague-Dawley Rats	Fetal effects	7 hr/day, days 6 - 15 of gestation (sacrifice on day 21)	Inhalation		1277.8 mg/m3	Corpora lutea/dam Pregnancy wastage Fetal body weight Fetal crown-rump length	John et al., 1977			1278.100	0.523	0.470		1148.57	0.292	1.000		334.998			
Vinyl Chloride	N.Z. White Rabbits	Fetal effects	7 hr/day, days 6 - 18 of gestation (sacrifice on day 29)	Inhalation		1277.8 mg/m3	corpora lutea/dam implantation sites/dam live fetuses/litter	John et al., 1977	*None of these effects noted at 2500 ppm (as compared to controls)*		1277.800	3.930	1.434		466.22	0.292	1.000		135.981			
Vinyl Chloride	CF-1 Mouse	Fetal anomalies	7 hr/day, days 6 - 15 of gestation (sacrifice on day 18)	Inhalation	127.8 mg/m3	1277.8 mg/m3	skeletal anomalies (unfused and delayed ossification in sternebrae, delayed ossification in skull)	John et al., 1977	*NOAEL = 50 ppm, LOAEL = 500 ppm*	127.8	1277.800	0.037	0.063	216.04	2160.09	0.292	1.000	63.013	630.028			
Vinyl Chloride	Sprague-Dawley Rats	Fetal anomalies	7 hr/day, days 6 - 15 of gestation (sacrifice on day 21)	Inhalation		1277.8 mg/m3	skeletal anomalies (rib spurs)	John et al., 1977	*LOAEL = 500 ppm*		1277.800	0.523	0.470		1148.30	0.292	1.000		334.920			
Vinyl Chloride	N.Z. White Rabbits	Fetal anomalies	7 hr/day, days 6 - 18 of gestation (sacrifice on day 29)	Inhalation		1277.8 mg/m3	skeletal anomalies (delayed ossification No. 5 in sternebrae)	John et al., 1977	*Although 500 ppm significantly different from control, these effects were not seen in 2500 ppm trtmt group. Also - no other anomaly effects were observed in either trtmt group.* *LOAEL = 500 ppm*		1277.800	3.930	1.434		466.22	0.292	1.000					
Vinyl Chloride	CFY Rats	Reproduction	24 hr/dy, days 1 - 9 of pregnancy (sacrifice on day 21)	Inhalation		4000 mg/m3	fetal loss (%) relative liver weights (%)	Ungvary et al., 1978	*only one test concentration (4000 mg/m3)*		4000.000	0.523	0.470		3594.60	1.000	1.000		3594.602			
Vinyl Chloride	CFY Rats	Organ growth	24 hr/dy, days 8 - 14 of pregnancy (sacrifice on day 21)	Inhalation		4000 mg/m3	Relative liver weight	Ungvary et al., 1978	*only one test concentration (4000 mg/m3)*		4000.000	0.523	0.470		3594.60	1.000	1.000		3594.602			
Vinyl Chloride	CFY Rats	Various	24 hr/dy, days 14-21of pregnancy (sacrifice on day 21)	Inhalation	>4000 mg/m3		Relative liver weight	Ungvary et al., 1978	*only one test concentration (4000 mg/m3)*	4000		0.523	0.470	3594.60		1.000	1.000	3594.602				
Vinyl Chloride	Rats	Behavior and Growth	6 days/week for 13 weeks	oral gavage	300 mg/kg/day		Appearance, Behavior, Weight gain, Food intake	Feron et al., 1975	*concentrations tested include 0, 30, 100 and 300 mg/kg/day* *appearance and behavior endpoints not specified*					300			0.857	257.143				
Vinyl Chloride	Rats	Organ Growth	6 days/week for 13 weeks	oral gavage	100 mg/kg/day	300 mg/kg/day	Relative liver and adrenal gland weight	Feron et al., 1975						100	300		0.857	85.714	257.143			
Vinyl Chloride	Rats	Blood chemistry	6 days/week for 13 weeks	oral gavage	30 mg/kg/day	100 mg/kg/day	Blood sugar, total leucocytes (females only)	Feron et al., 1975						30	100		0.857	25.714	85.714			
Vinyl Chloride	Rats	Growth	7 h/d, 5 d/wk, 4.5 months	Inhalation	>1278.1 mg/m3		Body Weight	Torkelson et al., 1961	*only one test concentration - 500 ppm*	1278.1		0.523	0.470	1148.57	0.00	0.292	1.000	334.998				
Vinyl Chloride	Rats	Organ Weights	7 h/d, 5 d/wk, 4.5 months	Inhalation		1278.1 mg/m3	Relative Liver Weight	Torkelson et al., 1961	*LOAEL = 500 ppm*		1278.1	0.523	0.470	0.00	1148.57	0.292	1.000	0.000	334.998			
Vinyl Chloride	Rats	Growth	7 hr/d, 5 days/wk, 6 months	Inhalation	>511 mg/m3		Body Weight	Torkelson et al., 1961		511		0.523	0.470	459.21	0.00	0.292	1.000	133.936				

Table C-58
Vinyl chloride TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL	LOAEL	Specific Effect	Reference	Notes	NOAEL (mg/m^3)	LOAEL (mg/m^3)	Body Weight (kg)	Inhalation Rate (m^3/d)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Hour per week adjustment	Week per day adjustment	Adjusted NOAEL (mg/kg/day)	Adjusted LOAEL (mg/kg/day)	GeoMean Calculation	GeoMean Calculation
MAMMALS																				(mg/m^3)	(mg/kg-d)
Vinyl Chloride	Rats	Organ Growth	7 hr/d, 5 days/wk, 6 months	Inhalation	127.8 mg/m3	255.6 mg/m3	Relative Liver Weight	Torkelson et al., 1961	*concentrations = 50, 100 and 200 ppm*	127.8	255.6	0.523	0.470	114.85	229.70	0.292	1.000	33.497	66.994		
Vinyl Chloride	Rabbit	Body and Organ Growth	7 hr/d, 5 days/wk, 6 months	Inhalation	2044 mg/m3		Weight	Torkelson et al, 1961	*concentrations = 50, 100 and 200 ppm* *NOAEL = 200 ppm*	2044		3.930	1.434	745.78	0.00	0.292	1.000	217.518			
Vinyl Chloride	Dog	Body and Organ Growth	7 hr/d, 5 days/wk, 6 months	Inhalation	511 mg/m3	1022 mg/m3	Weight	Torkelson et al, 1961	*concentrations = 50, 100 and 200 ppm* *NOAEL - 50 ppm, LOAEL = 100 ppm*	511	1022	10.800	3.621	171.35	342.69	0.292	1.000	49.976	99.952		
Vinyl chloride	Guinea pig	Growth	7 hr/d, 5 days/wk, 6 months	Inhalation	>511 mg/m3		Body Weight	Torkelson et al., 1961		511		0.890	0.414	237.90	0.00	0.292	1.000	69.387			
Vinyl chloride	Guinea pig	Body and Organ Growth	7 hr/d, 5 days/wk, 6 months	Inhalation	127.8 mg/m3	255.6 mg/m3	Relative Liver Weight	Torkelson et al., 1961	*concentrations = 50, 100 and 200 ppm* *NOAEL = 50 ppm, LOAEL = 100 ppm* *effect not noted at 200 ppm (511 mg/m3)*	127.8	255.6	0.890	0.414	59.50	119.00	0.292	1.000	17.353	34.707		
Vinyl chloride	albino Wistar Rats	Behavior and Appearance	lifetime (135-144 weeks), 84 weeks for highest dose (gavage) group	Oral (diet and gavage, dep. on dose)		5.0 mg/kg-d	unthriftiness, lethargy, emaciation, filthiness, liver, abdominal, and external tissue masses, difficulty breathing	Feron et al., 1981													
Vinyl chloride	albino Wistar Rats	Growth	lifetime (135-144 weeks), 84 weeks for highest dose (gavage) group	Oral (diet and gavage, dep. on dose)	300 mg/kg-d		Body Weight	Feron et al., 1981													
Vinyl chloride	albino Wistar Rats	Mortality	lifetime (135-144 weeks), 84 weeks for highest dose (gavage) group	Oral (diet and gavage, dep. on dose)		1.7 mg/kg-d	Mortality	Feron et al., 1981													
Vinyl chloride	albino Wistar Rats	Haematology, biochemistry	26 and/or 52 weeks	Oral (diet and gavage, dep. on dose)		14.1 mg/kg-d	Blood clotting time and increased alpha-foetoprotein in blood serum	Feron et al., 1981													
Vinyl chloride	albino Wistar Rats	Pathology	26 and 52 weeks	Oral (diet and gavage, dep. on dose)		14.1 mg/kg-d	Increased liver-to-body weight ratio, additional effects	Feron et al., 1981													

🟨 = Value used in identifying TRV

weights for B6C3F1 mice, CF-1 not listed

weights for Sprague-Dawley rats, CFY not listed

strain or species not listed; values assumed to be representative.
Used SD rats for "rats", and beagles for "dogs".

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	43.1	4	10.8
Lemming	43.1	2	21.6
Weasel	43.1	4	10.8

Rationale:

Identified relevant NOAELs for four species (highlighted); calculated geometric mean air concentration (242 mg/m^3).
This is below the lowest paired LOAEL (255.6 mg/m3), so was used as a chronic NOAEL.

Table C-59
Xylenes TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Other (as specified)	Specific Effect	Reference	Notes
MAMMALS										
Xylenes	Mouse	Maternal effects	d 6 - 15 gestation (sacrifice on d 18)	oral gavage	1030 mg/kg/day	2060 mg/kg/day		average gravid uterine weight average liver weight	Marks et al., 1982	
Xylenes	Mouse	Fetal effects	d 6 - 15 gestation (sacrifice on d 18)	oral gavage	2060 mg/kg/day	3100 mg/kg/day		average fetal weight % resoprtions/implants % fetal deaths/implants	Marks et al., 1982	
Xylenes	Mouse	Fetal development	d 6 - 15 gestation (sacrifice on d 18)	oral gavage	1030 mg/kg/day	2060 mg/kg/day		average % of malformed fetuses	Marks et al., 1982	
Xylenes	Rat	Survival	One time acute exposure (observation 2 wks)	oral gavage			LD50 = 3523 mg/kg/day	lethality	NTP, 1986b	*Deaths occurred within 48 hours of exposure*
Xylenes	Rat	Growth	14 days	oral gavage	0 mg/kg/day	125 mg/kg/day ***		body Weight	NTP, 1986b	**** no statistics*
Xylenes	Rat	Growth	13 weeks	oral gavage	500 mg/kg/day	1000 mg/kg/day ***		body Weight	NTP, 1986b	**** no statistics*
Xylenes	Rat	Survival	2 years	oral gavage	250 mg/kg/day	500 mg/kg/day		Lethality	NTP, 1986b	
Xylenes	Rat	Pathology	2 years	oral gavage	250 mg/kg/day	500 mg/kg/day		Leukemia Pituitary Gland ademona	NTP, 1986b	
Xylenes	Mouse	Survival	One time acute exposure (observation 2 wks)	oral gavage			LC50 = 5241 mg/kg/day	lethality	NTP, 1986b	*Deaths occurred within 32 hours of exposure* *Lower of male (5627 mg/kg) and female (5241 mg/kg) LC50s*
Xylenes	Mouse	Behaviour	One time acute exposure (observation 2 wks)	oral gavage	2000 mg/kg/day	4000 mg/kg/day ***		Tremors Prostration Slowed Breathing	NTP, 1986b	**** no statistics*
Xylenes	Mouse	Survival	14 days	oral gavage		4000 mg/kg/day		Lethality	NTP, 1986b	**** no statistics*
Xylenes	Mouse	Growth	13 weeks	oral gavage	1000 mg/kg/day	2000 mg/kg/day***		body Weight	NTP, 1986b	**** no statistics*
Xylenes	Mouse	Survival	2 years	oral gavage	1000 mg/kg/day			Lethality	NTP, 1986b	
Xylenes	Mouse	Growth	2 years	oral gavage	1000 mg/kg/day			Body Weight	NTP, 1986b	
Xylenes	Mouse	Cancer	2 years	oral gavage	1000 mg/kg/day			Nonneoplastic/neoplastic observations (various tissues)	NTP, 1986b	

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	250	4	63
Lemming	250	2	125
Weasel	250	4	63

Rationale:

Selected four applicable studies for growth, survival, and reproduction with NOAEL/LOAELs (highlighted).
Since at least 3 NOAELs, calculated geomean (599 mg/kg-d), however since highest paired NOAEL
(1030 mg/kg-day) is below the lowest paired LOAEL (500 mg/kg-d), used lowest NOAEL.

2-year NOAEL, so no UF needed.
Taxonomic UF of 4 reflects different Order, same Class.
Taxonomic UF of 2 reflects different Family, same Order.
Taxonomic UF of 4 reflects different Order, same Class.

Table C-60
Xylenes AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	Other	Specific Effect	Reference	Notes
AQUATIC								
Zooplankton								
Xylenes	Photobacterium phophoreum (Microtox)	Mortality	5 or 15 minutes	aqueous solution	LC50 = 8.55 mg/L	phosphorescence	Calleja et al., 1994	*nominal concentrations*
Xylenes	Brachionus calyciflorus	Mortality	24 hours	aqueous solution	LC50 = 310 mg/L	Lethality	Calleja et al., 1994	*nominal concentrations*
Xylenes	Artemia salina	Mortality	24 hr	aqueous solution	LC50 = 194 mg/L	Lethality	Calleja et al., 1994	*nominal concentrations*
Xylenes	Streptocephalus proboscideus	Mortality	24 hr	aqueous solution	LC50 = 87.6 mg/L	Lethality	Calleja et al., 1994	*nominal concentrations*
Xylenes	Daphnia magna	Mortality	24 hr	aqueous solution	LC50 = 75.48 mg/L	Lethality	Calleja et al., 1994	*nominal concentrations*
Xylenes	Daphnia magna	Mortality	24 hr	aqueous solution	TLm = >100 <1000 mg/L	Lethality	Dowden and Bennett, 1965	*nominal concentrations*
Fish								
Xylenes	Pimephales promelas	Mortality	96 hr	aqueous solution	LC50 = 42 mg/L	Lethality	Mattson et al., 1976	*nominal concentrations*
					🟨	= value used for AL development.		

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	Rationale
Zooplankton	8.55	LC50	10	**0.86**	Used lowest LC50 value; divided by UF of 10 to extrapolate from LC50 to LOEC.
Fish	42	96 hr LC50	10	**4.2**	Used only available study; divided LC50 by UF of 10 to extrapolate to LOEC.

Table C-61
Acenaphthene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Specific Effect	Reference	Notes
MAMMALS									
Acenaphthene	Mice	Various	90 days	oral gavage	>700 mg/kg/day		Survival Clinical signs Mean body wt Total food consumption Ophthalmology	Wolfe, 1989	
Acenaphthene	Mice	Various	90 days	oral gavage		175 mg/kg/day	Absolute and relative changes in weight to: Liver, Spleen, Ovary	Wolfe, 1989	
Acenaphthene	Mice	Various	90 days	oral gavage		350 mg/kg/day	Microscopic effects	Wolfe, 1989	

🟨 = Value used as basis for TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	LOAEL (mg/kg-d)	UF	TRV
Shrew	175	40	4.4
Lemming	175	20	8.8
Weasel	175	40	4.4

Rationale:

Only one applicable LOAEL (reproductive).
Divided subchronic LOAEL by UF of 10 to convert to chronic NOAEL.
Taxonomic UF of 2 reflects different Family, same Order.
Taxonomic UF of 4 reflects different Order, same Class.

Table C-62
Acenaphthene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	Other	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
Acenaphthene	Daphnia magna	Mortality	24 hr	aqueous solution	0.60 mg/L		LC50 = >280 mg/L	lethality	LeBlanc, 1980	
Acenaphthene	Daphnia magna	Mortality	48 hr	aqueous solution	0.06 mg/L		LC50 = 41 mg/L	lethality	LeBlanc, 1980	
Acenaphthene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 1.275 mg/L	lethality	Munoz and Tarazona, 1993	*dissolved in methanol*
Acenaphthene	Daphnia magna	Mortality	48 hr	aqueous solution			EC50 = 3.45 mg/L	Immobilization	Randall and Knopp, 1980	*other aspects of this study focused on the effects of oxidization on compound toxicity*
Fishes										
Acenaphthene	Pimephales promelas	Mortality	96 hr	aqueous solution			LC50 = 0.608 mg/L	Lethality	Cairns and Nebeker, 1982	
Acenaphthene	Pimephales promelas	Survival	32 -35 days	aqueous solution	0.509 mg/L	0.682 mg/L	-	Lethality	Cairns and Nebeker, 1982	*dissolved in MDF*
Acenaphthene	Pimephales promelas	Growth	32 - 35 days	aqueous solution	0.345 mg/L	0.495 mg/L	-	Weight/Length	Cairns and Nebeker, 1982	*dissolved in MDF*
Acenaphthene	Pimephales promelas	Mortality	72 hr	aqueous solution			LC50 = 1.7 mg/L	Lethality	Holcombe et al., 1983	
Acenaphthene	Salmo gairdneri	Mortality	72 hr	aqueous solution			LC50 = 0.8 mg/L	Lethality	Holcombe et al., 1983	
Acenaphthene	Salmo trutta (brown trout)	Mortality	72 hr	aqueous solution			LC50 = 0.6 mg/L	Lethality	Holcombe et al., 1983	
Acenaphthene	Pimephales promelas	Mortality	96 hr	aqueous solution			LC50 = 1.6 mg/L	Lethality	Holcombe et al., 1983	
Acenaphthene	Ictalurus punctatus (channel catfish)	Mortality	96 hr	aqueous solution			LC50 = 1.72 mg/L	Lethality	Holcombe et al., 1983	
Acenaphthene	Salmo gairdneri	Mortality	96 hr	aqueous solution			LC50 = 0.67 mg/L	Lethality	Holcombe et al., 1983	
Acenaphthene	Salmo trutta (brown trout)	Mortality	96 hr	aqueous solution			LC50 = 0.58 mg/L	Lethality	Holcombe et al., 1983	
Acenaphthene	Pimephales promelas	Mortality	96 hr	aqueous solution			LC50 = 0.208 mg/L		Lemke et al., 1983	*LC50 as compared to solvent control* *NO information as to how LC50 was calculated - I can't figure out how it was established*
Acenaphthene	Pimephales promelas	Mortality	96 hr	aqueous solution			LC50 = 0.226 mg/L		Lemke et al., 1983	*LC50 as compared to normal control* *NO information as to how LC50 was calculated - I can't figure out how it was established*
Acenaphthene	Pimephales promelas	Mortality	96hr	aqueous solution			LC50 = 0.155 mg/L	Lethality	Lemke, 1983	*study was an interlaboratory comparison of results (two tests run at each lab)* *I calculated the LC50 as the geo mean from the results of both tests at all labs* *In general procedures not completely clear*

🟨 = Value used as basis for TRV

II. Calculate ALs

	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	**Rationale:**
Zooplankton	0.06	NOEC	1	0.06	Used lowest NOEC for mortality. UF of 1 since NOEC.
Fish	0.345	NOEC	1	0.345	Used lowest NOEC for mortality, chronic study. UF of 1 since chronic NOEC.

Table C-63
Acenaphthylene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOAEL (mg/L)	LOAEL (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Fishes										
Acenaphthylene	Cyprinus carpio	Mortality	<1 to >5 days	aqueous solution (force fed)	—	—	132 mg/kg = Death < 19-hrs		Loeb and Kelly, 1963	*Static system, nominal concentrations reported; Fish weight = 3 (1-10) pounds. Authors describe effects as "acute"*
					111-116 mg/kg		No effect 90-hrs		Loeb and Kelly, 1963	*force fed in diet - need to convert to mg/L. Not relevant route of exposure.*

🟨 = value used for AL development.

▨ = eliminated from TRV development; no data or inappropriate route of administration.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Fish				NA	No relevant studies found.

Table C-64
Anthracene AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg)	LOAEL (mg/kg)	Other (as specified)	Specific Effect	Reference	Notes
TERRESTRIAL PLANTS										
Anthracene	Banksia ericifolia (heath banksia)	Mortality	32 days	Soil			LC50 = >1000 mg/kg	Emergence	Mitchell et al., 1988	*Native Australian plant* *Values presented as mg/kg air-dried soil*
Anthracene	Banksia ericifolia (heath banksia)	Growth	32 days	soil			EC50 = >1000 mg/kg	Growth	Mitchell et al., 1988	*Native Australian plant* *Values presented as mg/kg air-dried soil*
Anthracene	Casuarina distyla (she-oak)	Mortality	56 days	soil			LC50 = >1000 mg/kg	Emergence	Mitchell et al., 1988	*Native Australian plant* *Values presented as mg/kg air-dried soil*
Anthracene	Casuarina distyla (she-oak)	Growth	56 days	soil			EC50 = >1000 mg/kg	Growth	Mitchell et al., 1988	*Native Australian plant* *Values presented as mg/kg air-dried soil*
Anthracene	Eucalyptus eximia (yellow bloodwood)	Mortality	2 weeks post control germination	soil			LC50 = >1000 mg/kg	Emergence	Mitchell et al., 1988	*Native Australian plant* *values presented as mg/kg air-dried soil*
Anthracene	Eucalyptus eximia (yellow bloodwood)	Growth	2 weeks post control germination	soil			EC50 = >1000 mg/kg	Growth	Mitchell et al., 1988	*Native Australian plant* *Values presented as mg/kg air-dried soil*
Anthracene	Avena sativa (Oat)	Mortality	2 weeks post control germination	soil			LC50 = 525 mg/kg	Emergence	Mitchell et al., 1988	*Values presented as mg/kg air-dried soil*
Anthracene	Avena sativa (Oat)	Growth	2 weeks post control germination	soil			EC50 = 30 mg/kg	Growth	Mitchell et al., 1988	*Values presented as mg/kg air-dried soil*
Anthracene	Cucumis sativus (cucumber)	Mortality	2 weeks post control germination	soil			LC50 = >1000 mg/kg	Emergence	Mitchell et al., 1988	*Values presented as mg/kg air-dried soil*
Anthracene	Cucumis sativus (cucumber)	Growth	2 weeks post control germination	soil			EC50 = 720 mg/kg	Growth	Mitchell et al., 1988	*Values presented as mg/kg air-dried soil*
Anthracene	Glyceine max (soybean)	Mortality	2 weeks post control germination	soil			LC50 = >1000 mg/kg	Emergence	Mitchell et al., 1988	*Values presented as mg/kg air-dried soil*
Anthracene	Glyceine max (soybean)	Growth	2 weeks post control germination	soil			EC50 = >1000 mg/kg	Growth	Mitchell et al., 1988	*Values presented as mg/kg air-dried soil*

🟨 = value used for AL development.

LC50 = emergence is 50% of controls

EC50 = change in growth is 50% of controls

II. Calculate AL

EC50 (mg/kg)	UF	Tier II AL (mg/kg)
278	**5**	**56**
(geomean)		

Rationale:

Used 3 EC50 values from most relevant end points
(used yellow highlighted ones).
Calculated geometric mean value and divided by
UF=5 (EC50 for growth to LOEC or EC10).

Table C-65
Anthracene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL	LOAEL	Other	Specific Effect	Reference	Notes
AQUATIC										
Crustaceans										
Anthracene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 3.03 mg/L	Immobility	Bobra et al., 1983	*Nominal concentration.*
Anthracene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 0.036 mg/L	Immobility	Abernethy et al., 1986	*Nominal concentration.*
Anthracene	Artemia	Mortality	24 hr	aqueous solution			LC50 = >0.05 mg/L		Abernethy et al., 1986	*Nominal concentration.*
Anthracene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 11.19 mg/L (visible + UVA + UVB light)	Immobility	Lampi et al., 2006	*Dissolved in DMSO. Nominal concentration.*
Anthracene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 19.61 mg/L (visible + UVA light)	Immobility	Lampi et al., 2006	*Dissolved in DMSO. Nomonal concentration.*
Anthracene	Daphnia magna	Mortality	24 hr + photoinduction time	aqueous solution				Immobility	Newsted and Giesy, 1987	*Results are reported in lethal times not lethal doses. Discussed as nominal and measured concentrations. Measured concentrations at the end of the study only.*
Anthracene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 1.275 mg/L	Immobility	Munoz and Tarazona, 1993	*Methanol used as vehicle (max conc of 2%). Nominal concentrations.*
Anthracene	Daphnia pulex	Mortality	-	aqueous solution				Immobility	Allred and Giesy, 1985	*Results are reported in lethal times not lethal doses. Nominal concentration.*
Anthracene	Daphnia magna	Reproduction	21 d	aqueous solution		0.0021 mg/L		# of neonates per brood (total of 6 broods)	Holst and Giesy, 1989	*Study also looked at effects of UV radiation intensity but this part of the study was done in absence of UV. Measured concentrations twice a day.*
Anthracene	Daphnia magna Pimphales promelas			aqueous solution					Oris et al., 1990	*Effects of dissolved humic materials on photo-induced activity of anthracene* *No LC50 values for just anthracene. Nominal concentrations.*
Fish										
Anthracene	Pimphales promelas	Reproduction	8 weeks	aqueous solution		0.012 mg/L		hatching success	Hall and Oris, 1991	*Acetone used as vehicle* *LOAEL based on statistical results comparing the two test concentrations to the controls (interpreted from figures).*
Anthracene	Pimphales promelas	Mortality	maximum of 96 hr	aqueous solution				lethality	Oris and Giesy, 1987	*Lethal times presented not lethal doses. Measured concentrations (at the beginning of bioassays, at 12hr and at least one more time for initial and 12th hour solutions).*

🟨 = Value used as basis for TRV

	Test Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Tier II AL (ug/L)	**Rationale:**
Zooplankton	0.0021	21 day LOEC	1	**0.0021**	**2.1**	Lowest value was a LOAEL; used this value since lower than all LC50s (even when divided by UF of 5). No UF needed since LOEC.
Fish	0.012	LOEC	1	**0.012**	**12**	Only one LOAEL; used this value. No UF needed since LOEL.

Table C-66
Benzo(a)anthracene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other (as specified)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
Benzo(a)anthracene	Daphnia magna (< 24 hrs)	Lethality	48 hrs	aqueous	-	-	EC50 = 1.48 ug/L (Visible + UVA)	Immobility	Lampi et al., 2006	*Converted from EC50 = 6.49 nM. Nominal concentration.*
Benzo(a)anthracene	Daphnia magna (< 24 hrs)	Lethality	49 hrs	aqueous	-	-	EC50 =0.96 ug/L (Visible + UVA + UVB)	Immobility	Lampi et al., 2006	*Converted from EC50 = 4.2 nM.* *Visible + UVA + UVB = Full spectrum simulated solar radiation - likely more useful than Visible + UVA. Nominal concentration.*
Benzo(a)anthracene	Daphnia magna (< 24 hrs)	Lethality	-	aqueous	-	-	-	-	Newsted and Giesy, 1987	*Effects of UVA and UVB light on toxicity* *Results presented as lethal times for given dose not lethal doses. Discussed as both nominal and measured concentrations. Measured concentrations at the end of experiment.*
Benzo(a)anthracene	Daphnia pulex	Lethality	96 hr	aqueous			10 ug/L	Immobility	Trucco et al., 1983	*Measured concentrations but not specified how often.*
Fish										
Benzo(a)anthracene	Pimephales pimephales	Phototoxicity	-	aqueous	-	-	-	-	Oris and Giesy, 1987	*Flow-through study. Results presented as lethal times for given dose not lethal doses. Measured concentrations at the beginning of bioassay and at 12th hour and at least once more for initial and 12th hour solutions.*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)
Zooplankton	0.01	EC50	10	**0.0010**

Rationale:

Used measured study LC50.
Divided by UF of 10 to convert to LOEC.

Table C-67
Benzo(a)pyrene TRV Derivation for Mammalian Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Specific Effect	Reference	Test Sp. Body Weight (BWt) (kg)	Ingestion Rate (IRt) (g/g-day)	Notes
MAMMALS											
Benzo(a)pyrene	Mice	Reproduction	19 days	oral intubation	.49 mg/kg-d	-	Pregnancy maintenance, fetal development, survival, post-natal development, reproductive function	Rigdon and Neal, 1965	0.0395	19.29 g/d	*Average ingestion by lactating mothers*
Benzo(a)pyrene	Mice	Reproduction	180 days			10	reduced litter size; gametogenesis impairment	Mackenzie and Angevine 1981			

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV
Shrew	**0.49**	**4**	**0.12**
Lemming	**0.49**	**2**	**0.25**
Weasel	**0.49**	**4**	**0.12**

Rationale:

One NOAEL and one LOAEL for reproduction ; used NOAEL.

180 day study LOAEL supports use of NOAEL with no adjustment.

Taxonomic UF of 4 reflects different Order, same Class.

Taxonomic UF of 2 reflects different Family, same Order.

Taxonomic UF of 4 reflects different Order, same Class.

Table C-68
Benzo(a)pyrene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other (as specified)	Specific Effect	Reference	Notes
AQUATIC										
Algae										
Benzo(a)pyrene	Selenatrum capricornutum	Growth	72 hrs	aqueous	-	-	EC50 = 15 ug/L	cell numbers	Schoeny et al., 1988	*Assume nominal concentration (not specified).*
Benzo(a)pyrene	Scenedesmus acutus	Growth	73 hrs	aqueous	-	-	EC50 = 5 ug/L	cell numbers	Schoeny et al., 1988	*Assume nominal concentration (not specified).*
Benzo(a)pyrene	Ankistrodesmtus brawnii	Growth	74 hrs	aqueous	-	-	EC50 = 1300 ug/L	cell numbers	Schoeny et al., 1988	*Assume nominal concentration (not specified).*
Benzo(a)pyrene	Chlamydomonas reinhardtii	Growth	75 hrs	aqueous	-	-	EC50 = >4000 ug/L	cell numbers	Schoeny et al., 1988	*Assume nominal concentration (not specified).*
Benzo(a)pyrene	Ochromonas malhamenis	Growth	76 hrs	aqueous	-	-	EC50 = >4000 ug/L	cell numbers	Schoeny et al., 1988	*Assume nominal concentration (not specified).*
Benzo(a)pyrene	Euglena gracilis	Growth	77 hrs	aqueous	-	-	EC50 = >4000 ug/L	cell numbers	Schoeny et al., 1988	*Assume nominal concentration (not specified).*
Benzo(a)pyrene	Anabaena flosaquae	Growth	78 hrs	aqueous	-	-	EC50 = >4000 ug/L	cell numbers	Schoeny et al., 1988	*Assume nominal concentration (not specified).*
Zooplankton										
Benzo(a)pyrene	Daphnia magna (< 24 hrs)	Lethality	48 hrs	aqueous	-	-	EC50 = 1.62 ug/L (Visible + UVA)	Immobility	Lampi et al., 2006	*Converted from EC50 = 6.44 nM. Nominal concentrations*
Benzo(a)pyrene	Daphnia magna (< 24 hrs)	Lethality	48 hours	aqueous	-	-	EC50 = 0.98 ug/L (Visible + UVA + UVB)	Immobility	Lampi et al., 2006	*Converted from 3.89 nM.* *Visible + UVA + UVB = Full spectrum simulated solar radiation - likely more useful than Visible + UVA. Nominal concentrations.*
Benzo(a)pyrene	Daphnia magna (<48 hours)	Lethality	48 hr	aqueous	-	-	LC 50 = 250 ug/L	Immobility	Atienzar et al., 1999	*Other endpoints measured (growth, reproduction, fitness, DNA) but not quantified as Ecxs. Nominal concentrations.*
Benzo(a)pyrene	Daphnia pulex	Lethality	96 hr	aqueous	-	-	LC50 = 5 ug/L	Immobility	Trucco et al., 1983	*Measured concentrations but not specified how often.*
Benzo(a)pyrene	Daphnia magna (4 days old)	Lethality	24 hr	aqueous	-	-	LC50 = 40 ug/L	Immobility	Wernersson and Dave, 1997	*Not specified. Assume nominal concentration.*
Benzo(a)pyrene	Daphnia magna (< 24 hrs)	Lethality	-	aqueous	-	-	-		Newsted and Giesy, 1987	*Effects of UVA and UVB light on toxicity.* *Results presented as lethal times for given dose not lethal doses. Discussed as nominal and measured concentrations. Measured concentrations at the end of the study.*
Benzo(a)pyrene	Daphnia magna	-	-	aqueous	-	-	-	-	Oikari and Kukkonen, 1990	*Effect of DOC on bioavailability - no NOECs, LOECs or Ecxs. Nominal concentrations.*
Fish										
Benzo(a)pyrene	Pimephales promelas	Genetic Toxicity	-	aqueous	-	-	-	DNA strand breakage	Shugart, 1988	*No NOEC, LOEC or ECxs reported. Asume nominal concentrations (not specified)*
Benzo(a)pyrene	Various - algae, larva, daphnia	-	-	aqueous	-	-	-	-	Lu et al., 1977	*Environmental fate study - no NOECs, LOECs or Ecxs. Measured concentration (radioactive labelling) throughout experiments.*

🟨 = Value used in identifying AL

Taxonomic Group	Test Conc (ug/L)	Relevant Effect Level	UF	Tier II AL (ug/L)	Rationale:
Algae	5	EC50	10	**0.50**	Since less than 10, used lowest value. Divided by UF of 10 to convert to LOAEL.
Zooplankton	5	LC50	10	**0.50**	Used lowest value of measured studies. Divided by UF of 10 to convert to LOAEL.

Table C-69
Benzo(b)fluoranthene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other (as specified)	Specific Effect	Reference	Notes
Zooplankton										
Benzo(b)fluoranthene	Daphnia magna (< 24 hrs)	Lethality	48 hrs	aqueous	-	-	EC50 = 122 ug/L (Visible + UVA)	Immobility	Lampi et al., 2006	*Converted from EC50 = 483.62 nM. Nominal concentration.*
Benzo(b)fluoranthene	Daphnia magna (< 24 hrs)	Lethality	49 hrs	aqueous	-	-	EC50 = 10.39 ug/L (Visible + UVA + UVB)	Immobility	Lampi et al., 2006	*Converted from 41.2 nM* *Visible + UVA + UVB = Full spectrum simulated solar radiation. Nominal concentration.*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	**Rationale:**
Zooplankton	0.01039	EC50	10	**0.0010**	Since less than 10, used lowest value. Divided by UF of 10 to convert to LOAEL.

Table C-70
Chrysene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
Chrysene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	EC50 = 3.97 mg/L (visible + UVA + UVB light)	Lethality	Lampi et al., 2006	*Irradiation study focus in effects of photoinduction following exposure. Nominal concentration.*
Chrysene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	EC50 = NT (visible + UV A light)	Lethality	Lampi et al., 2006	*Irradiation study focus in effects of photoinduction following exposure. Nominal concentration.*
Chrysene	Daphnia magna	Mortality	24 hr	aqueous solution	-	-		Lethality	Newsted and Giesy, 1987	*Effects of UVA and UVB light on toxicity. Results presented as lethal times for given dose not lethal doses. Discussed as measured and nominal concentrations. Measured concentrations at the end of study only.*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)
Zooplankton	3.97	48 hr EC50	10	**0.40**

Rationale:

Since less than 10, used lowest value.

Divided by UF of 10 to convert to LOEC.

Table C-71
Dibenz(a,h)anthracene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Notes
AQUATIC										
Nectonic Invertebrates										
Dibenz(a,h)anthracene	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	-	Lethality	Newsted and Giesy, 1987	*Effects of UVA and UVB light on toxicity* *Results presented as lethal times for given dose not lethal doses. Discussed as nominal and measured concentrations. Measured concentrations at the end of the study only.*
Dibenz(a,h)anthracene	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	LC50 = 0.496 mg/L	Lethality	Wernersson and Dave, 1997	*Laboratory light only. Not specified. Assume nominal concentration.*
Dibenz(a,h)anthracene	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	UV-EC50 = 0.0046 mg/L	Lethality	Wernersson and Dave, 1997	*24 hour exposure in laboratory lighting + 2 hour UV exposure (to simulate sunlight) + 2 hour recovery. Not specified. Assume nominal concentration.*
Dibenz(a,h)anthracene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	EC50 =1.56 mg/L (Visible + UVA)	Lethality	Lampi et al., 2006	*Converted from EC50 = 5.6 nM. Nominal concentration.*
Dibenz(a,h)anthracene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	EC50 = 0.55 mg/L (Visible + UVA + UVB)	Lethality	Lampi et al., 2006	*Converted from 1.98 nM.* *Visible + UVA + UVB = Full spectrum simulated solar radiation .* *Nominal concentration.*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)
Zooplankton	0.0046	24 hr EC50	10	**0.00046**

Rationale:

Since less than 10, used lowest value.
Divided by UF of 10 to convert to NOAEL.

Table C-72
2,4-Dimethylphenol TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes
MAMMALS											
2,4-Dimethylphenol	Rat	Mortality	90 days	oral (gavage in corn oil)	180 mg/kg-d	540 mg/kg-d		survival	Daniel et al., 1993	0.269 (females), 0.4928 (males)	*Body weights are averages of controls at end of study. Deaths attributed to corrosive action of 2,4-DMP on esophagus and stomach.*
2,4-Dimethylphenol	Rat	Growth	90 days	oral (gavage in corn oil)	🟨 60 mg/kg-d	180 mg/kg-d		body weight	Daniel et al., 1993	0.269 (females), 0.4928 (males)	*Significant decrease in weight of females only at 180 mg/kg level, not significant but reduced at 540 mg/kg level. Male body weight significantly reduced at 540 mg/kg but was slightly increased in lower dose groups.*
2,4-Dimethylphenol	Rat	Histopathology	90 days	oral (gavage in corn oil)	60 mg/kg-d	180 mg/kg-d		hyperkeratosis and epithelial hyperplasia of the forestomach	Daniel et al., 1993	0.269 (females), 0.4928 (males)	
2,4-Dimethylphenol	Rat	Various	90 days	oral (gavage in corn oil)	60 mg/kg-d			organ absolute and relative weights, clinical chemistry	Daniel et al., 1993	0.269 (females), 0.4928 (males)	*Effects observed at various dose levels but often middle (and sometimes low) but not high dose groups statistically different from controls, effect levels differed between males and females.*

🟪 = eliminated from TRV development; non-target endpoint.

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	Value (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	Rat	60	20	3
Lemming	Rat	60	10	6
Least Weasel	Rat	60	20	3

Rationale: Chose only NOEAL associated with growth (60 mg/kg-day).
UF of 5 to account for subchronic to chronic.
UF of 4 applied for same class, different order.
UF of 2 applied for same order, different family.

Table C-73
2,4-Dimethylphenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route	NOEC (mg/L)	LOEC (mg/L)	Others (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
2,4-Dimethylphenol	Daphnia magna	Mortality	1 day	aqueous solution (fresh water)	—	—	LC_{50} = 8.3 (5.9-11)		Leblanc, 1980	Static system; Nominal concentrations
			2 days		1.0	—	LC_{50} = 2.1 (1.8-2.5)			
	Daphnia magna	Immobility	1 day	aqueous solution (fresh water)	—	—	IC_{50} = 0.096 (0.069-0.123) mmol		Devillers, 1988	Chemical >95% purity; Static system; Nominal concentrations in mmol.
	Ceriodaphnia dubia	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 3.4 (3.0-4.3)		Norberg-King, 1987	Static system; Nominal concentrations; (Reconstituted water [soft: Average Hardness & Alkalinity = 40-48 & 30-35 mg/L]; Organisms were fed throughout test)
							LC_{50} = 3.1 (2.6-3.7)			Static system; Nominal concentrations; (Lake Superior water [Average Hardness & Alkalinity = 45 & 30 mg/L]; Organisms were fed throughout test)
							LC_{50} = 6.3 (5.3-7.5)			Static system; Nominal concentrations; (diluted mineral artificial water [1 Perrier:9 Millipore; Average Hardness & Alkalinity = 40 & 30 mg/L]; Organisms were fed throughout test)
							LC_{50} = 5.4			Static system; Nominal concentrations; (diluted mineral artificial water [Organisms were fed a different type of food throughout test])
							LC_{50} = 5.4			Static system; Nominal concentrations; (diluted mineral artificial water [50 Perrier:50 Millipore; Average Hardness & Alkalinity = 105-125 & 110-112 mg/L; Organisms were fed a different type of food throughout test])
	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	—	—	EC_{50} = 4.8 (4.0-5.8)		Holcombe & Phipps, 1987	Flow-through system; measured concentrations
	Ceriodaphnia dubia	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 3.54 (3.28-3.58)		Spehar, 1987	Static system; measured concentrations; Organisms were fed throughout test
					—	—	LC_{50} = 3.34			Static system; measured concentrations; Organisms were not fed throughout test.
		Reproduction	7 days		0.81 ±0.27	1.87 ±0.01	—			Static and static-renewal; Measured concentrations
		Mortality			3.41 ±0.19	—	—			

Table C-73
2,4-Dimethylphenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route	NOEC (mg/L)	LOEC (mg/L)	Others (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Fish										
2,4-Dimethylphenol	Pimephales promelas	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 9.5 (8.4-11)		Phipps et al., 1981	Static system; Measured concentrations; Lake Superior dilution water
			4 days				LC_{50} = 17 (16-18)			Flow-through system; Measured concentrations; Lake Superior dilution water
			8 days				LC_{50} = 14 (12-15)			Flow-through system; Measured concentrations; Lake Superior dilution water
2,4-Dimethylphenol	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} =18.1		Broderius et al., 1995	Static system; Measured concentrations; Lake Superior dilution water; tested with 1-octanol in binary mixtures
					—	—	LC_{50} =15.4			Static system; Measured concentrations; Lake Superior dilution water; tested with phenol in binary mixtures
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 16.8		Holcombe et al., 1982	Flow-through system; Measured concentration; Growth showed a significant decreased mean weight at this concentration.
		Mortality	32 days		3.11	5.13	—			
		Growth			1.97	3.11	—			
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC50 = 18.1 (14.6-22.6)		Holcombe & Phipps, 1987	Flow-through system; measured concentrations
	Salmo gairdneri						LC50 = 9.2 (7.8-11.0)			
	Lepomis macrochirus						LC50 = 6.3 (4.1-9.6)			
	Oryzias latipes						LC50 = 12.6 (11.3-13.9)			
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)			LC50 = 16.6 (16.1-17.1)		Geiger et al., 1985	Flow-through system; measured concentrations

🟨 = value used for AL development.

Taxonomic Group	Conc. (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Zooplankton	0.81	NOEC - Reproduction	1	**0.81**	Used lowest bounded and measured NOEC value for reproduction from a longer duration study. No UF was applied to the NOEC value.
Fish	1.97	NOEC - Growth	1	**1.97**	Used lowest bounded and measured NOEC value for growth from a longer duration study that used a flow-through system. No UF was applied to the NOEC value.

Table C-74
Di-n-butylphthalate TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Specific Effect	Reference	Notes
MAMMALS									
Di-n-butylphthalate	Mice	Reproductive	105 days	diet	3000 mg/kg	10,000 mg/kg	No fertile/No cohabited (%) Litters/pair Live pups/litter Pups born alive (%) Live pup weight	Lamb et al., 1987	*Study conducted at dose levels of 300, 3000 and 10, 000 mg/kg (0.03, 0.3 and 1.0 %)* *No information on kg of food ingested per day.*
Di-n-butylphthalate	Mice	Reproductive	18 days of pregnancy	Diet		102.9 mg/kg/day	number of ossified coccygia	Shiota and Nishimura, 1982	*102.09 mg/kg/day = 500 mg DBP/kg food x 0.0071 kg food/day x 0.034 kg body weight* *food ingestion rate and body weight taken from Table 1 of paper*
Di-n-butylphthalate	Rat	Reproductive	6 days	Diet		500 mg/kg/day	relative testes weight	Gangolli, 1982	*As cited in Gangolli, 1982 from Cater et al.* *Literature review therefore method details are not available for each of the studies discussed*
Di-n-butylphthalate	Rat	Mortality	Acute - 1 time exposure (results after 7 days)	Oral	4000 mg/kg/day	8000 mg/kg/day	survival	Smith, 1953	*Literature review therefore method details are not available for each of the studies discussed*
Di-n-butylphthalate	Rat	Mortality	1 time exposure (results after 7 days)	Intramuscular	> 8000 mg/kg/day		survival	Smith, 1953	*Literature review therefore method details are not available for each of the studies discussed*
Di-n-butylphthalate	Rat	Growth	1 year	diet	2500 mg/kg	12500 mg/kg	body weight	Smith, 1953	*Daily food intakes shown to decrease over course of study.*

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV
Shrew	102.9	40	2.6
Lemming	102.9	20	5.1
Weasel	102.9	40	2.6

Rationale:

Utilized those highlighted in yellow; used LOAELs since lowest is below NOAEL. Since less than three, used lowest.
Divided by UF of 10 to convert from subchronic LOAEL to chronic NOAEL.
Taxonomic UF of 4 reflects different Order, same Class.
Taxonomic UF of 2 reflects different Family, same Order.

Table C-75
Di-n-butylphthalate TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	TRV (mg/kg-day)	Specific Effect	Reference	Notes
BIRDS								
Di-n-butylphthalate	ringed dove	reproduction	4 wks	oral (diet)	0.11	eggshell thickness and water permeability of the shell	Sample et al., 1996	*chronic LOAEL converted to chronic NOAEL using UF of 10; a chronic LOAEL of 1.1 mg/kg-d is also provided*

Table C-76
Di-n-butylphthalate AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	LOEC (mg/L)	NOEC (mg/L)	EC50 (mg/L)	LC50 (mg/L)	Reference	Notes
Algae										
Di-n-butylphthalate	Selenastrum capricornutum	growth	3	static		0.21	0.4		Adams et al., 1995	*Measured concentrations at the beginning and the end of bioassays.*
Di-n-butylphthalate	Scenedesmus obliquus	density	3	static			0.21		Huang et al., 1999	*Nominal concentrations.*
Nectonic Invertebrates										
Di-n-butylphthalate	Daphnia magna	death	3	static		1.7	2.99		Adams et al., 1995	*Measured concentrations at the beginning and the end of bioassays.*
Di-n-butylphthalate	Daphnia magna	death	1	static			10.35		Huang et al., 1999	*Nominal concentrations.*
Di-n-butylphthalate	Daphnia magna	reproduction	1	static		0.5	1		Huang et al., 1999	*Nominal concentrations.*
Di-n-butylphthalate	Daphnia magna	death, reproduction	21	flow-thru	2.5	0.96			Rhodes et al., 1995	*Measured concentrations (Two of four replicates analyzed at days 0, 7, 14 and 21).*
Di-n-butylphthalate	Daphnia magna	death	3	static				2.1	Sanders et al., 1973	*Measured once in triplicate. Assumed nominal concentrations.*
Di-n-butylphthalate	Daphnia magna	reproduction	21	static			0.003		Sanders et al., 1973	*2 later studies show this value is incorrect. M. Concentrations measured once in triplicate. Considering the length of time for bioassay concentration assumed as nominal.*
Fish										
Di-n-butylphthalate	Pimephales promelas	death	3	flow-thru		0.32		0.92	Adams et al., 1995	*Measured concentrations at the beginning and the end of bioassays.*
Di-n-butylphthalate	Cyprinodon variegatus	death	3	static		0.6		<.6	Adams et al., 1995	*Measured concentrations at the beginning and the end of bioassays.*
Di-n-butylphthalate	Salmo mykiss	death	3	flow-thru		0.5		1.6	Adams et al., 1995	*Measured concentrations at the beginning and the end of bioassays.*
Di-n-butylphthalate	Pimephales promelas	death	3	static				1.3	Mayer et al., 1972	*Nominal concentrations.*
Di-n-butylphthalate	Salmo gairdneri	death	3	static				6.47	Mayer et al., 1972	*Nominal concentrations.*
Di-n-butylphthalate	Oncorhynchus mykiss		120		0.19	0.1			Rhodes et al., 1995	*Details not provided on endpoints. Measured concentrations from at least one to two replicates (alternated weekly) at days 0, 1, 2, 7 and weekly thereafter).*

🟨 = value used for AL development.

Taxonomic Group	Value (mg/L)	Relevant Value	UF	Tier II AL (mg/L)	Rationale:
Algae	0.21	NOEC	1	**0.21**	Only one in appropriate category (growth) and also measured study; used NOEC, so no UF needed.
Zooplankton	0.96	NOEC	1	**0.96**	Since less than 10, used lowest NOEC for reproduction for measured study; excluded lowest EC50 (highlighted in blue) since static and not reproducible in later studies: Outlier. Since NOEC, no UF needed
Fish	0.32	NOEC	1	**0.32**	Since less than 10; used lowest NOEC for flow-through measured studies. Rhodes study not used since no information on endpoints. No UF needed since NOEC used.

Table C-77
Fluoranthene AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Reference Author	Test Species	Endpoint	Duration (d)	EC20 (mg/kg soil)	Notes
TERRESTRIAL PLANTS					
Sverdrup et al., 2003	Sinapsis alba	Seedling growth	21	490	*Seedling growth was more sensitive than seedling emergence.*

🟨 = value used for AL development.

II. Calculate AL

NOAEL (mg/kg-d)	UF	Tier II AL
490	**5**	**98**

Rationale:

Used EC20 values as if it were LOAEL.

Divided by UF of 5 to convert from EC20 to EC10/LOAEL.

Table C-78
Fluoranthene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	EC10 (mg/L)	EC50 (mg/L)	LC10 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC													
Zooplankton													
Fluoranthene	Daphnia magna eggs	lethality	one instar	water					0.036	0.074	death	Barata and Baird, 2000	*Nominal and measured concentrations. Measured concentrations at the beginning and at the end of tests.*
Fluoranthene	Daphnia magna	feeding	one instar	water	0.01		0.0195	0.0378			concentration that affected given percentages of individuals feeding	Barata and Baird, 2000	*Nominal and measured concentrations. Measured concentrations at the beginning and at the end of tests.*
Fluoranthene	Daphnia magna	reproduction	one instar	water	0.03		0.0314	0.0515			concentration that affected given percentages of individuals reproduction	Barata and Baird, 2000	*Nominal and measured concentrations. Measured concentrations at the beginning and at the end of tests.*
Fluoranthene	Daphnia magna	brood mass	one instar	water	0.02		0.0178	0.0439			concentration that affected given percentages of study groups' brood mass	Barata and Baird, 2000	*Nominal and measured concentrations. Measured concentrations at the beginning and at the end of tests.*
Fluoranthene	Daphnia magna	body mass	one instar	water	0.02		0.0135	0.1044			concentration that affected given percentages of individuals body mass	Barata and Baird, 2000	*Nominal and measured concentrations. Measured concentrations at the beginning and at the end of tests.*
Fluoranthene	Daphnia magna	lethality	2	water						0.0087	death	Hatch and Burton, 1999	*Measured at the beginning and the end of experiment of high and low concentrations.*
Fluoranthene	Hyalella azteca	lethality	10	water	0.025						no significant effects on survivorship at any concentrations	Hatch and Burton, 1999	*Measured at the beginning and the end of experiment of high and low concentrations.*
Fluoranthene	Hyalella a zteca	feeding inhibition	10	water		0.00625					leaf disc processing	Hatch and Burton, 1999	*Measured at the beginning and the end of experiment of high and low concentrations.*
Fluoranthene	Hyalella azteca	growth	10	water	0.025						growth not significantly decreased at any concentration	Hatch and Burton, 1999	*Measured at the beginning and the end of experiment of high and low concentrations.*
Fluoranthene	Hyalella azteca	lethality	2	water				0.0109			death	Hatch and Burton, 1999	*Measured at the beginning and the end of experiment of high and low concentrations.*
Fluoranthene	Daphnia magna	lethality	0.0416	water						0.004	death	Kagan et al., 1985	*Assume nominal concentration.*
Fluoranthene	Artemia salina	lethality	0.0416	water						0.04	death	Kagan et al., 1985	
Fluoranthene	Daphnia magna	lethality	1	water	<8.8					1300	death	LeBlanc, 1980	*Nominal concentration.*

Table C-78
Fluoranthene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	EC10 (mg/L)	EC50 (mg/L)	LC10 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC													
Fluoranthene	Daphnia magna	lethality	2	water	<8.8					320	death	LeBlanc, 1980	*Nominal concentration.*
Fluoranthene	Daphnia magna	feeding inhibition	2	water				0.07			feeding inhibition	McWilliam and Baird, 2002	*Note: no mortality below 1mg/L. Nominal and measured concentrations. Concentratiions were measured from the highest three concentrations in each series and stock solutions at the beginning of experimentand at 24 and 48 hr from the highest concentration.*
Fluoranthene	Daphnia magna	growth inhibition	7	water				0.194			reduced growth rates	Olmstead and LeBlanc, 2005	*Nominal concentration.*
Fluoranthene	Ceriodaphnia dubia	lethality	2	water						0.045	death	Oris et al., 1991	*Reported as measured values.Measured at least once during study but frequency of measurment not specified.*
Fluoranthene	Ceriodaphnia dubia	reproduction inhibition	7	water				0.03345			lower mean total # of young per female	Oris et al., 1991	*Reported as measured values.Measured at least once during study but frequency of measurment not specified.*
Fluoranthene	Daphnia magna	organism immobility	10					0.1026			immobile after prodding	Suedel et al., 1993	*Water only toxicity test*
Fluoranthene	Hyalella azteca	organism immobility	10					0.0449			immobile after prodding	Suedel et al., 1993	*Water only toxicity test*
Fluoranthene	Daphnia magna	lethality	2	water	0.085					0.1057	death	Suedel and Rodgers, 1996	*Water only toxicity test*
Fluoranthene	Daphnia magna	lethality	10	water	0.09					0.1026	death	Suedel and Rodgers, 1996	*Water only toxicity test*
Fluoranthene	Hyalella azteca	lethality	2	water	<.074					0.0922	death	Suedel and Rodgers, 1996	*Water only toxicity test*
Fluoranthene	Hyalella azteca	lethality	10	water	0.018					0.0303	death	Suedel and Rodgers, 1996	*Water only toxicity test*
Fluoranthene	Daphnia magna	lethality	21	water	0.017	0.035					Under fluorescent light	Spehar et al., 1999	*Measured concentrations but not specified how frequently*
Fluoranthene	Daphnia magna	lethality	21	water	0.0014	0.0015					Under UV light	Spehar et al., 1999	*Measured concentrations but not specified how frequently*
Fluoranthene	Mysidopsis bahia	lethality	21	water	0.0111	0.0188					Under fluorescent light	Spehar et al., 1999	*Measured concentrations (weekly)*
Fluoranthene	Mysidopsis bahia	lethality	21	water	0.006	0.0014					Under UV light	Spehar et al., 1999	*Measured concentrations (weekly)*
Fluoranthene	Daphnia magna	lethality	0.0833	water				0.78			death	Wernersson and Dave, 1998	*Nominal concentration*
Fluoranthene	Daphnia magna	lethality	0.0833	water				0.0084			death	Wernersson and Dave, 1998	*Nominal concentration*

Table C-78
Fluoranthene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	EC10 (mg/L)	EC50 (mg/L)	LC10 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC													
Fish													
Fluoranthene	Pimephales promelas	inhibited reproduction	98	water				EC = 0.0079			33% reduction in egg production	Diamond et al., 1995	*It appears that the population developed a resistance to the fluoranthene and did not respond to a significant level. Measured concentrations at least once during experiment but more information was not available.*
Fluoranthene	Pimephales promelas	egg hatchability	6	water				EC = 0.0062			33.4% reduction in egg hatching	Diamond et al., 1995	
Fluoranthene	Pimephales promelas	larvae survival	6	water				EC = 0.0062			44.8% reduction in survival of hatched larvae	Diamond et al., 1995	
Fluoranthene	Pimephales promelas	behavioral	0.0104	water	0.0086	0.0086-0.014					avoidance of fluoranthene plume in an experimental tank	Farr et al., 1995	*Measured concentration only once.*
Fluoranthene	Pimephales promelas	lethality	0.021	water						0.2	death	Kagan et al., 1985	*Assumed nominal concentration.*
Fluoranthene	Pimephales promelas	gill damage	1	water		0.0061					alterations in secondary lamellae of gills	Weinstein et al., 1997	*Measured concentrations daily*
Fluoranthene	Pimephales promelas	gill damage	0.5	water		0.0125					alterations in secondary lamellae of gills	Weinstein et al., 1997	*Measured concentrations daily*
Fluoranthene	Pimephales promelas	survival	21	water	0.0104	0.0217					Under fluorescent light	Spehar et al., 1999	*Measured oconcentration twice weekly.*
Fluoranthene	Pimephales promelas	survival	21	water	0.0014	0.0048					Under UV light	Spehar et al., 1999	*Measured oconcentration twice weekly.*
Fluoranthene	Pimephales promelas	lethality	32	water				EC = 0.0217			67% reduction in survival	Spehar et al., 1999	*Measured oconcentration twice weekly.*
Fluoranthene	Pimephales promelas	inhibited growth	32	water				EC = 0.0217			27% reduction in length of fish	Spehar et al., 1999	*Measured oconcentration twice weekly.*
Fluoranthene	Pimephales promelas	inhibited growth	32	water				0.0217			50% reduction in dry weights	Spehar et al., 1999	*Measured oconcentration twice weekly.*

🟨 = value used for AL development.

Taxonomic Group	Value	Relevant Value (mg/L)	UF	Tier II AL (mg/L)	**Rationale:**
Zooplankton	NOEC	0.0014	1	0.0014	Four NOECs considered from measured studies (highlighted in blue or yellow) with relevant endpoints. Lowest is 0.0014 mg/L. No UF needed since NOEC.
Fish	NOEC	0.0014	1	0.0014	Used lowest NOEC for measured study; other endpoints higher. No UF needed since NOEC.

Table C-79
Fluorene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	LOAEL (mg/kg-d)	Specific Effect	Reference	Notes
MAMMALS								
Fluorene	Mice	Various	13 weeks	oral gavage	125	Mortality/Toxicity Symptoms Body Weight Hematology Pathology	Toxicity Research Laboratories, 1989a	*All data kept separate for male and female rats* *Overall all NOEC, LOEC or ECx was calculated (for both sexes or for all effects)* *Test concentrations = 0, 125, 250 and 500 mg/kg/day*

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	LOAEL (mg/kg-d)	UF	TRV
Shrew	125	40	3.13
Lemming	125	20	6.25
Weasel	125	40	3.13

Rationale:

Only one LOAEL; divided by a UF of 10 for subchronic LOAEL to chronic NOAEL.

Taxonomic UF of 2 reflects different Family, same Order.

Taxonomic UF of 4 reflects different Order, same Class.

Table C-80
Fluorene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC	EC10 (mg/L)	EC50 (mg/L)	LC10 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC													
Zooplankton													
Fluorene	Daphnia magna	survival						28.26			death	Lampi et al., 2006	*UV light study. Nominal concentration.*
Fluorene	Daphnia magna											Newsted, 1987	*Lethal times, not concentrations. Discussed as nominal and measured concentrations. Measured concentrations at the end of the study.*

EC50 Calculated from 0.17 mM

🟨 = value used for AL development.

Taxonomic Group	Value	Relevant Value	UF	Tier II AL (mg/L)
Zooplankton	28.3	EC50	10	**2.8**

Rationale:

Only one value available. Divided by UF of 10 to convert from EC50 to LOEC.

Table C-81
1-Methylnaphthalene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	FIR (mg/day)	BW (kg)	Dose (mg/kg-day)
MAMMALS														
1-Methylnaphthalen	B6C3F1 Mouse	Growth	81 weeks	oral (food, mixed in with corn oil)	143.7 mg/kg-d (females), 140.2 mg/kd-d (males)			body weight	Murata et al., 1993	0.03225	*Body weights are means of initial and final weights from control groups, average of male (32.5 g) and female (32 g) weights. Growth retardation observed in 0.15% group after 10 weeks but completely recovered after 72-80 weeks. Diets contained 0.15% and 0.075% in food, total doses over 81 weeks estimated to be 40.6 and 42.6 g/kg and 79.5 and 81.5g/kg in males and females, respectively in low and high dose groups, respectively. Statistical significance not discussed. Converted to daily dose by dividing total study dose of 79.5 g/kg by study duration of 567 days. Used lower of NOELs for male and female mice.*			140.2
1-Methylnaphthalen	B6C3F1 Mouse	Organ weights	81 weeks	oral (food, mixed in with corn oil)		75.1 (females), 71.6 (males) mg/kd-d		brain, salivary glands, hearts, thymus, lung, pancreas, spleen, kidney, testis	Murata et al., 1993	0.03225	*Organ weights and relative organ weights significantly increased or decreased in male and/or female mice, significant differences varied by organ. Increased thymus weight attributed to lymphoma development, others from causes "unknown". ATSDR (2005) identifies these as not dose-related (see summary below).*			
1-Methylnaphthalen	B6C3F1 Mouse	Blood	81 weeks	oral (food, mixed in with corn oil)		75.1 (females), 71.6 (males) mg/kd-d		increased monocytes, hemoglobin, total lipid, phospholipid, neutral fat, other parameters	Murata et al., 1993	0.03225	*ATSDR (2005) identifies the doses in this study as follows: 0.075% = 75.1 mg/kg-d females, 71.6 mg/kg-d males; 0.15% = 143.7 mg/kg-d females, 140.2 mg/kg-d males.*			
1-Methylnaphthalen	B6C3F1 Mouse	Mortality	81 weeks	oral (food, mixed in with corn oil)	143.7 mg/kg-d (females), 140.2 mg/kd-d (males)			survival	Murata et al., 1993	0.03225	*Once high dose female and one control male died. Not a statistically significant effect.*			
1-Methylnaphthalen	Mouse	Respiratory	81 weeks	oral (food, mixed in with corn oil)		71.6 mg/kg-d		pulmonary alveolar proteinosis	ATSDR, 2005		*Toxicological profile (TP 67) identifies this as a LOAEL from the Murata et al., 1993 study (corresponds to 0.075% dose in male mice).*			
1-Methylnaphthalen	Mouse	Various	81 weeks	oral (food, mixed in with corn oil)	143.7 mg/kg-d			cardiological, gastrological, hematological, hepatic, renal, endocrine, body weight, neurological, immunological, reproductive	ATSDR, 2005		*Toxicological profile (TP 67) identifies this as a NOEL for the systems listed based on the Murata et al., 1993 study (dose corresponds to 0.15% dose in female mice). Identified as NOEL for various effects typically based on lack of dose-related changes, lack of histopathological lesions, and/or observations of effects in only one gender.*			

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	Value (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	Mouse	140.2	4	35.1
Lemming	Mouse	140.2	2	70.1
Least Weasel	Mouse	140.2	4	35.1

Rationale: Used chronic NOEL for growth since only relevant endpoint. Used lower of male and female NOELs (140.2 mg/kg-d). No UF needed since chronic
UF of 4 applied for same class, different order (shrew, least weasel).
UF of 2 applied for same order, different family (lemming).

Table C-82
1-Methylnaphthalene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Algae and Other Phytoplankton										
1-Methylnaphthalene	Selenastrum capricornutum	Growth	14 days	aqueous solution (fresh water)	—	—	IC_{10} = 6 IC_{50} = 12 IC_{90} = 34		Gaur, 1988	Static system; Nominal concentrations
	Chlamydomonas angulosa	Photosynthesis	3 hours	aqueous solution (fresh water)	—	—	EC_{50} = 0.012 mmol/m3		Hutchinson et al., 1980	Toxicological values were reference from EPA ECOTOX: Aquatic Report, Reference Number 5065; Nominal concentrations reported; This is a very short-term study that focuses on photosynthesis. Chlorella vulgaris is a more traditional green algae that maybe more representative to the North Slope. Information on Chlamydomonas angulosa says it's generally found in habitats rich in ammonium salt and rarely in brackish/marine water or snow.
	Chlorella vulgaris						EC_{50} = 0.036 $mmol/m^3$			
Zooplankton										
1-Methylnaphthalene	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 10 $mmol/m^3$ (1.422 mg/L)		Bobra et al., 1983	Static, closed system (no air space); nominal concentrations reported in $mmol/m^3$.
Fishes										
1-Methylnaphthalene	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 9		Mattson et al., 1976	Static nonrenewal system; Nominal concentrations

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Algae	6	IC10	1	**6**	Used the IC_{10} value in the long-term growth study with algae. No UF needed since the endpoint is an IC_{10}.
Zooplankton	1.422	48-hour EC50	10	**0.14**	Used the only EC_{50} value and divided by UF of 10 to convert to LOEC.
Fish	9	96-hour LC50	10	**0.9**	Used the only LC_{50} value and divided by UF of 10 to convert to LOEC.

Table C-83
2-Methylnaphthalene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Other (as specified)	Specific Effect	Reference	Notes
MAMMALS										
2-Methylnaphthalene	Mice	Systemic effects	81 weeks	Diet		50.3		Pulmonary proteinosis	Murata et al., 1997	*NOECs, LOECs and ECxs not reported*

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	LOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	50.3	20	2.52
Lemming	50.3	10	5.03
Weasel	50.3	20	2.52

Rationale:

Divided by UF of 5 to extrapolate from chronic LOAEL to NOAEL for non-target endpoint.

Taxonomic UF of 4 reflects different Order, same Class.

Taxonomic UF of 2 reflects different Family, same Order.

Taxonomic UF of 4 reflects different Order, same Class.

Table C-84
2-Methylnaphthalene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg-d)	LOAEL (mg/kg-d)	Other	Specific Effect	Reference	Notes
AQUATIC										
Algae										
2-Methylnaphthalene	Chlorella vulgaris	Photosynthsis Inhibition	3 - 4 days	aqueous solution	-	-	EC50 = 8.96 mg/L	$^{14}CO_2$ uptake	Hutchinson et al., 1980	*assume nominal concetrations*
2-Methylnaphthalene	Chlamydomonas angulosa	Photosynthsis Inhibition	3 - 4 days	aqueous solution	-	-	EC50 = 4.48 mg/L	$^{14}CO_2$ uptake	Hutchinson et al., 1980	*assume nominal concetrations*
Zooplankton										
2-Methylnaphthalene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 1848.6 mg/L	Lethality	Bobra et al., 1983	*assume nominal concentrations*
2-Methylnaphthalene	Daphnia magna	Body burden	48 hr	aqueous solution	-	-	-	-	Pawlisz and Peters, 1993	*Study focused on effects of contaminants on body burden*
2-Methylnaphthalene	Daphnia magna	Body burden	48 hr	aqueous solution	-	-	-	-	Pawlisz and Peters, 1995	*Study focused on effects of contaminants on body burden*
2-Methylnaphthalene	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 1450.4 mg/L	Lethality	Abernethy et al., 1986	*nominal concentrations*
2-Methylnaphthalene	Artemia (salt water species)	Mortality	24 hr	aqueous solution	-	-	LC50 = 473.5 mg/L	Lethality	Abernethy et al., 1986	

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Algae	4.48	EC50	10	**0.45**	Identified lowest value. Divided by UF of 10 to extrapolate from EC50 to LOEC.
Zooplankton	1450	48 hr LC50	10	**145**	Identified lowest value. Divided by UF of 10 to extrapolate from EC50 to LOEC.

Table C-85
2-Methylphenol TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Reference Author	Test Species	Endpoint	Duration (d)	NOEL mg/kg feed	LOEL mg/kg feed	Notes
MAMMALS						
Hornshaw, et al. 1986	Mink (*Mustela vison*)	reproduction	180	🟨 1,600		*Converted to 268.1 mg/kg-d based on BW of 1.35 kg and ingestion rate of 362 mg chemical/day.*
Hornshaw, et al. 1986	Mink (*Mustela vison*)	growth	28		2,520	
Hornshaw, et al. 1986	Mink (*Mustela vison*)	Survival	28	2,520		
Hornshaw, et al. 1986	European Ferrets (*Mustela putorious furo*)	Survival	28	4,536		

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOEL (mg/kg-d)	UF	TRV (mg/kg-day)
Shrew	268.1	4	**67.0**
Lemming	268.1	4	**67.0**
Weasel	268.1	1	**268**

Rationale:

Used lowest NOEL. Chronic reproductive study, so no UF needed.

Taxonomic UF of 4 reflects different Order, same Class.
Taxonomic UF of 4 reflects different Order, same Class.
Same Genus; no UF needed.

Table C-86
3-Methylphenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL	LOAEL	Other	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
3-Methylphenol	Daphnia magna	Mortality	24 hr	aqueous solution	-	-	IC50 = 19 mg/L	Mortality	Devillers, 1988	*Closed system. Nominal concentration.*
3-Methylphenol	Daphnia magna	Mortality	48 hr	aqueous solution	-	-	LC50 = 18.8 mg/L	Mortality	Parkhurst et al., 1979	*This was not a toxicological study. The authors were interested in body burdens of radiolabels at LC$_{50}$ concentrations determined in other studies. (***LC50 value from Konemann, H. Toxicology. 1981:19, 209-221.) Assume nominal concentrations (not specified in the text).*
3-Methylphenol	Daphnia pulicaria	Mortality	48 hr	aqueous solution	-	-	> 99.5 mg/L	Mortality	DeGraeve et al., 1980	*Measured once only. Not specified at which sttep of the bioassay. Assume nominal concentration.*
Fish										
3-Methylphenol	Salmo gairdneri	Mortality	96 hr	aqueous solution	-	-	8.9 mg/L	Mortality	Pickering and Henderson, 1966	*LC50. Nominal concentration*
3-Methylphenol	Pimephales promelas	Mortality	96 hr	aqueous solution	-	-	55.9 mg/L	Mortality	Pickering and Henderson, 1966	*LC50. Nominal concentration*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale:
Zooplankton	18.8	48 hr LC50	10	**1.88**	Used lowest value. Divided by UF of 10 to convert LC50 to LOAEL.
Fish	8.9	96 hr LC50	10	**0.89**	Used lowest value. Divided by UF of 10 to convert LC50 to LOAEL.

Table C-87
4-Methylphenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	LOEC (mg/L)	NOEC (mg/L)	EC (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC											
Zooplankton											
4-Methylphenol	Tetrahymena pyriformis	growth inhibition	2	water			157		50% growth inhibition	Schultz et al., 1996	*nominal concentrations*
4-Methylphenol	Tetrahymena pyriformis	growth inhibition	2.5	water			168.25		50% growth inhibition	Schultz and Riggin, 1985	*nominal concentrations*
4-Methylphenol	Tetrahymena pyriformis	growth inhibition	2	water			157		50% growth inhibition	Schultz et al., 1996	*nominal concentrations*
4-Methylphenol	Tetrahymena pyriformis	growth inhibition	1	water			160		slowed growth rate	Yoshioka et al., 1985	*nominal concentrations*
4-Methylphenol	Daphnia magna	lethality	2	water				1.4	death	Parkhurst et al., 1979	*nominal concentrations*
4-Methylphenol	Daphnia magna	lethality	2	water				22.7	death	DeGraeve et al., 1980	*concentrations measured once during study period*
4-Methylphenol	Hyalella azteca	lethality	4	water			5		44% mortality rate	Stout and Cooper, 1983	*measured continuously in stream channels - not enough information to confirm if truly measured concentration*
4-Methylphenol	Hyalella azteca	lethality	4	water				<2	death	Stout and Cooper, 1983	*sub-referenced information from Cooper and Stout 1982. It is suspected by Stout that mortality rates were due to low DO levels rather than p-cresol concentration; measured continuously in stream channels - not enough information to confirm if truly measured concentration*
Algae											
4-Methylphenol	Spirogyra sp.	dissolved oxygen	0.125	water		4.6	14		73% decrease in dissolved oxygen	Stout and Cooper, 1983	*nominal concentrations*
4-Methylphenol	Spirogyra sp.	respiration rates	0.125	water		4.6	14		64% increase in respiration rates	Stout and Cooper, 1983	*measured continuously in stream channels - not enough information to confirm if truly measured concentration*
Fish											
4-Methylphenol	Salmo gairdneri	lethality	4	water				7.9	death	McKim et al., 1985	*measured concentrations*
4-Methylphenol	Salmo gairdneri	lethality	4	water				69	death	Hodson et al., 1984	*measured concentrations*
4-Methylphenol	Salmo gairdneri	lethality	4	intraperitoneal injection			0.73		death	Hodson et al., 1984	*not relevant route*
4-Methylphenol	Salmo gairdneri	lethality	4	oral intubation			0.87		death	Hodson et al., 1984	*not relevant route*
4-Methylphenol	Salmo gairdneri	lethality	4	water	5.6			7.9	death; physical stress noted at given LOEC	DeGraeve et al., 1980a	*concentrations measured once during study period*
4-Methylphenol	Pimephales promelas	lethality	4	water	22.7			28.6	death; physical stress noted at given LOEC	DeGraeve et al., 1980a	*concentrations measured once during study period*
4-Methylphenol	Pimephales promelas	lethality	0.042					>30	death	Mattson et al., 1976	*nominal concentrations*
4-Methylphenol	Pimephales promelas	lethality	1					26	death	Mattson et al., 1976	*nominal concentrations*
4-Methylphenol	Pimephales promelas	lethality	2					21	death	Mattson et al., 1976	*nominal concentrations*
4-Methylphenol	Pimephales promelas	lethality	3					21	death	Mattson et al., 1976	*nominal concentrations*
4-Methylphenol	Pimephales promelas	lethality	4					19	death	Mattson et al., 1976	*nominal concentrations*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Value	UF	Tier II AL (mg/L)	Rationale
Zooplankton	1.4	LC50	10	**0.14**	Identified lowest LC50. Divided by UF of 10 to extrapolate from LC50 to LOEC.
Algae	4.6	NOEC	1	**4.6**	Used NOEC from single available study. No UF needed since NOEC.
Fish	5.6	LOEC	1	**5.6**	Identified lowest LOEC (all lethality tests). Two separate studies, both measured. Did not use EC values since not typical water exposure route, and nominal study. No UF needed since LOEC.

Table C-88
Naphthalene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	**Test Species**	**Endpoint**	**Duration**	**Route**	**NOAEL (mg/kg-day)**	**LOAEL (mg/kg-day)**	**Specific Effect**	**Reference**	**Test Sp. Body Weight (BWt)**	**Ingestion Rate (IRt)**	**Notes**
MAMMALS											
naphthalene	Rat	clinical	13 wk	gavage		100 mg/kg	rough hair coats (also some weight decrease)	Battelle, 1980a	170-215 g males, 135-155 g females	doses were 1 ml mixture per 200 g body weight, administered 5 d/wk. Feed consumption average for males in control group = 14.3 g/d, females = 9.4 g/d	
naphthalene	Rat	clinical	13 wk	gavage		400 mg/kg	diarrhea, weight decrease, renal lesions, rough coats, lethargy, and hunched posture (females only), also some hematological effects	Battelle, 1980a	0.16875	0.01185	*Hematology data also presented but no statistics were performed on these data.*
naphthalene	Rat	growth	13 wk	gavage		200 mg/kg	significant weight decrease	Battelle, 1980a			
naphthalene	Mouse	clinical	13 wk	gavage		200 mg/kg	rough coats and lethargy, decreased diet consumption (week 5 - not clear if persistent through rest of duration).	Battelle, 1980b	25.1-33.2 g males, 18.6-26.7 g females; 0.0259 kg	doses were 5 ml mixture per kg body weight, administered 5 d/wk. Feed consumption average for males in control group = 4.1 g/d, females = 3.6 g/d; 0.00385 kg/day	*Decreased weight gain also observed in females in a dose-dependent trend, however authors believe the data do not really express toxicity due to lack of supporting data and lack of observed trend in male mice.*
naphthalene	Rat	lesions	2 yr	inhalation		10 ppm (50 mg/m3)	nonneoplastic lesions	NTP, 2000b	248-498 g males, 151-309 g females, control group averages; 0.3015 kg	0.57	*6 hr/d, 5 d/wk*
naphthalene	Mouse	lesions	2 yr	inhalation		10 ppm (50 mg/m3)	nonneoplastic lesions	NTP, 1992	roughly 25-35 g males, 20-30 g females, from graph; 0.0275 kg	0.042	*6 hr/d, 5 d/wk*
naphthalene	Mouse	reproduction	90 d	gavage	133		reduced testes weight	Shopp et al., 1984	males		
naphthalene	Rat	reproduction	9 d	gavage	150	450	GREP	Navarro et al., 1992	females		
naphthalene	Mouse	reproduction	8 d	gavage		300	PROG	Booth et al., 1983	females		
naphthalene	Mouse	reproduction	17 d	gavage		300	PROG	Hardin et al., 1987	females		
naphthalene	Rabbit	reproduction	6 m	gavage	120		PROG	Navarro et al., 1992	females		
naphthalene	Rat	Growth	9 d	gavage	50	150	reduced body weight gain	Navarro et al., 1991	females		
naphthalene	Rat	Growth	14 d	gavage	50		reduced body weight gain	Germansky and Jamall, 1988	males		
naphthalene	Mouse	growth	14 d	gavage	53	267	reduced body weight gain	Shopp et al., 1984	males		
naphthalene	Rabbit	reproduction	23 d	gavage	250	630	resorbed embryos	Pharmakon Research, 1985	females		
naphthalene	Rat	growth	60 d	gavage		700	reduced body weight gain	Tao et al., 1991	females		

🟨 = Value used in identifying TRV

Food Ingestion Rate Calculations for NTP, 1980a

for mouse	1.99x(BW^1.0496)
for rats	0.8x(BW^0.8206)

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV	
Shopp et al., 1984	133			
Navarro et al., 1992	150			
Navarro et al., 1992	120			
Navarro et al., 1991	50			
Germansky and Jamall, 1988	50			
Shopp et al., 1984	53			
Pharmakon, 1986	250			
geomean	**96.7**	**2**	**48.4**	lemming
		4	**24.2**	shrew, weasel

Rationale:

More than three NOAELs with growth, reproduction, or survival/mortality.

Took geometric mean of all seven NOAELs.

UF of 2 represents different Family, same Order.

UF of 4 represents different Order, same Class.

Table C-89
Naphthalene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	NOEC (mg/L)	LOEC (mg/L)	EC50 (mg/L)	LC50 (mg/L)	Other	Specific Effect	Reference	Value (mg/kg-d)	Notes
AQUATIC												
Zooplankton												
Naphthalene	Daphnia pulex	reproduction/ growth	NR; chronic test (>125 days)	0.28-0.38					body length, number of live young	Geiger and Buikema, 1982		*5.6% WSF. Measured concentrations only once in the study in early stage. Assume nominal concentration because of long duration of test.*
Naphthalene	Daphnia pulex	mortality	48-h				2.92-3.89		mortality	Geiger and Buikema, 1982		*WSF naph (100%) = 5.08-6.76 mg/L. Measured concentrations only once in the study.*
Naphthalene	Daphnia pulex									Geiger et al., 1980		*This is the same study as the above with a different discussion. Measured once in stock solution. Assume nominal concentration.*
Naphthalene	Daphnia magna	mortality	48-h				16.718		immobility	Bobra et al., 1983	130 mmol/m3	*Nominal concentration. Saturated solutions prepared in situ and assumed no loss due evaporation.*
Naphthalene	Daphnia magna	mortality	48-h				4.74534		immobility	Abernethy et al., 1986	36.9 mmol/m3	*Nominal concentration but controlled for vaporization in closed system throuugh elimination of air spaces in exposure chambers.*
Naphthalene	Daphnia magna	mortality	48-h				8.6		mortality	LeBlanc, 1980		*Nominal concentration.*
Naphthalene	Daphnia magna	mortality	24-h				17		mortality	LeBlanc, 1980		*Nominal concentration.*
Naphthalene	Daphnia magna	immobility	48-h			2.194			immobility	Munoz and Tarazona, 1993	2194 ug/L	*study also provides some synergistic effects data. Nominal concentration.*
Naphthalene	Daphnia magna	immobility	24-h			2.305			immobility	Munoz and Tarazona, 1993	2305 ug/L	*Nominal concentration.*
Naphthalene	Daphnia pulex	mortality	96-h				1		mortality	Trucco et al., 1983	1000 ug/L	*Measured concentrations but not specified how often. Assume nominal concentration.*
Naphthalene	Daphnia magna									Kukkonen et al., 1990		*bioavailability study; no toxicity data. Measured concentration once only. Assume nominal concentration.*
Naphthalene	Daphnia magna	mortality	48-h				3.4 (4.1 by probit)		mortality	Crider et al., 1982		*Measured initial and final concentration.*
Naphthalene	Daphnia magna	mortality	24-h				13.2 (6.6 by probit)		mortality	Crider et al., 1982		*Measured initial and final concentration.*
Naphthalene	Daphnia magna	circulatory	24-h		5				hemoglobin reduction	Crider et al., 1982		*Measured initial and final concentration.*
Naphthalene	Daphnia magna	respiration	24-h		10				reduced oxygen consumption	Crider et al., 1982		*Measured initial and final concentration.*
Naphthalene	Daphnia magna	behavior	24-h	<1	>5				behavioral changes	Crider et al., 1982		*Measured initial and final concentration.*
Naphthalene	Daphnia magna	mortality	48-h				17.2		mortality	Epsey, 1985		*Nominal concentration.*
Naphthalene	Daphnia pulex	mortality	48-h				3.4		mortality	Geiger and Buikema, 1981		*Nominal concentration.*
Naphthalene	Daphnia pulex	metabolism	24-h	0.51-0.68					oxygen consumption and filtering rate	Geiger and Buikema, 1981		
Naphthalene	Daphnia magna	immobility	24-h			15			immobility	Juttner et al., 1995		*Measured concentration once at the beginning of experiment. Because short duration of experiment concentrations can be assumed to be measured.*
Naphthalene	Daphnia magna	mortality	48-h				2.16		immobility	Millemann et al., 1984		*Measured concentrations at the beginning and the end of tests.*
Naphthalene	Gammarus minus	mortality	48-h				3.93		mortality	Millemann et al., 1984		*Measured concentrations at the beginning and the end of tests.*

Table C-89
Naphthalene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	NOEC (mg/L)	LOEC (mg/L)	EC50 (mg/L)	LC50 (mg/L)	Other	Specific Effect	Reference	Value (mg/kg-d)	Notes
AQUATIC												
Algae												
Naphthalene	Chlorella pyrenoidosa	respiration	48 hours		15				inhibited oxygen consumption and evolution	Struble and Harmon, 1985		*Abstract only. No information availabe regarding determination of naphthalene concentrations.*
Naphthalene	Chlamydomonas angulosa	photosynthesis inhibition	3 hr			9.645			50% reduction in photosynthesis	Hutchinson et al., 1980	75 mmol/m3	*Nominal concentration.*
Naphthalene	Chlorella vulgaris	photosynthesis inhibition	3 hr			19.29			50% reduction in photosynthesis	Hutchinson et al., 1980	150 mmol/m3	*Nominal concentration.*
Naphthalene	Selenastrum capricornutum		4 hr			2.96			50% reduction in rate of C14 assimilation	Millemann et al., 1984		*Measured concentrations at the beginning and the end of tests.*
Naphthalene	Nitzschia palea		4 hr			2.82			50% reduction in rate of C14 assimilation	Millemann et al., 1984		*Measured concentrations at the beginning and the end of tests.*
Naphthalene	Chlamydomonas angulosa	mortality	1-7 days					35	immediate immobility, 61% mortality after 1 day, increased lag time prior to cell division (3-d vs 1-d) but no effect on doubling time or final yield	Soto et al., 1975		*Open system. Nominal concentration*
Naphthalene	Chlamydomonas angulosa	mortality	1-7 days					35	immediate immobility, 85% mortality after 1 day, 97-98% after 3-7 days, 1-2 day lag time in doubling but no effect on doubling time or final yield	Soto et al., 1975		*Closed system. Nominal concentration.*
Naphthalene	Chlamydomonas angulosa	metabolic activity-related parameters	7 d		15				changes in major cellular components; no cell division, morphological differences (not specified), significant decrease in total cellular protein	Soto et al., 1977		*Returned to normal in recovery period following 7-d closed system period. Nominal concentration.*
Naphthalene	Chlamydomonas angulosa	metabolic activity-related parameters	7 d	15					cellular pigments and total cellular carbon	Soto et al., 1977		*Nominal concentration.*
Naphthalene	Chlamydomonas angulosa	morphology	8 d		15				complete immobility, lack of flagella, granulation, increase in contractile vacuole activity, lipid deposits inside vacuoles, cell wall thickening, thylakoidal structure rearrangement, increased # and size of starch grains, stigma globules became less osmiophilic, dense osmiophilic deposition in vacuoles and increased vacuole size.	Soto et al., 1979		*Nominal concentration.*

Table C-89
Naphthalene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	NOEC (mg/L)	LOEC (mg/L)	EC50 (mg/L)	LC50 (mg/L)	Other	Specific Effect	Reference	Value (mg/kg-d)	Notes
AQUATIC												
Fish												
Naphthalene	Pimephales promelas	mortality	96-h				7.9		mortality	DeGraeve et al., 1982		*Measured concentration only once. Assume nominal concentration.*
Naphthalene	Oncorhynchus mykiss/Salmo gairdneri	mortality	96-h				1.6		mortality	DeGraeve et al., 1982		*Measured concentration only once. Assume nominal concentration.*
Naphthalene	Pimephales promelas	reproduction, growth	30 d	0.45	0.85				egg hatchability, larval weight and length	DeGraeve et al., 1982		*Concentration measured weekly.*
Naphthalene	Pimephales promelas	mortality	30 d	1.84	4.38				100% fry mortality @ LOEC, no significant fry mortality at NOEC	DeGraeve et al., 1982		*Concentration measured weekly.*
Naphthalene	Pimephales promelas	mortality	96-h				6.14		mortality	Broderius et al., 1995		*Measured daily.*
Naphthalene	Pimephales promelas	mortality	1.15-4.15 hr					lethal body burden 8 mmol/kg wet	lethal body burden	deMaagd et al., 1997	fish weight average 0.6 g	*Not using this study b/c only one concentration tested, which killed all fish and is higher than LC50s from other studies. Measured concentration only once at the end of test. Due to short duration of test asume measured concentration.*
Naphthalene	lepomis macrochiris	mortality	96-h				31		mortality	Epsey, 1985		*16.6 mg/L at beginning of exposure, 100% of fish died between 1.15 and 4.15 hrs. Nominal concentration.*
Naphthalene	Pimephales promelas		96-h				6.08		mortality	Holcombe et al., 1984		*Not clear if this is naphthalene; test used material 5601-56-1 and refers to "survival in the effluent bioassays."*
Naphthalene	Pimephales promelas		96-h		4.42				lethargy	Holcombe et al., 1984		*Measured concentrations (daily).*
Naphthalene	Pimephales promelas		96-h		5.98				equilibrium loss and deformity	Holcombe et al., 1984		*Measured concentrations (daily).*
Naphthalene	Pimephales promelas	mortality	96-h				1.99		immobilization	Millemann et al., 1984		*Measured concentrations at the beginning and the end of tests.*
Naphthalene	salmo gairdneri	reproduction/mortality	27 d				0.12		egg and larvae mortality (including teratogenic effects)	Millemann et al., 1984		*Measured concentrations at the beginning and the end of tests.*
Naphthalene	micropterus salmoides	reproduction/mortality	7 d				0.68		egg and larvae mortality (including teratogenic effects)	Millemann et al., 1984		*Measured concentrations at the beginning and the end of tests.*

🟨 = value used for AL development.

Taxonomic Group	Relevant Value (mg/L)	Endpoint	UF	Tier II AL (mg/L)	Rationale:
Zooplankton	5	LOEC	5	**1.00**	Used lowest LOEC from measured study. Used a UF of 5 to extrapolate to longer-term study.
Fish	0.45	NOEC	1	**0.45**	Used lowest relevant NOEC from measured study. Excluded Milemann et al., 1984 because study was on trout (less relevant). No UF needed since chronic NOEC.
Algae	2.82	LC50	10	**0.28**	Used lowest growth-based EC50 value from measured study. Divided by UF of 10 for LC50 to LOEC.

Table C-90
Phenanthrene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL	LOAEL	Other	Specific Effect	Reference	Notes
AQUATIC										
Algae										
Phenanthrene	Chlorella vulgaris	Photosynthesis Inhibition	3 hrs	aqueous solution			EC50 = 1.12 mg/L	14CO2 uptake	Hutchinson et al., 1980	*Nominal concentration.*
Phenanthrene	Chlamydomonas angulosa	Photosynthesis Inhibition	3 hrs	aqueous solution			🟨 EC50 = 0.94 mg/L	14CO2 uptake	Hutchinson et al., 1980	*Nominal concentration.*
Zooplankton										
Phenanthrene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 1.16 mg/L	Lethality	Bobra et al., 1983	*Nominal concentration. Saturated solutions prepared in situ and assumed no loss due evaporation.*
Phenanthrene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 0.21 mg/L	Lethality	Abernathy et al., 1986	*Nominal concentration but controlled for vaporization in closed system throuugh elimination of air spaces in exposure chambers.*
Phenanthrene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 0.699 mg/L (visible + UVA)	Lethality	Lampi et al., 2006	*Nominal concentration*
Phenanthrene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 0.478 mg/L (visible + UVA + UVB)	Lethality	Lampi et al., 2006	*Nominal concentration*
Phenanthrene	Daphnia magna	Mortality		aqueous solution				Lethality	Newsted and Giesy, 1987	*results are reported in lethal times not lethal doses. Discussed as nominal and measured concentrations. Measured concentrations at the end of the study only.*
Phenanthrene	Daphnia magna	Mortality	48 hr	aqueous solution			EC50 = 0.383 mg/L	Lethality	Munoz and Tarazona, 1993	*Nominal concentration.*
Phenanthrene	Daphnia magna	Mortality	24 hr	aqueous solution			EC50 = 0.861 mg/L	Lethality	Munoz and Tarazona, 1993	*Nominal concentration.*
Phenanthrene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 0.843 mg/L	Lethality	Eastmond et al., 1984	*Nominal concentration.*
Phenanthrene	Daphnia pulex	Mortality	96 hr	aqueous solution			LC50 = 0.1 mg/L	Lethality	Trucco et al., 1983	*Measured concentrations but not specified how often.*
Phenanthrene	Daphnia pulex	Mortality	48 hr	aqueous solution			LC50 = 1.14 mg/L	Lethality	Geiger and Buikema, 1981	*Nominal concentration.*
Phenanthrene	Daphnia pulex	Mortality	48 hr	aqueous solution			LC20 = 0.096 mg/L	Lethality	Geiger and Buikema, 1981	*Actual LC20 was presented as range (0.096 - 0.13 mg/L) - only presented lower value. Nominal concentration.*
Phenanthrene	Daphnia pulex	Mortality	48 hr	aqueous solution			LC30 = 0.31 mg/L	Lethality	Geiger and Buikema, 1981	*Actual LC30 was presented as range (0.31 - 0.41 mg/L) - only presented lower value.. Nominal concentration.*
Phenanthrene	Daphnia magna	Mortality	48 hr	aqueous solution			EC50 = 0.34 mg/L	Lethality	Brooke, 1993	*Measured every 24 hours.*
Phenanthrene	Daphnia magna	Mortality	21 day	aqueous solution	🟨 0.048 mg/L	0.093 mg/L		Lethality	Brooke, 1993	*Measured on renewal days.*
Phenanthrene	Daphnia magna	Mortality	48 hr	aqueous solution			LC50 = 0.212 mg/L	Lethality	Brooke, 1994	*Measured every 24 hours.*
Phenanthrene	Daphnia pulex	Mortality	48 hr	aqueous solution			LC50 = 0.734 mg/L	Lethality	Passino and Smith, 1987	*Nominal concentration.*
Phenanthrene	Daphnia pulex	Growth and Fecundity	16 day	aqueous solution		0.06 mg/L		Length Number of Neonates/Parent	Savino and Tanabe, 1989	Both nominal and measured concentrations. Nominal concentration used to calculate NOEALs due to large discrepancy between measured and nominal concentrations.
Phenanthrene	Daphnia pulex	Mortality	46 hr	aqueous solution			LC50 = 0.96 mg/L	Lethality	Geiger and Buikema, 1982	*LC50 presented as a range (0.96 - 1.28 mg/L) - only lower value is presented.* *Study also looked at reproductive endpoints but results are presented . Measured concentration only once at the beginning of tests. Assume nominal concentration.*
Phenanthrene	Daphnia pulex	Reproduction	see notes	aqueous solution	0.11 mg/L	0.36 mg/L		Appearance of first brood	Geiger and Buikema, 1981	*Study compared various reproductive endpoints between only two treatment groups (0.11 and 0.36 mg/L). Various endpoints, including appearance of first brood, measured in length of days - therefore no given time length for study. Nominal concentration.*

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	**Rationale:**
Algae	0.94	EC50	10	**0.094**	Used lowest EC50. Since EC50, divided by UF of 10 to convert to LOEC
Zooplankton	0.048	21-day NOEC	1	**0.048**	Utilized lowest NOEC for measured data, which is a chronic study. No UF needed.

Table C-91
Phenol TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Author	Test Species	Endpoint	Duration (d)	NOAEL (mg/kg-d)	LOAEL (ppm in drinking water)	Notes
MAMMALS							
Phenol	Ryan et al., 2001	Rats	Reproduction	70 pre-pairing	70	350	*2 generations - thru pregnancy and lactation*
Phenol	Jones-Price, 1983	Mice	Growth, reproduction, teratology	10	140	280	*Females only, days 6-15 of gestation*

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV)

	NOAEL (mg/kg-d)	UF	TRV
Shrew	70	4	17.5
Lemming	70	2	35.0
Weasel	70	4	17.5

Rationale:

Lowest reproductive NOAEL used since fewer than three studies.
No UF needed since NOAEL and 2-generation reproductive study.
UF of 2 represents different Family, same Order.
UF of 4 represents different Order, same Class.

Table C-92
Phenol AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Reference Author	Test Species	Endpoint	Duration (d)	NOAEL (ppm in drilling fluid soil)	Notes
TERRESTRIAL PLANTS					
Miller et al., 1980	Corn	growth, yield	56	6.83	*No statistics, looked at effects of all different kinds of things in drilling mud, but didn't give provide any details.*
				🟨	= value used for AL development.

II. Calculate AL

NOAEL	UF	Tier II AL
6.83	**1**	**6.8**

Rationale:

Since only 1 NOAEL; used as AL value.

No UF needed since chronic growth and yield study on relevant (monocot) species.

Table C-93
Phenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Taxa	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	EC10	EC90	EC50 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC														
Fish														
Phenol		Salmo gairdneri	lethality	4	water		6.3				8.9	death; physical stress noted at given LOEC vales	DeGraeve et al., 1980a	*Measured only once (not specified at what stage). Assume nominal concentration.*
Phenol		Pimephales promelas	lethality	4	water		50				67.5	death; physical stress noted at given LOEC vales	DeGraeve et al., 1980a	*Measured only once (not specified at what stage). Assume nominal concentration.*
Phenol		Pimephales promelas	lethality	4	water		17.6				24.9	death; physical stress noted at given LOEC vales	DeGraeve et al., 1980a	*test temperature was 25C- unlike all others conducted at 14C. Measured only once (not specified at what stage). Assume nominal concentration.*
Phenol		Pimephales promelas	hatchability	30	water					68.5		45.2% hatchability	DeGraeve et al., 1980a	*Measured weekly.*
Phenol		Pimephales promelas	survivability	30	water	68.5						highest concentration had no significant effect on survivorship	DeGraeve et al., 1980a	*Measured weekly.*
Phenol		Pimephales promelas	growth inhibition	30	water					14.5		significantly reduced mean length	DeGraeve et al., 1980a	*Measured weekly.*
Phenol		Pimephales promelas	growth inhibition	30	water					2.5		significantly reduced mean weight	DeGraeve et al., 1980a	*Measured weekly.*
Phenol		Salmo gairdneri	survivability	58	water	13.8						highest concentration had no significant effect on survivorship	DeGraeve et al., 1980a	*Measured weekly.*
Phenol		Salmo gairdneri	growth inhibition	58	water					0.2		significantly reduced mean length	DeGraeve et al., 1980a	*Measured weekly.*
Phenol		Salmo gairdneri	growth inhibition	58	water					0.2		significantly reduced mean weight	DeGraeve et al., 1980a	*Measured weekly.*
Phenol		Oncorhynchus mykiss	lethality	4	water						8.9	death	Degraeve et al., 1980b	*Measured only once (not specified at what stage). Assume nominal concentration.*
Phenol		Pimephales promelas	lethality	4	water						67.5	death	Degraeve et al., 1980b	*Measured only once (not specified at what stage). Assume nominal concentration.*

Table C-93
Phenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Taxa	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	EC10	EC90	EC50 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC														
Phenol (carrier solvent- saline)		Salmo gairdneri	lethality	4	water						103 (umol/L)	death	Hodson et al., 1984	*measured concentrations (ref in 4methylphenol folder)*
Phenol (carrier solvent- saline)		Salmo gairdneri	lethality	4	intraperitoneal injection						4.34 (mmol/kg)	death	Hodson et al., 1984	*measured concentrations*
Phenol (carrier solvent- saline)		Salmo gairdneri	lethality	4	oral intubation						5.68 (mmol/kg)	death	Hodson et al., 1984	*measured concentrations*
Phenol (carrier solvent- oil)		Salmo gairdneri	lethality	4	intraperitoneal injection						5.83 (mmol/kg)	death	Hodson et al., 1984	*measured concentrations*
Phenol		Pimephales promelas	lethality	32	water	3.57						no concentration significantly affected survivability	Holcombe et al., 1982	*3.57mg/L was highest conc tested*
Phenol		Pimephales promelas	decreased growth	32	water		3.57					significantly decreased mean weight at this concentration	Holcombe et al., 1982	*Measured weekly.*
Phenol		Pimephales promelas	lethality	4	water						28.8	death	Holcombe et al., 1982	*Not specified when measured. Assume nominal concentration.*
Phenol		Oncorhynchus mykiss	lethality	2	water			10.3	16.6	13.1		death	Tisler and Zagorc-Koncan, 1997	*Nominal concentration*
Phenol		Pimephales promelas	lethality	0.042							>50	death	Mattson et al., 1976	*Nominal concentration*
Phenol		Pimephales promelas	lethality	1							>50	death	Mattson et al., 1976	*Nominal concentration*
Phenol		Pimephales promelas	lethality	2							>50	death	Mattson et al., 1976	*Nominal concentration*
Phenol		Pimephales promelas	lethality	3							33	death	Mattson et al., 1976	*Nominal concentration*
Phenol		Pimephales promelas	lethality	4							32	death	Mattson et al., 1976	*Nominal concentration*
Zooplankton														
Phenol		Daphnia magna	physical stress	1	water					19.6		immobilization for 15+ seconds	Crisinel et al., 1994	*Nominal concentration.*
Phenol		Daphnia magna	physical stress	2	water					5.55		immobilization for 15+ seconds	Crisinel et al., 1994	*Nominal concentration.*
Phenol		Streptocephalus rubricaudatus	lethality	1	water						36.3	death	Crisinel et al., 1994	*Nominal concentration.*
Phenol		Streptocephalus texanus	lethality	1	water						21.9	death	Crisinel et al., 1994	*Nominal concentration.*
Phenol		Streptocephalus proboscideus	lethality	1	water						NA		Crisinel et al., 1994	*Nominal concentration.*
Phenol		Artemia salina	lethality	1	water						28.2	death	Crisinel et al., 1994	*Nominal concentration.*

Table C-93
Phenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Taxa	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	EC10	EC90	EC50 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC														
Phenol		Daphnia magna	lethality	2	water						>109.0	death	DeGraeve et al., 1980a	*Measured only once (not specified at what stage). Assume nominal concentration.*
Phenol		Daphnia pulicaria	lethality	2	water						>109	death	DeGraeve et al., 1980b	*Measured only once (not specified at what stage). Assume nominal concentration.*
Phenol		Daphnia magna	reproduction inhibition	16	water	0.16				10		50% of population experienced reproduction inhibition	Deneer et al., 1988	*Nominal concentration.*
Phenol		Daphnia magna	growth inhibition	16	water	0.16				0.46		10% of population experienced growth inhibition	Deneer et al., 1988	*Nominal concentration.*
Phenol		Daphnia magna	immobilization	1	water					0.000395 mol/L		immobilization for 15+ sec.	Devillers, 1988	*Converts to 37.2 mg/L (MW = 94.11). Nominal concentration.*
Phenol		Daphnia magna	reproduction inhibition	16	water					10		50% of population experienced reproduction inhibition	Hermens et al., 1984	*corrected values for recoveries. Nominal and measured concentrations. Frequency of measurments not specified.*
Phenol		Daphnia magna	lethality	2	water						23	death	Hermens et al., 1984	*corrected values for recoveries. Nominal and measured concentrations. Frequency of measurments not specified.*
Phenol		Ceriodaphnia dubia	ingestion rate	1hr	water	31						no effect on ingestion at or below this concentration	Juchelka and Snell, 1995	*Measured concentration not specified . Assume nominal concentration.*
Phenol		Ceriodaphnia dubia	reproductive inhibition	7	water	4						no effect on reproduction at or below this concentration	Juchelka and Snell, 1995	*Measured concentration not specified . Assume nominal concentration.*
Phenol		Daphnia magna	immobility	2	water					6.6		immobile test subjects and possibly dead	Keen and Baillod, 1985	*Measured concentration at the beginning and the end of test.*
Phenol		Daphnia magna	lethality	1	water	2.2					29	death	Leblanc, 1980	*Nominal concentration.*
Phenol		Daphnia magna	lethality	2	water	2.2					12	death	Leblanc, 1980	*Nominal concentration.*
Phenol		Ceriodaphnia dubia	lethality	2	water						3.1	death	Oris et al., 1991	*Measured concentration - did not specified how often. Assume nominal concentration.*
Phenol		Ceriodaphnia dubia	reproduction inhibition	4	water					5.5		lower mean total # of young per female	Oris et al., 1991	*Measured concentration - did not specified how often. Assume nominal concentration.*
Phenol		Ceriodaphnia dubia	reproduction inhibition	7	water					4.9		lower mean total # of young per female	Oris et al., 1991	*Measured concentration - did not specified how often. Assume nominal concentration.*

Table C-93
Phenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Taxa	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	EC10	EC90	EC50 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC														
Phenol		Daphnia magna	lethality	2	water						30.1	death	Parkhurst et al., 1979	*Treated effluent. Assume nominal concentrations (not specified in the text).*
Phenol		Daphnia obtusa	immobility	1	water					8.9		immobility for 10+seconds	Rossini and Ronco, 1996	*Measured at the beginning of test only. Assume nominal concentration.*
Phenol		Daphnia obtusa	immobility	2	water					5.5		immobility for 10+seconds	Rossini and Ronco, 1996	*Measured at the beginning of test only. Assume nominal concentration.*
Phenol		Daphnia pulex	lethality	2	water			4.1	150	25		death	Tisler and Zagorc-Koncan, 1997	*Nominal concentration*
Phenol		Brachionus calyciflorus	lethality	1	water						111.5	death	Crisinel et al., 1994	*Nominal concentration.*
Phenol	rotifer	Brachionus plicatilis	ingestion rate	1h	water	250						no effect on ingestion at or below this concentration	Juchelka and Snell, 1995	*this study was primarily to develop NOEC values- thus only NOEC reported here. Measured concentration not specified . Assume nominal concentration.*
Phenol	rotifer	Brachionus plicatilis	reproductive inhibition	2	water	125						no effect on reproduction at or below this concentration	Juchelka and Snell, 1995	*Measured concentration not specified . Assume nominal concentration.*
Phenol	rotifer	Brachionus plicatilis	ingestion rate	1hr	water	250						no effect on ingestion at or below this concentration	Juchelka and Snell, 1995	*Measured concentration not specified . Assume nominal concentration.*
Phenol	rotifer	Brachionus plicatilis	reproductive inhibition	2	water	25						no effect on reproduction at or below this concentration	Juchelka and Snell, 1995	*Measured concentration not specified . Assume nominal concentration.*
Phenol	protozoa	Paramecium aurelia	ingestion rate	1hr	water	31						no effect on ingestion at or below this concentration	Juchelka and Snell, 1995	*Measured concentration not specified . Assume nominal concentration.*
Phenol		Photobacterium phosphoreum	physical stress	5min	water					24.4		immobilization for 15+ seconds	Crisinel et al., 1994	*Nominal concentration.*
Phenol		Photobacterium phosphoreum	physical stress	15min	water					28.2		immobilization for 15+ seconds	Crisinel et al., 1994	*Nominal concentration.*
Phenol		Photobacterium phosphoreum	physical stress	30min	water					27		immobilization for 15+ seconds	Crisinel et al., 1994	*Nominal concentration.*
Phenol		Mixed bacterial culture	lethality	5	water	70		283				death	Tisler and Zagorc-Koncan, 1997	*microtox test. Nominal concentration.*

Table C-93
Phenol AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Taxa	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	LOEC (mg/L)	EC10	EC90	EC50 (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC														
Algae														
Phenol		Scenedesmus quadricauda	lethality	1	water			184	882	403		death	Tisler and Zagorc-Koncan, 1997	*Nominal concentration.*
											🟨	= value used for AL development.		

Taxonomic Group	Relevant Value (mg/L)	Endpoint	UF	Tier II AL (mg/L)	Rationale:
Fish	3.57	LOEC/EC10	1	**3.57**	Used lowest of five relevant LOEC/EC10 values; 32-day study, measured concentrations.
Zooplankton	5.5	EC50	10	**0.55**	Did not use lower EC50 results from DeGraeve et al., 1980a since much lower than other EC50 values and nominal study. Used lowest EC50 from measured studies since lower than other measured study NOECs. Divided by a UF of 10 to convert to LOEC.
Algae	184	EC10	1	**184**	Used EC10 value from single study. Relevant/equivalent to LOEC. Since LOEC-based value, no UF needed.

Table C-94
Pyrene TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration	Route	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Other	Specific Effect	Reference	Notes
MAMMALS										
Pyrene	Mouse	Various	13 weeks	gastric gavage	< 75 mg/kg/day			Ophthamology Hematology/Serum Chemistry Organ/Tissue Necropsy Histology	Toxicity Research Laboratories, 1989b	

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV
Shrew	**75**	**20**	**3.8**
Lemming	**75**	**10**	**7.5**
Weasel	**75**	**20**	**3.8**

Rationale:

Since only 1 NOAEL; used as TRV value.

Divided by UF 5 for subchronic to chronic.

Taxonomic UF of 4 reflects different Order, same Class.

Taxonomic UF of 2 reflects different Family, same Order.

Taxonomic UF of 4 reflects different Order, same Class.

Table C-95
Pyrene AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	Other	Specific Effect	Reference	Notes
AQUATIC								
Zooplankton								
Pyrene	Daphnia magna	Mortality	48 hr	aqueous solution	LC50 = 1.82 mg/L	Lethality	Bobra et al., 1983	*Nominal concentration.*
Pyrene	Daphnia magna	Mortality	48 hr	aqueous solution	LC50 = 0.091 mg/L	Lethality	Abernethy et al., 1986	*Nominal concentration.*
Pyrene	Artemia	Mortality	24 hr	aqueous solution	LC50 = >0.099 mg/L	Lethality	Abernethy et al., 1986	*Nominal concentration.*
Pyrene	Daphnia magna	Mortality	48 hr	aqueous solution	LC50 = 0.00433 mg/L (visible light + UVA)	Immobility	Lampi et al., 2006	*Nominal concentration.*
Pyrene	Daphnia magna	Mortality	48 hr	aqueous solution	LC50 = 0.00458 mg/L (visible light + UVA + UVB)	Immobility	Lampi et al., 2006	*Nominal concentration.*
Pyrene	Daphnia magna	Mortality	-	aqueous solution		Lethality	Granier et al., 1999	*Study focused on effect of DOM on pyrene toxicity. Nominal concentration.*
Pyrene	Daphnia magna	Mortality	-	aqueous solution		Lethality	Newsted and Giesy, 1987	*Study measured Lethal Times not Lethal Dose (i.e., time to kill 50% of test population at given concentration). Discussed as nominal and measured concentrations. Measured concentrations at the end of the study only.*
Pyrene	Daphnia magna	Mortality	24 hr	aqueous solution	EC50 = > 1.024 mg/L (laboratory light)	Lethality	Wernersson and Dave, 1997	*Nominal concentration.*
Pyrene	Daphnia magna	Mortality	24 hr	aqueous solution	EC50 = 0.0057 mg/L (see notes)	Lethality	Wernersson and Dave, 1997	*24 hour exposure to pyrene + 2 hour photo exposure + 2 hour recovery. Nominal concentration.*
Fish								
Pyrene	Pimephales promelas	Mortality	30 min - 1 hour irradiation + 24 hour	aqueous solution	0.22 mg/L, 5 mg/L	Lethality: phototoxicity	Kagan et al., 1987	*Data were unique - survival curve decreased with increasing concentration then following 10% survival, survival curve increased. Resulted in two LC50 values. Measured concentration (five times over 24 hour period).*

🟨 = Value used in identifying AL

	Test Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Tier II AL (ug/L)	**Rationale:**
Fish	0.22	24 hr LC50	10	**0.022**	**22**	Less than 10, so lowest value used. Since LC50, divided by UF of 10 to convert to LOAEL.
Zooplankton	0.00458	48 hr LC50	10	**0.00046**	**0.458**	Less than 10, so lowest value used. Since LC50, divided by UF of 10 to convert to LOAEL.

Table C-96
Antimony AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	LOEC (mg/L)	NOEC (mg/L)	EC (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Critical Value (mg/kg-d)	Notes
AQUATIC												
Zooplankton												
Antimony	Hyalella azteca	lethality	7	water				0.687	death	Borgmann et al., 2005		*Static tests. Soft water (measured).*
Antimony (anion salt)	Hyalella azteca	lethality	7	water				>1	death	Borgmann et al., 2005		*Statics tests. Soft water (nominal).*
Fish												
Antimony	Cyprinodon variegatus	lethality	1	water	6.2	NA	>6.2<8.3		death	Heitmuller et al., 1981	static tests	*Static tests. Nominal concentrations.*
Antimony	Cyprinodon variegatus	lethality	2	water	6.2	NA	>6.2<8.3		death	Heitmuller et al., 1981	static tests	*Static tests. Nominal concentrations.*
Antimony	Cyprinodon variegatus	lethality	3	water	6.2	NA	>6.2<8.3		death	Heitmuller et al., 1981	static tests	*Static tests. Nominal concentrations.*
Antimony	Cyprinodon variegatus	lethality	4	water	6.2	NA	>6.2<8.3		death	Heitmuller et al., 1981	static tests	*Static tests. Nominal concentrations.*

🟨 = value used for AL development.

Taxonomic Group	Value (mg/L)	Endpoint	UF	Tier II AL (mg/L)
Zooplankton	0.687	LC50	10	0.069
Fish	6.2	LOEC	1	6.2

Rationale:

Only one study; used measured concentration.

Divided by UF of 10 to convert from LC50 to LOEC.

Only one study, so used longest duration.

Since LOEC, no UF needed.

Table C-97

Arsenic AL Derivation for Terrestrial Plants

Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels

Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg)	LOAEL (mg/kg)	Reference	Notes
TERRESTRIAL PLANTS									
Arsenic	As8	Barley	growth and yield	365	soil	10	50	Jiang and Singh, 1994	
Arsenic	As8	Ryegrass	growth and yield	365	soil	10	50	Jiang and Singh, 1994	

🟨 = value used for AL development.

II. Calculate AL

NOAEL (mg/kg)	UF	Tier II AL
10.0	**1.0**	**10**

Rationale:

Less than three NOAELs; both the same value.

No UF since chronic for a relevant (monocot) species.

Table C-98
Arsenic AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC mg/L	EC mg/L	LC50 mg/L	Specific Effect	Reference	Notes
AQUATIC											
Zooplankton											
Arsenic	As11	Daphnia	lethality	2	water	NA	NA	3.8	death	Mount and Norberg, 1984	*Static tests.Nominal concentrations.*
Arsenic	As11	Daphnia	lethality	2	water	NA	NA	1.9	death	Mount and Norberg, 1984	*Static tests.Nominal concentrations.*
Arsenic	As11	Ceriodaphnia	lethality	2	water	NA	NA	1.8	death	Mount and Norberg, 1984	*Static tests.Nominal concentrations.*
Arsenic	As11	Simocephalus	lethality	2	water	NA	NA	1.7	death	Mount and Norberg, 1984	*Static tests.Nominal concentrations.*
Fish											
Arsenic	As12	Pimephales	stressed environ.	2	water	6	9.6	9.9	stress protein response	Dyer et al., 1993	*LC1 = 1.8. Measured concentrations.*

🟨 = Value used in identifying AL

Taxonomic Group	Test Conc (mg/L)	Relevant Value	UF	Tier II AL (mg/L)	Tier II AL (ug/L)	Rationale:
Zooplankton	1.7	LC50	10	**0.17**	**170**	Evaluated lowest values for different species; since <10, used lowest one.
						Divided by UF of 10 to convert from LC50 to LOEC.
Fish	1.8	LC1	1	**1.8**	**1800**	Used LC1 as approximation of 10th percentile toxicity value.
						No UF needed since used essentially LOEC.

Table C-99
Barium TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	NOEC mg/kg	LOEC mg/kg	Specific Effect	Reference
BIRDS								
Barium	Ba2	Chicks	Growth	28	1000	2000	growth, body weight	Johnson et al., 1960

🟨 = Value used in identifying TRV

Body Weight Calculations from Study **FIR**

1-d	28-d	avg	BW (kg)	g/28d	g/d
17 g	700 g	358.5	0.3585	1240	44.29

Conversion from mg/kg to dose:

conc (mg/kg)	FIR (kg/d)	mg/d	NOAEL
1000	0.044	44.3	124

(all information on broiler chicks)

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	NOAEL (mg/kg-d)	UF	TRV (mg/kg-day)
Ptarmigan	124	5	24.8
Goose	124	20	6.2
Loon	124	20	6.2
Lapland longspur	124	20	6.2
Snowy owl	124	20	6.2

Rationale:

Used NOEC, converted to dose.

Divided by UF of 5 to convert from subchronic to chronic duration.
Taxonomic UF of 4 reflects different Order, same Class.

Table C-100
Barium AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg)	LOAEL (mg/kg)	Specific Effect	Reference	Notes
TERRESTRIAL PLANTS										
Barium	Ba1	barley	growth; yield	14	soil	ND	500	reduced yield	Chaudry et al., 1977	*Loam soil; Yolo cty.*
Barium	Ba1	bush beans	growth; yield	14	soil	1000	2000	reduced yield	Chaudry et al., 1977	

🟨 = value used for AL development.

II. Calculate AL

LOAEL (mg/kg)	UF	Tier II AL (mg/kg)
500	**1**	**500**

Rationale:

Lowest LOAEL below lowest NOAEL, so used LOAEL.

No UF needed since LOAEL (e.g., EC10) for relevant endpoint (yield).

Table C-101
Barium AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC mg/L	LC50 mg/L	EC mg/L	Specific Effect	Reference
AQUATIC										
Barium	Ba1	Daphnia	Lethality	2	Water	68	410		Lethality. *Nominal concentrations.*	LeBlanc, 1980
Barium	Ba2	Daphnia	Reproduction	21	Water		14	5.8	16 percent reproductive impairment. *Nominal concentrations.*	Biesinger and Christensen, 1972
								🟨	= Value used in identifying AL	

Taxonomic Group	**Text Conc**	**Units**	**Endpoint**	**UF**	**Tier II AL (mg/L)**	**Tier II AL (ug/L)**	**Rationale:** Used EC16 value due to longer study duration and most relevant endpoint.
Zooplankton	5.8	mg/L	EC16	1	**5.8**	**5800**	No UF needed since EC16.

Table C-102
Cadmium AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Reference Author	Test Species	Endpoint	Duration (d)	NOEC (mg/kg soil)	LC50 (mg/kg)	EC25 (mg/kg)	LOEC (mg/kg)	Specific Effect	Reference	Notes
TERRESTRIAL PLANTS										
Cadmium									Adema and Henzen, 1989	*Hydroponic study - not applicable.*
Cadmium	corn	yield reduction	through maturity			18			Bingham et al., 1975	*Sewage sludge amended with Cd - only summarized data for monocots*
Cadmium	wheat	yield reduction	through maturity			50			Bingham et al., 1975	*Sewage sludge amended with Cd*
Cadmium	little bluestem	germination, yield	84	20					Miles and Parker, 1979a	
Cadmium	wheat	reduced yield	35				2.5		Haghiri, 1973	*Silty clay soil: only 3 plants per dose level.*
Cadmium	corn	reduced yield	28	50			100		Lehoczky et al., 1996	*5 plants per dose.*
Cadmium	little bluestem	yield reduction	42	10			30		Miles and Parker, 1979b	*3 plants per dose.*
Cadmium	Kentucky bluegrass	yield reduction	42	10			30		Miles and Parker, 1979b	*3 plants per dose.*
Cadmium	red fescue	growth reduction		10			50		Carlson and Rolfe, 1979	*With fertilizer; 100 mg/kg NOEC without fertilizer.*
Cadmium	ryegrass	growth reduction		50			100		Carlson and Rolfe, 1979	*With fertilizer; 100 mg/kg NOEC without fertilizer.*
Cadmium	oat	root biomass, plant decomposition	42	10			20		Khan and Frankland, 1984	
Cadmium	wheat	root biomass, plant decomposition	42				50		Khan and Frankland, 1984	
Cadmium	wheat	yield reduction	161			30			Muramoto et al., 1990	*EC30*
Cadmium	ryegrass	root elongation							Wong and Bradshaw, 1982	*Hydroponic study - not applicable.*
Cadmium	alfalfa	yield	100				250		Taylor and Allinson, 1981	*Data poorly presented.*
Cadmium	corn	yield	31				2.5		Miller et al., 1977	*Sandy loam soil; 3 plants per dose.*

🟨 = value used for AL development.

geomean 17.5 mg/kg

II. Calculate AL

NEOC (mg/kg)	UF	Tier II AL (mg/kg)
17.5	**1**	**18**

Rationale:

Calculated geometric mean for seven NOECs.

Chronic NOEC; no UF needed.

Table C-103
Cadmium AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	EC (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
Cadmium	Ceriodaphnia	death	2	immersion			0.068		Mount and Norberg, 1984	*Nominal concentrartions.*
Cadmium	Daphnia pulex	death	2	immersion			0.066		Mount and Norberg, 1984	*Nominal concentrartions.*
Cadmium	Daphnia magna	death	2	immersion			0.118		Mount and Norberg, 1984	*Nominal concentrartions.*
Cadmium	Daphnia magna	death	2	immersion			0.039		Schuytema et al., 1984	*Measured concentrations (using atomic absorption flame or graphite furnace techniques)*
Cadmium	Daphnia magna	fecundity	21	immersion	0.0032				Van Leeuwen et al., 1985	*Exp't B: Nominal concentrations. [Exp't C used measured concentrations where the LOEL= 0.363 ug/L(Total Cd) and 0.300 ug/L (dissolved)]*
Algae										
Cadmium	Chlamydomonas	morphology	8 mo			.00049 uM			Visviki and Rachlin, 1994	
Cadmium	Dunaliella	morphology	8 mo			.00049 uM			Visviki and Rachlin, 1994	
Cadmium	Chlamydomonas	photosynthesis	acute			0.0032			Overnell, 1975	*Approximately EC50.; nominal concentrations*

🟨 = value used for AL development.

Taxonomic Group	Value (mg/L)	Endpoint	UF	Tier II AL (mg/L)
Zooplankton	0.0032	NOEC	1	0.0032
Algae	0.0032	EC50	10	0.00032

Rationale:

Fewer than ten values, so used NOEC, which was below lowest LOEC.

No UF needed since long-term NOEC value.

Used photosynthesis EC50 as most relevant endpoint.

Divided by UF of 10 to convert from EC50 to LOEC.

Table C-104
Chromium AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Lethal Conc. (mg/kg)	NOEC (mg/kg)	EC50 (mg/kg)	Reference	Notes
TERRESTRIAL PLANTS									
Chromium (III)									
Cr (III)		Avena sativa (oats)	growth	14		10	159	Adema and Henzen, 1989	*Loam soil.*
Cr (III)		Avena sativa (oats)	growth	14		10	97	Adema and Henzen, 1989	*Humic sand.*
Chromium (VI)									
Cr (VI)		Lolium perenne	root growth	14			2	Wong and Bradshaw, 1982	

🟨 = value used for AL development.

II. Calculate AL

Chemical	Endpoint	Value (mg/kg)	UF	Tier II AL	Rationale:
Cr (III)	NOEC	**10**	**1**	**10**	Used NOEC for relevant endpoint (growth). No UF needed since seedling growth NOEC.
Cr (VI)	NOEC	**2.0**	**5**	**0.4**	Used EC50. Divided by UF of 5 to convert from EC50 to LOEC/EC10.

Table C-105
Copper AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Lethal Conc. (mg/kg feed)	NOEC (mg/kg feed)	NOEL (mg/kg feed)	25% Weight Reduction (mg/kg)	Other (mg/kg)	NOAEC (mg/kg)	Reference Author	Notes
TERRESTRIAL PLANTS												
Copper	CuTerr16	Andropogon scoparius	Shoot, root weight	84				37			Miles and Parker, 1979a	*No effect from copper on germination of big bluestem.*
Copper	CuTerr16	Rudbeckia hirta	Total mortality	84					200		Miles and Parker, 1979a	*LC100.*
Copper	CuTerr17	Alfalfa	10% yield depletion	not stated					EC10 = 785		Gonzales, 1991	*Looked at 10 different soils, ranged from 32 to 1,600 mg/kg depending on the soil type. Lower values from sandy soils.*
Copper	CuTerr19	Maize	Chlorosis	15			317.7				Mocquot et al., 1996	
Copper	CuTerr21	Ryegrass	Root growth								Wong and Bradshaw, 1982	*No statistics, looked at comparative toxicity of different metals.*
Copper	CuTerr22	Cotton	Yield reduction by 50%						EC50 = 400		Rehab and Wallace, 1978	

🟨 = value used for AL development.

II. Calculate AL

Value (mg/kg)	UF	Tier II AL (mg/kg)
37	**1**	**37**

Rationale:

Used EC25 from chronic study; biomass reduction.

No UF needed since chronic EC25; lower than other EC10 and NOEL values.

No UF needed since chronic EC25; lower than other EC10 and NOEL values.

Table C-106
Copper AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Solution	Duration (d)	LC50 (µg/L)	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	IC50 (µg/L)	EC50 (µg/L)	Reference Author	Notes
AQUATIC													
Algae													
Copper	Cu8	Pseudokirchneriella subcapitata	Survival	Reconstituted water	21		29.4	42.4			831	DeSchamphelaere and Janssen, 2004	*Lowest of 35 tests, low DOC and pH.*
Copper	Cu3	Chlamydomonas bullosa	Ultrastructural changes									Visviki and Rachlin, 1994	*No toxicity data that I could find.*
Copper	Cu11	Chlamydomonas geitleri	Growth rate, final yield, cellular Cu content									Hall et al., 1989	*No levels provided.*
Copper	Cu36	Chlamydomonas reinhardtii										Overnell, 1975	*No levels provided.*
Copper	Cu26	Chlamydomonas reinhardtii	Cell density	Pond water	3		15 to 35					Winner and Owen, 1991	*Looked at effect of hardness, DOC, and alkalinity on toxicity.*
Copper	Cu26	Chlamydomonas reinhardtii	Deflagellation	Pond water	3		20 to 35					Winner and Owen, 1991	*Looked at effect of hardness, DOC, and alkalinity on toxicity.*
Zooplankton													
Copper	Cu1	Daphnia magna	Survival		2	54						Mount and Norberg, 1984	*100 mL water.*
Copper	Cu1	Daphnia pulex	Survival		2	53						Mount and Norberg-King, 1985	*100 mL water.*
Copper	Cu1	Ceriodaphnia reticula	Survival		2	17						Mount et al., 1986	*15 mL water.*
Copper	Cu2	Ceriodaphnia dubia	Survival	Reconstituted soft water	1		4	6	5	5		Jop et al., 1995	*15 mL water.*
Copper	Cu2	Ceriodaphnia dubia	Reproduction	Reconstituted soft water	1		4	6	5	5		Jop et al., 1995	*15 mL water.*
Copper	Cu2	Ceriodaphnia dubia	Survival	River Water	1		19	37	11	15		Jop et al., 1995	*15 mL water.*
Copper	Cu2	Ceriodaphnia dubia	Reproduction	River Water	1		10	14	11	15		Jop et al., 1995	*15 mL water.*
Copper	Cu4	Ceriodaphnia dubia	Survival	Reconstituted hard water	2	12						Banks et al., 2003	*Combined toxicity with diazanon.*
Copper	Cu5	Ceriodaphnia dubia	Survival	Reconstituted hard water	2	35						Belanger et al., 1989	
Copper	Cu5	Ceriodaphnia dubia	Survival	Reconstituted hard water	2	79						Belanger et al., 1989	*Hardness 94 mg/L CaCO3.*
Copper	Cu6	Ceriodaphnia dubia	Survival	Reconstituted water	2	406	219					Cowgill and Milazzo, 1991a	
Copper	Cu6	Ceriodaphnia dubia	Survival	Reconstituted water	4	302	79					Cowgill and Milazzo, 1991b	
Copper	Cu6	Ceriodaphnia dubia	Survival	Reconstituted water	9	192	79					Cowgill and Milazzo, 1991b	
Copper	Cu7	Daphnia magna	Survival	Reconstituted water	21		29.4	42.4			34.6	DeSchamphelaere and Janssen, 2004	*Lowest of 35 tests, low DOC and pH.*
Copper	Cu8	Daphnia magna	Survival	Reconstituted water	2						66.8	DeSchamphelaere et al., 2005	
Copper	Cu4	Ceriodaphnia dubia	Survival	Reconstituted hard water	2	12						Banks et al., 2003	*Combined toxicity with diazanon.*

Table C-106
Copper AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Solution	Duration (d)	LC50 (µg/L)	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	IC50 (µg/L)	EC50 (µg/L)	Reference Author	Notes
AQUATIC													
Copper	Cu9	Daphnia pulex	Survival	Creek water	2	37						Dobbs et al., 1994	
Copper	Cu22	Ceriodaphnia dubia	Survival	Reconstituted water	4	60						Murray-Gulde et al., 2002	
Copper	Cu22	Ceriodaphnia dubia	Reproduction	Reconstituted water	7		25	50				Murray-Gulde et al., 2002	
Copper	Cu23	Daphnia magna										Shaner and Knight, 1985	*Looked at copper in sediment not water.*
Copper	Cu24	Daphnia magna	Swimming velocity	Reconstituted water	1	9.77						Untersteiner et al., 2003	
Copper	Cu12	Daphnia magna	Population density	Reconstituted water								Jin et al. 1991	*No levels provided.*
Copper	Cu13	Daphnia magna	Survival	Reconstituted water	1						536	Khangarot and Rathore, 2003	
Copper	Cu13	Daphnia magna	Survival	Reconstituted water	2						93	Khangarot and Rathore, 2003	
Copper	Cu14	Ceriodaphnia dubia	Survival	Reconstituted water	1	20.1						Kim et al., 1999	*Deionized water.*
Copper	Cu14	Ceriodaphnia dubia	Survival	Reconstituted water	1	87.2						Kim et al., 1999	*Water with unequilibrated dissolved organic matter (DOM).*
Copper	Cu14	Ceriodaphnia dubia	Survival	Reconstituted water	1	119.2						Kim et al., 1999	*Water with 1 day equilibrated DOM.*
Copper	Cu16	Daphnia magna	Survival	Reconstituted hard water	2	26 to 59						Lazorchak and Waller, 1993	*Looked at effect of feeding daphnia and not feeding daphnia.*
Copper	Cu17	Daphnia longispina	Survival	ASTM hard water	2	104 to 242						Lopes et al., 2004	*Looked at sensitivity to copper of 265 lineages, all with different sensitivities.*
Copper	Cu21	Ceriodaphnia dubia	Survival	Reconstituted water	1	40						Milam et al., 2005	
Copper	Cu21	Daphnia magna	Survival	Reconstituted water	1	120						Milam et al., 2005	
Copper	Cu18	Ceriodaphnia cf. dubia	Survival	Reconstituted soft water	2						1.6	Markich et al., 2005	*Looked at the effect of hardness on toxicity.*
Copper	Cu29	Ceriodaphnia dubia	Survival	Lake water	2						55 to 96	Borgmann and Charlton, 1984	
Copper	Cu33	Ceriodaphnia dubia	Survival	Reconstituted water	1	4 to 54						Kim et al., 2001	*Looked at effect of pH and Hardness.*
Copper	Cu26	Ceriodaphnia dubia	Survival	Pond water	3		50 to 80					Winner and Owen, 1991	
Copper	Cu30	Daphnia magna	Survival	Reconstituted water	2	31						Borgmann and Ralph, 1983	
Copper	Cu1	Simocephalus vetulus	Survival		2	57						Mount et al., 1987	*15 mL water.*

Table C-106
Copper AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Solution	Duration (d)	LC50 (µg/L)	NOEC (µg/L)	LOEC (µg/L)	MATC (µg/L)	IC50 (µg/L)	EC50 (µg/L)	Reference Author	Notes
AQUATIC													
Fish													
Copper	Cu9	Pimephales promelas	Survival	Creek water	2	284						Dobbs et al., 1994	
Copper	Cu15	Pimephales promelas	Larval survival	Reconstituted water	9	188						Kolok et al., 2004	*Looked at survival of different groups, this is the lowest value.*
Copper	Cu19	Pimephales promelas	Survival	POWT water - tertiary	1	600 to 900						Markle et al., 2000	*Looked at effect of the age of the minnows on the values.*
Copper	Cu19	Pimephales promelas	Survival	POWT water - tertiary	2	200 to 600						Markle et al., 2000	*Looked at effect of the age of the minnows on the values.*
Copper	Cu19	Pimephales promelas	Survival	POWT water - tertiary	4	150 to 600						Markle et al., 2000	*Looked at effect of the age of the minnows on the values.*
Copper	Cu22	Pimephales promelas	Survival	Reconstituted water	4	675	125	250				Murray-Gulde et al., 2002	
Copper	Cu27	Pimephales promelas	Survival	Stream water	7	70			16			Norberg and Mount, 1985	
Copper	Cu28	Pimephales promelas	DNA Measurements	Hard raw well water	4							Parrott and Sprague, 1993	
Copper	Cu28	Pimephales promelas	RNA Measurements	Hard raw well water	4							Parrott and Sprague, 1993	
Copper	Cu28	Pimephales promelas	Protein Measurements	Hard raw well water	4							Parrott and Sprague, 1993	
Copper	Cu31	Pimephales promelas	Survival	Stream water	4							Brungs et al., 1976	
Copper	Cu9	Lepomis macrochirus (sunfish)	Survival	Creek water	2	4300						Dobbs et al., 1994	
Copper	Cu2	Salvelinus fontinalis (brook trout)	Survival	Reconstituted	10		75	158	109	187		Jop et al., 1995	*34L water.*
Copper	Cu2	Salvelinus fontinalis	Growth	Reconstituted	10		75	158	109	187		Jop et al., 1995	*34L water.*
Copper	Cu2	Salvelinus fontinalis	Survival	River Water	10		312	438	112	292		Jop et al., 1995	*34L water.*
Copper	Cu2	Salvelinus fontinalis	Growth	River Water	10		79	160	112	292		Jop et al., 1995	*34L water.*

🟨 = value used for AL development.

Taxonomic Group	Value (µg/L)	Endpoint	UF	Tier II AL (mg/L)	Rationale
Zooplankton	11.3	10th percentile	10	**0.0011**	Calculated 10th percentile using LC50 and EC50 for survival and reproduction (see table below); used longest duration within a study. Divided by UF of 10 to convert to LOEC.
Algae	29.4	NOEC	1	**0.029**	Only one study. NOEC used, so no UF needed.
Fish	70	LC50	10	**0.0070**	Used lowest LC50 for survival/growth since below NOECs. Divided LC50 by UF of 10 to convert to LOEC.

Table C-107
Lead AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOAEL (mg/kg)	LOAEL (mg/kg)	Reference	Soil type	Notes
TERRESTRIAL PLANTS										
Lead	Pb1	Little bluestem	germination	96	Soil	See effect	340	Miles and Parker, 1979a	2 sandy soils	*Only one dose level. 25% reduction.*
Lead	Pb2	ryegrass	growth	30	soil	1000	5000	Carlson and Rolfe, 1979	silt loam soils	*Average of three clippings (10, 20, and 30 days). Threshold.*
Lead	Pb2	fescue	growth	30	soil	1000	5000	Carlson and Rolfe, 1979	silt loam soils	*Average of three clippings (10, 20, and 30 days). Threshold.*
Lead	Pb3	oat	root biomass reduction	7 or 30	soil	100	500	Khan and Frankland, 1984	english soils	*Fungal-based degradation.*
Lead	Pb3	wheat	root biomass reduction	7 or 30	soil	NA	500	Khan and Frankland, 1984	various	
Lead	Pb4	wheat	yield reduction	161	soil	3000	10000	Muramoto et al., 1990	alluvial soil	
Lead	Pb5	alfalfa	yield reduction	100	soil	250	NA	Taylor and Allinson, 1981	sandy loam	*Greenhouse.*
Lead	Pb6	corn	shoot length	31	soil	125	250	Miller et al., 1977	loamy sand	*Greenhouse.*
Lead	Pb7	corn	root elongation	7	soil	100	250	Hassett and Koeppe, 1976	loamy sand	*From seeds.*

🟨 = value used for AL development.

II. Calculate AL

NOAEL (mg/kg)	UF	Tier II AL (mg/kg)
1000		
100	1	**100**
3000		
250		
125		
100		
313	(geometric mean)	

Rationale:

Used all NOAELs from different studies since all with relevant endpoints.

Calculated geomean (313 mg/kg) of highlighted values, which is greater than the lowest bounded LOAEL (250 mg/kg). Therefore selected lowest NOAEL of 100 mg/kg. No UF used since long-term NOAELs.

Table C-108
Lead AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC mg/L	EC mg/L	LC50 mg/L	Specific Effect	Reference	Critical Value (mg/kg-d)	Notes
AQUATIC												
Zooplankton												
Lead	Pb5	Daphnia	lethality	2	water	NA	NA	4.4	death	Mount and Norberg, 1984	static tests	*Nominal concentrations*
Lead	Pb6	Daphnia	lethality	2	water	NA	NA	5.1	death	Mount and Norberg, 1984	static tests	*Nominal concentrations*
Lead	Pb7	Ceriodaphnia	lethality	2	water	NA	NA	0.53	death	Mount and Norberg, 1984	static tests	*Nominal concentrations*
Lead	Pb8	Simocephalus	lethality	2	water	NA	NA	4.5	death	Mount and Norberg, 1984	static tests	*Nominal concentrations*
Algae												
Lead	Pb9	Chlamydomonas	photosynthesis	15 min	water	NA	9e-5 M	NA	EC50; reduced O2	Overnell, 1975		*Filtered; nominal concentrations*

Note: 🟨 = Value used in identifying AL

Taxonomic Group	Test Conc (mg/L)	Endpoint	UF	Tier II AL (mg/L)	Tier II AL (ug/L)	**Rationale:**			
Zooplankton	0.53	LC50	10	0.053	53	Used lowest LC50. Divided by UF of 10 to convert to LOEC	**Conversion of M to mg/L:**	**Overnell, 1975**	
							.00009 moles/L x	Pb MW = 233.19 g/mole	
Algae	20.99	EC50	10	2.1	2099	Converted LC50 to concentration.	Pb concentration =	0.02099	g/L
						Divided by 10 to convert from LC50 to LOEC.	Pb concentration =	20.99	mg/L

Table C-109
Mercury TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	NOEC mg/kg feed	LOEC (mg/kg feed)	Weight (BWt) (kg)	(IRt) g/g-d	Reference Author	Notes	IR	Dose
MAMMALS												
Weasel Studies												
Mercury	HgTerr3	Mink	no effects; including repro	150	10		1.45	150 g/d	Aulerich et al., 1974	*Mercuric chloride.*	1.5	1.03
Lemming/Shrew Studies												
Mercury	HgTerr4	Rats	kidney nephropathy	730	2.5	5	0.315	0.04	NTP, 1993b	*Mercuric chloride.*	0.1	0.317
Mercury	HgTerr4	Mice	kidney nephropathy	730		5	0.031	0.2	NTP, 1993b	*Mercuric chloride.*	1	32.3
Mercury	HgTerr5	Swiss Mice	kidney morphology	20 months		4000 ppm			Revis et al., 1989	*Oral exposure route (in feed pellets). Most food incorporated contaminated soil/sediments (with other metals contamination as well), some had mercuric chloride added to specific levels in the contaminated soil.*		
Mercury	HgTerr5	Swiss Mice	kidney function	20 months	2000 ppm				Revis et al., 1989	*Oral exposure route (in feed pellets). Most food incorporated contaminated soil/sediments (with other metals contamination as well), some had mercuric chloride added to specific levels in the contaminated soil.*		

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Value (mg/kg-day)	Endpoint	UF	TRV
Shrew	0.32	NOEC	4	0.08
Lemming	0.32	NOEC	2	0.16
Least Weasel	1.03	NOEC	1	1.03

Rationale:

One reproductive NOEC for rats and mice; converted to dose. No UF since chronic NOAEL.
Taxonomic UF of 2 reflects different Family, same Order.
Only mink NOEC used; converted to dose. No UF since chronic NOAEL.
Taxonomic UF of 4 reflects different Order, same Class.

Table C-110
Mercury TRV Derivation for Birds
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	NOEC mg/kg feed	LD50 mg/kg feed	LOEL (mg/kg feed)	25% Weight Reduction mg/kg	Weight (BWt) (kg)	(IRt) g/g-d	Reference	Notes	IR mg/d	Dose mg/kg-d
BIRDS														
Mercury	HgTerr1	Japanese quail	Mortality	28		200					El-Begearmi et al., 1980	*HgCl. Estimated, no calculation provided.*		
Mercury	HgTerr2	Japanese quail	Net reproductivity	140	4		8		0.15	31 g/d	Hill and Schaffner, 1976	*HgCl. Slightly depressed at concentrations greater than 8 ppm in feed. 4 ppm enhanced reproductivity.*	0.124	0.83

🟨 = Value used in identifying TRV

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Value (mg/kg-day)	UF	TRV (mg/kg-day)
Ptarmigan	0.83	1	0.83
Goose	0.83	4	0.21
Loon	0.83	4	0.21
Lapland longspur	0.83	4	0.21
Snowy owl	0.83	4	0.21

Rationale:

Used single NOEC for reproduction endpoint; converted to dose.

No UF needed since chronic reproduction NOAEL.

Taxonomic UF of 4 reflects different Order, same Class.

Table C-111
Mercury AL Derivation for Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	**Reference Number**	**Test Species**	**Endpoint**	**Duration (d)**	**Lethal Conc. (mg/kg feed)**	**NOEC (mg/L)**	**LD50 (mg/kg feed)**	**EC50 (ppm)**	**Reference Author**	**Notes**
TERRESTRIAL PLANTS										
Mercury	HgTerr6	Barley		7		5			Mukhiya et al., 1983	
Mercury	CuTerr21	Ryegrass	Root growth					6.3	Wong and Bradshaw, 1982	*No statistics, looked at comparative toxicity of different metals.*

🟨 = value used for AL development.

II. Calculate AL

NOEC (mg/kg)	UF	Tier II AL (mg/kg)
5	**1**	**5**

Rationale:

Only one NOEC; used it. Below EC50 for ryegrass.

No UF needed since NOEC.

Table C-112
Nickel AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Solution	Duration (d)	LC50 ug/L	NOEC ug/L	LOEC ug/L	EC50 ug/L	Reference Author	Notes
Nickel	Ni1	Daphnia magna	Survival	Reconstituted water	2				1000	Haley and Kurnas, 1993	Nickel-coated graphite fibers; measured concentrations.

🟨 = Value used in identifying AL

Taxonomic Group	Test Conc (ug/L)	Endpoint	UF	Tier II AL (ug/L)	**Rationale:**
Zooplankton	1000	EC50	10	**100**	Used only value. Divided by UF of 10 to convert from EC50 to LOEC.

Table C-113

Selenium AL Derivation for Terrestrial Plants

Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels

Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	NOEC mg/kg	LOEC m/kg	EC20 mg/kg	Reference Author	Notes
TERRESTRIAL PLANTS								
Selenium	Sorghum vulgare		42	1	2		Carlson et al., 1991	*Yield*
Selenium	Wheat (Triticum aestivum)		135	2.5	5		Singh and Singh, 1978	*Yield*
Selenium	Wheat		28			4	Martin et al., 1936	*Yield*

🟨 = value used for AL development.

II. Calculate AL

NOEC (mg/kg)	UF	Tier II AL (mg/kg)
1.0	**1**	**1.0**

Rationale:

Used lowest NOEC since fewer than three NOECs or LOECs.

UF not needed since relevant endpoint (yield) and NOEC.

Table C-114
Selenium AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration days	Route	NOEC (µg/L)	EC (µg/L)	LC50 (µg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
Selenium	S. expinosus	abundance	514	water		2		effective LOEC	Crane et al., 1992	*Samples collected from pond. Measured concentrations.*
Selenium	G. testudinaria	abundance	21	water		2		effective LOEC	Crane et al., 1992	*Samples collected from pond. Measured concentrations.*
Selenium	E. lamellatus	abundance	21	water		2		effective LOEC	Crane et al., 1992	*Samples collected from pond. Measured concentrations.*
Selenium	A. harpae	abundance	21	water		2		effective LOEC	Crane et al., 1992	*Samples collected from pond. Measured concentrations.*
Selenium	Ergasilus sp.	abundance	21	water	25			highest dose tested	Crane et al., 1992	*Samples collected from pond. Measured concentrations.*
Selenium	Cyclops sp.	abundance	21	water	25			highest dose tested	Crane et al., 1992	*Samples collected from pond. Measured concentrations.*
Selenium	Daphnia magna	lethality	2	water			710	death	Halter et al., 1980	*Static tests. Measured concentrations.*
Selenium	Daphnia magna	lethality	4	water			430	death	Halter et al., 1980	*Static tests. Measured concentrations.*
Selenium	Daphnia magna	lethality	14	water			430	death	Halter et al., 1980	*Static tests. Measured concentrations.*
Selenium	Hyallela azteca	lethality	2	water			940	death	Halter et al., 1980	*Static tests. Measured concentrations.*
Selenium	Hyallela azteca	lethality	4	water			340	death	Halter et al., 1980	*Static tests. Measured concentrations.*
Selenium	Hyallela azteca	lethality	14	water			70	death	Halter et al., 1980	*Static tests. Measured concentrations.*
Selenium	Hyallela azteca	no effect	21	water	30			no effect concentration	Halter et al., 1980	*Level in which control results equaled experiment. Measured concentrations.*
Selenium	Daphnia magna	lethality	2	water			2560	death in acute testing	Ingersoll et al., 1990	*ASTM soft water; sodium selenate. Measured concentrations.*
Selenium	Daphnia magna	lethality	2	water			700	death in acute testing	Ingersoll et al., 1990	*ASTM soft water; sodium selenate. Measured concentrations.*
Selenium	Daphnia magna	lethality	2	water			1790	death in acute testing	Ingersoll et al., 1990	*ASTM soft water; Inorganic selenium mixture. Measured concentrations.*
Selenium	Daphnia magna	reproduction	21	water		1410		Sig. delayed day first gravid	Ingersoll et al., 1990	*Survival at this concentration was 5%, next down (.711mg/L) was 93.3% survival. Measured concentrations.*
Selenium	Daphnia magna	reproduction	21	water	348			Sig. decreased number of young	Ingersoll et al., 1990	*Measured concentrations.*
Selenium	Daphnia magna	lethality	1	water	220		660	death	LeBlanc, 1980	*Nominal concentrations.*
Selenium	Daphnia magna	lethality	2	water	220		430	death	LeBlanc, 1980	*Nominal concentrations.*
Fish										
Selenium	Pimephales promelas	lethality	14	water			0.6	death	Halter et al., 1980	*Static tests. Measured concentrations.*
Selenium	Pimephales promelas	hatchability of eggs	47h-96h	water	≤40,000			normal hatch rates	Halter et al., 1980	*Although Se levels >15 mg/L did sig. reduce incubation times. Measured concentrations.*
Selenium	Pimephales promelas	body weight	98 hr	food	30			No effect on body weight	Hermanutz, 1992	*Experimental streams; measured concentrations.*
Selenium	Pimephales promelas	reproduction	98 hr	food		10		Fewer offspring, more deformed offspring	Hermanutz, 1992	*Experimental streams; measured concentrations.*
Selenium	Pimephales promelas	reproduction	98 hr	food	30			no inhibiting effects on reproduction	Ogle and Knight, 1989	*Measured concentrations.*

🟨 = value used for AL development.

Taxonomic Group	Value (µg/L)	Endpoint	UF	Tier II AL (mg/L)	**Rationale:**
Zooplankton	2	LOEC	1	0.0020	All EC values were used; equal to LOEC. No UF needed since LOEC (i.e., EC10) is goal.
Fish	10	EC	5	0.0020	Selected longest duration for body weight or reproduction in measured study; used EC value since below NOEC. UF of 5 used EC is below other NOECs, but above NOEC for lethality.

Table C-115
Silver AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Algae and Other Phytoplankton										
Silver	Chlamydomonas reinhardtii	Growth	4 days	aqueous solution (fresh water)	—	0.00066	EC_{50} = 15.1 ±6.5 (Influent) nM EC_{50} = 13.2 ±5.8 (Effluent) nM EC_{50} = 13.5 ±4.8 (internal	Growth Inhibition	Hiriart-Baer et al., 2006	Static-continuous culture system; Nominal and measured concentrations reported in nmol of free Ag+ uptake [Ag+ mol. Weight = 107.8682]. Convert 6.1 nM free Ag+: 6.1e-9 mol/L * 107.8682 g/mol * 1e3 mg/g = 0.00066 mg/L Convert 8.8 nM free Ag+: 8.8e-9 mol/L * 107.8682 g/mol * 1e3 mg/g = 0.00095 mg/L
	Pseudokirchneriella subcapitata					0.00095	EC_{50} = 15.1 ±6.5 (Influent) nM EC_{50} = 13.2 ±5.8 (Effluent) nM EC_{50} = 13.5 ±4.8 (internal dose) amol/cell			
	Scendesmus quadricauda	Growth	~7 days	aqueous solution (fresh water)	—	0.0095	—	Population Growth Rate	Bringmann and Kuhn, 1980	Static system; Nominal concentrations (concentrations given as test results for inorganic substances are principally referred to the effective ion); Study duration is unclear may have been longer.
	Selenastrum capricornutum	Growth	10 days	aqueous solution (fresh water)			IC_{50} = 0.0857 (Ag_2SO_3) IC_{50} = 0.0758 ($AgNO_3$)	Growth Inhibition	Schmittschmitt et al., 1996	Static system; Measured concentrations reported.
Zooplankton										
Silver	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	0.034	—	LC_{50} = 0.0015 (0.0014-0.0017)		LeBlanc, 1980	Static system; Nominal concentrations reported with 95% confidence intervals in parentheses; Diluent water mean hardness = 72 mg/L $CaCO_3$
	Ceriodaphnia dubia	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.014		Mount and Norberg, 1984	Static-renewal system; Nominal concentrations reported with 95% confidence intervals in parentheses; Diluent water mean hardness = 45 mg/L CaCO3
	Ceriodaphnia reticulata						LC_{50} = 0.011 (0.008-0.014)			
	Simocephalus vetulus						LC_{50} = 0.015 (0.013-0.018)			
	Ceriodaphnia dubia	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.00092 (0.00069-0.00123) [AgNO3] LC_{50} >1.93 [AgCl] LC_{50} >12 [Ag(S2O3)n]		Rodgers et al., 1997	Static system; Measured concentrations with 95% confidence intervals in parentheses; Diluent water mean hardness = 70 mg/L $CaCO_3$; LC_{50} values were the same at 4 days and 10 days.
		Reproduction	10 days		0.00053	0.00114				
	Daphnia magna	Mortality	4 days		—	—	LC_{50} = 0.00106 (0.00099-0.00114) [AgNO3] LC_{50} >1.93 [AgCl] LC_{50} >12 [Ag(S2O3)n]			
		Reproduction	10 days		0.0008	0.00122				

Table C-115
Silver AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Silver	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.002317 (0.001749–0.002884)		Karen et al., 1999	Static-renewal system; Measured concentrations reported with 95% confidence intervals in parentheses; Tests ran with varying water quality parameters. Toxicological values were selected that had the closest similarities to the North Slope water quality characteristics based on background values from the Consolidated Background Report (SLR, 2013).
	Daphnia magna	Mortality	2 days	aqueous solution (fresh water)			LC_{50} = 0.003309 (0.0009988-0.001604)		Lemke, 1981	Static system; Measured concentrations reported with 95% confidence intervals in parentheses; Tests ran with varying water quality parameters. Toxicological values were selected that had the closest similarities to the North Slope water quality characteristics based on background values from the Consolidated Background Report (SLR, 2013).
	Ceriodaphnia dubia	Mortality	7 days	aqueous solution (fresh water)	0.004-0.005	0.008-0.010	ChV = 0.0057-0.0071 IC_{10} = 0.0045-0.0058 IC_{25} = 0.0052-0.0073 IC_{50} = 0.0064-0.0098		Birge & Zuiderveen, 1996	Static-renewal system; Measured concentrations reported; Two independent experiments.
	Ceriodaphnia dubia	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.00076 (0.00053-0.00109)		Bielmyer et al., 2007	Static system; Measured concentrations reported with 95% confidence intervals in parentheses.
	Daphnia magna	Immobile	2 days	aqueous solution (fresh water)	—	—	EC_{50} = 0.0009 (0.0008-0.001)		Holcombe et al., 1987	Toxicological values were reference from EPA ECOTOX: Aquatic Report, Reference Number 12665; Flow-through system; Measured concentrations reported with 95% confidence intervals in parentheses.
Fishes										
Silver	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.0116 (0.0081-0.0308) [$AgNO_3$] LC_{50} >1.93 [AgCl] LC_{50} >12 [$Ag(S_2O_3)n$]		Rodgers et al., 1997	Static system; Measured concentrations reported with 95% confidence intervals in parentheses; Diluent water mean hardness = 70 mg/L $CaCO_3$.
			10 days				LC_{50} = 0.0106 (0.0075-0.0259) [$AgNO_3$] LC_{50} >0.93 [AgCl] LC_{50} >12 [$Ag(S_2O_3)n$]			
	Lepomis macrochirus	Mortality	1 day	aqueous solution (fresh water)	—	—	LC_{50} = 0.8		Buccafusco et al., 1981	Static system (capped jars); Nominal concentrations reported with 95% confidence intervals in parentheses.
			4 days				LC_{50} = 0.06 (0.05-0.07)			
	Pimephales promelas	Mortality	2 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.00563 (0.005–0.00626)		Karen et al., 1999	Static system; Measured concentrations reported with 95% confidence intervals in parentheses; Tests ran with varying water quality parameters. Toxicological values were selected that had the closest similarities to the North Slope water quality characteristics based on background values from the Consolidated Background Report (SLR, 2013).
	Oncorhynchus mykiss				—	—	LC_{50} = 0.02842 (0.02509–0.03219)			
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.007371 (0.0056533-0.008342)		Lemke, 1981	Flow-through system; Measured concentrations reported with 95% confidence intervals in parentheses; Tests ran with varying water quality parameters. Toxicological values were selected that had the closest similarities to the North Slope water quality characteristics based on background values from the Consolidated Background Report (SLR, 2013).
	Oncorhynchus mykiss				—	—	LC_{50} = 0.011497 (0.0094978-0.014111)			

Table C-115
Silver AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Silver	Oncorhynchus mykiss	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.01 LC_{25} = 0.005 LC_{10} = 0.0008 LC_1 = 0.0001		Birge & Zuiderveen, 1996	Static-Renewal system; Measured concentrations reported.
	Micropterus salmoides						LC_{50} = 0.11 LC_{25} = 0.07 LC_{10} = 0.018 LC_1 = 0.004			
	Ictalurus punctatus						LC_{50} = 0.01 LC_{25} = 0.007 LC_{10} = 0.002 LC1 = 0.0003			
	Carassius auratus						LC_{50} = 0.02 LC_{25} = 0.01 LC_{10} = 0.004 LC_1 = 0.001			
	Pimephales promelas	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.00337 (0.00302-0.00375)		Bielmyer et al., 2007	Static system; Measured concentrations; They also used silver nitrate
	Oncorhynchus mykiss	Mortality	4 days	aqueous solution (fresh water)	—	—	LC_{50} = 0.006 (0.005-0.007)		Holcombe et al., 1987	Toxicological values were reference from EPA ECOTOX: Aquatic Report, Reference Number 12665; Flow-through system; Measured concentrations reported with 95% confidence intervals in parentheses.
	Pimephales promelas						LC_{50} = 0.009 (0.008-0.010)			
	Lepomis macrochirus						LC_{50} = 0.013 (0.009-0.020)			

🟨 = value used for AL development.

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Algae	0.00066	LOEC - Growth	1	**0.0007**	Used lowest LOEC. No UF was applied to the LOEC value.
Zooplankton	0.00053	NOEC - Reproduction	1	**0.0005**	Used lowest measured and bounded NOEC value from the most sensitive species in the chronic reproduction study. No UF was applied to the NOEC value.
Fish	0.0001	LC_1 - Mortality	5	**0.00002**	Used lowest measured LC_1 value from the most sensitive species in the study. The LC_1 value was divided by an UF of 5 to extrapolate a sub-chronic to chronic duration.

Table C-116
Vanadium AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/L)	EC (mg/L)	LC50 (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Zooplankton										
Vanadium	Daphnia magna	lethality	0.25	water		1.7		death of 0/20 (0%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.25	water		3.4		death of 0/20 (0%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.25	water		1.7		death of 1/20 (5%)	Tomasik et al., 1995	*Hard water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.5	water		3.4		death of 0/20 (0%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.5	water		1.7		death of 1/20 (5%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.5	water		1.7		death of 2/20 (10%)	Tomasik et al., 1995	*Hard water. Nominal data.*
Vanadium	Daphnia magna	lethality	1	water		1.7		death of 12/20 (60%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	1	water		3.4		death of 16/20 (80%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.75	water		6.8		death of 18/20 (90%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.75	water		1.7		death of 2/20 (10%)	Tomasik et al., 1995	*Hard water. Nominal data.*
Vanadium	Daphnia magna	lethality	1	water		6.8		death of 19/20 (95%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	1	water		1.7		death of 2/20 (10%)	Tomasik et al., 1995	*Hard water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.25	water		6.8		death of 4/20 (20%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.75	water		1.7		death of 7/20 (35%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.5	water		6.8		death of 8/20 (40%)	Tomasik et al., 1995	*Soft water. Nominal data.*
Vanadium	Daphnia magna	lethality	0.75	water		3.4		death of 9/20 (45%)	Tomasik et al., 1995	*Soft water. Nominal data.*

🟨 = value used for AL development.

Taxonomic Group	Value (mg/L)	Endpoint	UF	Tier II AL (mg/L)	**Rationale**
Zooplankton	1.7	EC10	1	**1.7**	Used EC10 concentrations from different time periods; all were the same. Since EC10 is target, no UF needed.

Table C-117
Zinc AL Derivation for Terrestrial Plants
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC (mg/kg)	LOEC (mg/kg)	Specific Effect	Reference	Soil type	Notes
TERRESTRIAL PLANTS											
Zinc	Zn8	Little bluestem	germination	96	Soil	NA	NA	salt effect (ZnCl)	Miles and Parker, 1979b	2 sandy soils	*Only one dose level. 25% reduction.*
Zinc	Zn9	wheat	yield reduction	161	Soil	3000	10000		Muramoto et al., 1990	alluvial soil	
Zinc	Zn10	wheat, oats	growth		soil			reduction	Carroll and Loneragan, 1968		*Zinc in nutrient solution - concs. Reported in mM.*

🟨 = value used for AL development.

II. Calculate AL

NOEC (mg/kg)	UF	Tier II AL (mg/kg)
3000	**1**	**3000**

Rationale:

Only one NOEC and one LOEC; used lowest value.

Long-term NOEC, so no UF used.

Table C-118
Zinc AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Reference Number	Test Species	Endpoint	Duration (d)	Route	NOEC mg/L	LC50 mg/L	LOEC mg/L	Specific Effect	Reference	Notes
AQUATIC											
Zooplankton											
Zinc	Zn14	Cyclops	Mortality	2	water	0.8	3.31	NA	Lethality	Abbasi et al., 1988	*Nominal concentrations.*
Zinc	Zn11	Daphnia	Mortality	21	water	0.1	0.15	NA	Lethality	Munzinger and Monicelli, 1991	*EC% not calculable; at least EC50. Measured concentrations*
Zinc	Zn12	Ceriodaphnia	Mortality	2	water	NA	0.115	NA	Lethality	Belanger and Cherry, 1990	*pH 8 results (3 organisms/pH). Measured concentrations, average of three reported values from different rivers.*
Zinc	Zn12	Ceriodaphnia	Reproduction	7	water	0.03	NA	0.075	Young/female	Belanger and Cherry, 1990	*Measured concentrations (pH 6, 8, and 9 studied), average of three reported values from different rivers.*
Zinc	Zn15	Daphnia	Mortality	2	water	NA	0.068	NA	Lethality	Mount and Norberg, 1984	*Nominal concentrations.*
Zinc	Zn15	Daphnia	Mortality	2	water	NA	0.107	NA	Lethality	Mount and Norberg, 1984	*Nominal concentrations.*
Zinc	Zn15	Ceriodaphnia	Mortality	2	water	NA	0.076	NA	Lethality	Mount and Norberg, 1984	*Nominal concentrations.*
Zinc	Zn 16	Daphnia	Mortality	2	water	0.9	2.8	NA	Lethality	Bowmer et al., 1998	*Measured concentrations.*
Fish											
Zinc	Zn10	Pimephales	Mortality	7	water	0.0846	0.238	0.125	Lethality	Norberg and Mount, 1985	*static renewal test. Nominal concentrations.*
Zinc	Zn13	Pimephales	Mortality	21	water	NA	NA	NA	sensitization	Hobson and Birge, 1989	*No raw data presented; can't use study..*
Zinc	Zn 16	B. rerio	Mortality	4	water	12.9	23.1	--	Lethality	Bowmer et al., 1998	*Zinc chloride. Nominal and measured concentrations.*

🟨 = Value used in identifying AL

Receptor Group	Value (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Tier II AL (ug/L)	**Rationale:**
Zooplankton	0.075	LOEC	1	**0.075**	**75**	Used LOEC since lowest effect level of measured concentration studies, and only one targeting non-lethal relevant endpoint. Below LC50s and NOECs for other measured studies. No UF needed since reproduction LOEC.
Fish	12.9	NOEC	1	**12.9**	**12900**	Used lowest NOEC since only one study with measured values. No UF needed since NOEC used.

Table C-119
Cyanide TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	FIR (mg/day)	Dose (mg/day)	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)
MAMMALS															
Cyanide (as KCN)	Rat (Wistar)	Reproduction	16.3 (control) to 19.7 (test) days pre-pregnancy, throughout gestation and 21 day lactation period	Oral (Diet)	500 ppm (note in table says 1.25 g KCN/kg diet)			Litter size, birth weights, offspring mortality rate	Tewe and Maner, 1981	0.273 (dams prior to treatment)	*Only tested one concentration. Control diet contained added KCN+. Used measurements (FIR, BWt) for animals fed control diet through all subdivisions of groups throughout study. Food was analyzed and "no remarkable loss of added cyanide over 48-hr" reported (results not shown). Dams fed KCN through gestation, lactation.*	34,500 (test dams during lactation period). 20,000 (during gestation) Assumed 21 day gestation. Average FIR=27,250	34.1	125	
Cyanide (as KCN)	Rat (Wistar)	Maternal toxicity	16.3 (control) to 19.7 (test) days pre-pregnancy, throughout gestation and 21 day lactation period	Oral (Diet)	500 ppm (note in table says 1.25 g KCN/kg diet)			Body weight, relative liver and kidney weights	Tewe and Maner, 1981	0.273 (dams prior to treatment)	*Dams fed KCN through gestation, lactation.*	37,500 (control dams during lactation period)			
Cyanide (as KCN)	Rat (Wistar)	Growth	28 day growth period	Oral (Diet)		500 ppm (note in table says 1.25 g KCN/kg diet)		Growth rate, feed consumption, protein efficiency ratio	Tewe and Maner, 1981	0.0061 (pups at birth) plus 0.0035 gain per day. Weight halfway through growth period=0.0551	*Pups fed KCN diet in postweaning growth phase. Only concentration tested other than control.*	12,300 (weanling rats during growth phase)	15.38		279
Cyanide (as KCN)	Rat (Wistar)	Reproduction	16.3 (control) to 19.7 (test) days pre-pregnancy, throughout gestation and 21 day lactation period	Oral (Diet)		500 ppm (note in table says 1.25 g KCN/kg diet)		reduced liver weight in pups	Tewe and Maner, 1981	0.273 (dams prior to treatment)	*Pregnant dams fed KCN diet during gestation. Only concentration tested other than control.*	37,500 (control dams during lactation period; rate during gestation not reported)			
Cyanide (as KCN)	Rats	Growth	11.5 months	Oral (Diet)		1500 ppm		Weight gain (reduced in both (+) and (-) control + KCN groups)	Philbrick et al., 1979	0.043	*Study conducted using + and - control and treatment (control + KCN) diets. Only one treatment concentration tested. Study began with weanling rats. FIR measured but not reported. Used food consumption rate equation for laboratory mammals from EPA 1988: F=0.056*W^0.6611*	6995	10		244
Cyanide (as KCN)	Rats	Mortality, clinical toxicity	11.5 months	Oral (Diet)	1500 ppm				Philbrick et al., 1979	0.043		6995	10	244	

Table C-119
Cyanide TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	FIR (mg/day)	Dose (mg/day)	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)
MAMMALS															
Cyanide (as KSCN)	Rats	Growth	11.5 months	Oral (Diet)	2240 ppm			Weight gain	Philbrick et al., 1979	0.043	*Study conducted using + and - control and treatment (control + KSCN) diets. Only one treatment concentration tested. Study began with weanling rats. FIR measured but not reported. Used food consumption rate equation for laboratory mammals from EPA 1988: F=0.056*W^0.6611*	6995	17	390	
Cyanide (as KSCN)	Rats	Mortality, clinical toxicity	11.5 months	Oral (Diet)	2240 ppm				Philbrick et al., 1979	0.043		6995	17	390	
Cyanide (as KCN)	Rat	Mortality	18 days	Oral (Diet)	480 ppm	960 ppm		survival	Maner and Gomez, 1973	not reported	*Various numbers of rats (out of 5 tested) died at each dose level except 2400 ppm. Authors indicate that concentrations below 2400 ppm are sublethal. No statistical tests conducted.*	7,067 (control rats for 18 day experiment; 127.2 g reported, assumed total consumed over 18 day period)			
Cyanide (as KCN)	Rat	Growth	18 days	Oral (Diet)			480 ppm	body weight gain	Maner and Gomez, 1973	not reported	*Weight gain declined steadily with increasing concentrations; concentrations of 480, 960,1600, 2400, 3200, 4800, and 8000 ppm tested.*	7,067 (control rats for 18 day experiment; 127.2 g reported, assumed total consumed over 18 day period)			
Cyanide (as KCN)	Rats	Thyroid status	4 months and 11 months	Oral (Diet)			1500 ppm	Plasma thyroxine decrease	Philbrick et al., 1979	0.043	*Effect observed at 4 months but not at 11 months, (+) and (-) control + KCN groups*	Measured but not reported			
Cyanide (as KCN)	Rats	Thyroid status	4 months and 11 months	Oral (Diet)			1500 ppm	Thyroxine secretion rate decrease	Philbrick et al., 1979	0.043	*Effect observed at 4 and 11 months, (+) and (-) control + KCN groups*	Measured but not reported			
Cyanide (as KCN)	Rats	Thyroid status	11 months	Oral (Diet)			1500 ppm	Thyroid weight	Philbrick et al., 1979	0.043	*(+) and (-) control + KCN groups*	Measured but not reported			
Cyanide (as KSCN)	Rats	Thyroid status	4 months and 11 months	Oral (Diet)			2240 ppm	Plasma thyroxine decrease	Philbrick et al., 1979	0.043	*Effect observed at 4 and 11 months, (+) and (-) control + KSCN groups*	Measured but not reported			
Cyanide (as KSCN)	Rats	Thyroid status	4 months and 11 months	Oral (Diet)			2240 ppm	Thyroxine secretion rate decrease	Philbrick et al., 1979	0.043	*Effect observed at 4 months, (+) and (-) control + KSCN groups, and at 11 months in (+) control + KSCN group only*	Measured but not reported			
Cyanide (as KSCN)	Rats	Thyroid status	11 months	Oral (Diet)			2240 ppm	Thyroid weight	Philbrick et al., 1979	0.043	*(+) and (-) control + KCN groups*	Measured but not reported			

Table C-119
Cyanide TRV Derivation for Mammals
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site-Related Chemical	Test Species	Endpoint	Duration (d)	Route	NOEL	LOAEL	Other	Specific Effect	Reference	Weight (BWt) (kg)	Notes	FIR (mg/day)	Dose (mg/day)	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)
MAMMALS															

🟨 = Value used in identifying TRV

▨ = eliminated from TRV development; poor quality data.

II. Calculate Toxicity Reference Value (TRV) as Basis for AL

	Endpoint Species	Value (mg/kg-day)	UF	TRV (mg/kg-day)
Shrew	Rat	125	4	31.3
Lemming	Rat	125	2	62.5
Least Weasel	Rat	125	4	31.3

Rationale: Use lowest NOAEL for reproduction (125 mg/kg-day). This is lower than the lowest LOAEL, so use it as the TRV.
UF of 4 applied for same class, different order.
UF of 2 applied for same order, different family.

Table C-120
Cyanide AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
Algae and Other Phytoplankton										
Cyanide	Myriophyllum spicatum	Growth	32 days	aqueous solution (fresh water)	—	—	IC_{50} = 22.4 (Root Weight) IC_{50} = 20.0 (Shoot Weight) IC_{50} = 28.6 (Root Length) IC_{50} = 27.3 (Shoot Length)	Inhibition of Growth	Stanley, 1974	Static test; Nominal concentrations reported; As of 2011 has not been documented in Alaska.
	Chlamydomonas reinhardtii	Growth	3 days	aqueous solution (fresh water)	—	—	EC_{50} = 0.331 (0.309-0.354) EC_{10} = 0.158 (0.138-0.176) mg/L	Biomass, General Population Changes	Brack and Rottler, 1994	Static system (sealed bipartite test vessel); Measured concentrations reported with 95% confidence intervals in parentheses.
	Scendesmus quadricauda	Growth	~7 days	aqueous solution (fresh water)	—	0.03	—	Population Growth Rate	Bringmann and Kuhn, 1980	Static system; Nominal concentrations reported (concentrations given as test results for inorganic substances are principally referred to the effective ion); Study duration is unclear.
Zooplankton										
Cyanide	Ceriodaphnia dubia	Mortality	2 days	aqueous solution (fresh water)	—	—	EC_{50} = 2.52 ±0.20		Lee et al., 1997	Static test; Nominal concentrations; Study was used for development of Ceriodaphnia algal uptake suppression test (CAUST) for short-term toxicity screening.
			30 minutes				EC_{50} = 4.8 (30-min Microtox)			
		Food Consumption	1 hour				EC_{50} = 0.94 ±0.17 (1-hour CAUST)			
Fishes										
Cyanide	Rhinichthys atratulus Semotilus atromaculatus	Mortality	2-3 days	aqueous solution (fresh water)	—	—	LT_{50} = 0.19		Burdick and Lipschuetz, 1950	Static test; Measured concentrations reported; Both fish don't appear to be relevant to Alaska.
	Salmo gairdneri	Growth	18 days	aqueous solution (fresh water)	—	0.01	—	Histological changes Growth Physiology Respiration	Dixon and Leduc, 1981	Static-renewal test; Nominal concentrations reported; Endpoints based on physiological changes rather than mortality (decreased weight, increased respiration, and liver damage).
	Lepomis macrochirus	Mortality	4 days	aqueous solution (fresh water)	—	—	TLm = 0.18 mg/L		Patrick et al., 1968	Static test; Nominal concentrations reported.
	Lepomis macrochirus	Reproduction	28-289 days	aqueous solution (fresh water)	0.0052	0.0194	LC_{50} = 0.125 (0.115-0.135)		Smith et al., 1979	Flow-through system with modified diluter; Measured concentrations (Epstein colorimetric method) reported with 95% confidence intervals in parentheses.
	Pimephales promeles				0.0129 - 0.0196	—	LC_{50} = 0.131 (0.124-0.138) LTC = 0.120			
	Perca favescens	Mortality	4 days		—	—	LC_{50} = 0.108 (0.102-0.115)			
	Salvelinus fontinalis				0.0057	0.0112	LC_{50} = 0.0937 (0.0851-0.103)			
	Salmo gairdneri				—	—	LC_{50} = 0.0572 (0.0557-0.0587)			
	Pomoxis nigromaculatus				—	—	LC_{50} = 0.101 (0.0847-0.121)			
	Micropterus salmoides				—	—	LC_{50} = 0.101 (0.0957-0.107)			

Table C-120
Cyanide AL Derivation for Aquatic Receptors
Site-Wide Project Work Plan - Part III: Revised Site-Wide Conceptual Site Model and Screening Levels
Prudhoe Bay Unit, Alaska, BP Exploration (Alaska) Inc.

I. Identify Relevant References

Site - Related Chemical	Test Species	Endpoint	Duration (days)	Route (media type)	NOEC (mg/L)	LOEC (mg/L)	Other (mg/L)	Specific Effect	Reference	Notes
AQUATIC										
	🟨	= value used for AL development.								

Taxonomic Group	Conc (mg/L)	Relevant Effect Level	UF	Tier II AL (mg/L)	Rationale
Algae	0.158	EC10 - Growth	1	**0.16**	Used the lowest measured EC_{10} value that used a sealed container. No UF was applied to the EC_{10} value.
Zooplankton	2.52	48-hour EC50	10	**0.25**	Used EC_{50} value from known test method. The EC_{50} value was divided by a UF of 10 to extrapolate from EC_{50} to LOEC.
Fish	0.0052	NOEC	1	**0.005**	Used lowest measured and bounded NOEC values from a long-term reproduction study. No UF was applied to the NOEC value.

APPENDIX D

TOXICOLOGICAL ARTICLE LIST

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