HUMAN HEALTH RISK ASSESSMENT FOR PROPOSED STP MCKAY THERMAL PROJECT – PHASE 2

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1.0 INTRODUCTION

The proposed STP McKay Thermal Project – Phase 2 (the Project) by Southern Pacific Resource Corp. (STP) consists of a 24,000 bbl/d expansion of the existing STP McKay Thermal Project – Phase 1. Combined, the Phase 1 and Phase 2 projects will generate a total production (i.e., approved + expansion) capacity of 36,000 bbd/d of bitumen. The Project will use steam assisted gravity drainage technology (i.e., SAGD or *in situ* oil sands development) to extract the bitumen. The Project is located 45 km northwest of Fort McMurray and 40 km southwest of the community of Fort McKay.

This Human Health Risk Assessment (HHRA) describes the nature and significance of the potential short-term (i.e., acute) and long-term (i.e., chronic) health risks posed to people exposed to the Chemicals of Potential Concern (COPCs) emitted or released from the Project. The HHRA examines the potential health risks attributable to the Project in combination with existing, approved and planned emission sources in the region.

2.0 SCOPE OF ASSESSMENT

The scope of the HHRA was based on the following:

- Terms of Reference issued by Alberta Environment (AENV 2011) for the HHRA;
- Focused HHRA work plan that was developed between STP and Alberta Health and Wellness (Intrinsik 2011); and,
- Issues and/or concerns expressed by specific regulatory and community stakeholders regarding potential health risks associated with the Project.

The scope of the assessment is discussed in greater detail in the sections below.

2.1 Terms of Reference

This assessment was completed to address Section 6.1 of the Terms of Reference (AENV 2011), which requires STP to describe those aspects of the project that may have implications for public health. The terms of reference was developed after the release of the public disclosure document describing the nature and schedule of the Project (STP 2011). The specific requirements addressed in the HHRA based on the Terms of Reference are as follows:

- Determine quantitatively whether there may be implications for public health arising from the Project;
- Document any health concerns raised by stakeholders during consultation on the Project;
- Document any health concerns identified by aboriginal communities or groups resulting from impacts of existing development and of the Project specifically on their traditional lifestyle and include an aboriginal receptor type in the assessment;
- Describe the potential health impacts resulting from higher regional traffic volumes and the increased risk of accidental leaks and spills; and,
- Discuss mitigation strategies to minimize the potential impact of the Project on human health.

In addition to the requirements identified in the Terms of Reference, the HHRA evaluated previous SAGD environmental impact assessments that have been submitted to Alberta Environment to identify specific issues or concerns that should be addressed in the HHRA for

the Project. Finally, as part of the HHRA, a Screening Level Wildlife Risk Assessment (SLWRA) was included (Appendix F).

2.2 Focused Human Health Risk Assessment Work Plan

In 2010, Alberta Health and Wellness (AHW) developed what was intended to be a step-by-step process for undertaking focused HHRA of in situ oil sands developments. The intent was that applicants would be able to make certain modifications to the approach typically adopted for risk assessments in order to reduce the level of complexity and shorten the regulatory review period.

In order for an in situ project to qualify for a focused HHRA, the Project needs to meet a number of conditions, namely:

- There must be a recent Environmental Impact Assessment (EIA) available that can be used as a partial surrogate for the proposed project;
- This surrogate EIA must contain relevant Baseline, Application and Planned Development assessment cases and contain a comprehensive HHRA applicable to the proposed project; and,
- There must be sufficient and applicable regional environmental (i.e., measured) data available in the region of the proposed project.

The Project meets the requirements and is located in close proximity to the following three SAGD projects:

- Petro-Canada/Suncor MacKay River Expansion Project (Petro-Canada 2007);
- Proposed AOSC MacKay River Commercial Project (AOSC 2009); and
- Proposed Dover Commercial Project (DOC 2010).

The Project will utilize similar well-established in situ technology currently proposed for the Dover and AOSC commercial facilities, and approved for the Suncor MacKay River Expansion facility. AHW and STP determined that the Project meets the conditions and criteria to proceed to a focused HHRA and developed a detailed work plan (Intrinsik 2011). This work plan recommends the scope of work for the focused HHRA and provides the necessary information based on the consultation between AHW and STP to determine that the Project would qualify for a focused HHRA. AHW approved the focused HHRA work plan for the Project on June 24, 2011. The work plan for the focused HHRA can be found in Appendix G.

2.3 Public Issues and Concerns

A description of site visits and any information that Aboriginal groups (First Nation and Métis) shared regarding Traditional Land Use and Traditional Knowledge in and around the Project is provided in the Project application (STP 2011, Part F). This section contains a full description of STP's engagement with the Aboriginal groups in and around the Project area.

Health was raised as one of the key issues of concern, with residents in the area indicating that they are concerned about an overall deterioration in air quality, water quality and traditional food quality (i.e., fish and game). This concern is addressed in this HHRA, specifically as it relates to potential health effects associated with air and water quality changes.

Consultation activities designed to identify the concerns and issues held by key stakeholders and Aboriginal groups included:

- public open house sessions;
- individual and group meetings;
- telephone conversations;
- e-mail and other correspondence; and,
- announcements in regional and local news media.

A complete listing of the consultation activities is provided in the Project application (STP, 2011, Part F).

2.4 Spatial Boundaries

The HHRA focused on the potential health risks associated with chemical concentrations in two areas:

- Local Study Area (LSA), consisting of a 50 km × 50 km area (approximate radius of 25 km) centered on the Project.
- Regional Study Area (RSA), consisting of a 270 km x 305 km area surrounding the Project.

The HHRA LSA and RSA are consistent with the Air Quality study areas (MEMS 2011a). The majority of the receptor locations evaluated in the HHRA lie within the boundaries of the LSA and a few locations of interest (such as the communities of Fort McKay and Fort McMurray) have also been included in the HHRA based on public consultation (STP 2011, Part F).

2.5 Temporal Durations Assessed

The HHRA assessed both short and long term health risks associated with the chemicals emitted from the Project. The two exposure durations used can be described as follows:

- Acute: exposure extends over a time period covering minutes to a day.
- Chronic: exposure occurs continuously or regularly over extended periods, lasting for periods of months to years, and possibly extending over an entire lifetime.

Although the operational life of the Project is expected to be 25 years, the HHRA assumed that the chemical emissions attributable to the Project would continue for a period of 80 years. The assumption of 80 years coincides with a person's assumed lifespan (Health Canada 2009a).

2.6 Assessment Cases

Maximum predicted ground-level air concentrations provided by the air quality team were compared to regulatory-endorsed exposure limits protective of human health in order to quantify the potential risks. Potential health risks were assessed for the three assessment cases that follow:

- Baseline Case: includes potential health risks associated with existing projects and those that have been approved but are not yet operational.
- Application Case: includes potential health risks associated with the Baseline Case and the Project.
- Planned Development Case (PDC): includes potential health risks associated with all of the projects and activities incorporated in the Application Case as well as those projects

that were publicly disclosed six months prior to the submission of the Project application and EIA report.

In addition to the assessment cases defined by the Terms of Reference, the HHRA assessed two incremental scenarios defined by the Project alone (Project Scenario) and Future sources (Future Scenario). The Project Scenario was calculated at each receptor location, and is represented by the difference between the Application Case and Baseline Case. The Future Scenario represents future incremental risks and was calculated in a similar manner by subtracting the Baseline Case from the Planned Development Case. These scenarios, represented by incremental changes, are required for the assessment of carcinogenic risks in the HHRA. Finally, the HHRA included the assessment of an Upset scenario.

3.0 HUMAN HEALTH RISK ASSESSMENT APPROACH

3.1 Guiding Principles

A number of guiding principles were applied in completion of the HHRA that are common to the assessment of the potential health effects of all chemicals, regardless of source. These principles have been proven through years of scientific investigation and observation. These principles are as follows:

- All chemicals, regardless of type or source, possess some degree of intrinsic toxicity (i.e., all chemicals have the capacity to cause some level of harm or injury, dependent on the dose).
- In general, for non-carcinogenic substances (i.e., chemicals that do not cause cancer), the intrinsic toxicity of a chemical (i.e., the capacity to produce a harmful effect or physiological injury) is only expressed if the exposure exceeds a critical threshold level, at which point health effects may occur. Below this threshold dose, adverse health effects are unlikely to occur. The severity of the effects will depend on the sensitivity of an individual to the particular substance, and the level of exposure received, with more severe effects occurring with increasing dose.
- The toxicity of a chemical largely depends on its molecular structure. Within limits, chemicals having similar structures will produce similar toxicological effects. This principle allows the health effects of a chemical of unknown toxicity to be predicted by comparison to the known health effects produced by a second surrogate chemical with a similar molecular structure.
- The health effects produced by a chemical depend on the nature, extent and duration of exposure. It is important to distinguish between the health effects that may result from acute exposures of short duration and effects that may occur following chronic or long term exposure. Also, health effects may differ according to the route of exposure (i.e., inhalation versus oral exposure).

3.2 Health Risk Assessment Methods

The potential health risks associated with the Project emissions were examined using a conventional risk assessment paradigm. The risk assessment paradigm is consistent with those developed by Health Canada (1995; 2009a), the Canadian Council of Ministers of the Environment (CCME 2006), and the US Environmental Protection Agency (US EPA 2005). This approach has been endorsed by a number of provincial regulatory authorities in the past,

including Alberta Environment, Alberta Health and Wellness, and the Alberta Energy Resources and Conservation Board (ERCB).

The risk assessment paradigm involves the following steps (Figure 3.1**Error! Reference source not found.**):

- **Problem Formulation**: identification of the COPCs associated with Project emissions, characterization of people potentially 'at risk' and identification of relevant exposure pathways.
- **Exposure Assessment**: quantification of the potential amount or dose of each COPC that could be received by humans through all relevant exposure pathways. Exposure pathways assessed include air inhalation as well as exposures via soil, water, plants, berries, wild game and fish.
- **Toxicity Assessment**: identification of potential adverse health effects associated with exposure to each of the COPCs, the conditions under which these effects are observed and determination of the maximum safe dose of the chemical for sensitive individuals following exposure for a prescribed period (i.e., identification of acute and chronic exposure limits for the COPCs).
- **Risk Characterization**: comparison of estimated exposures (identified in the exposure assessment) with exposure limits (identified during the toxicity assessment) to identify potential health risks for the different assessment cases, as well as discussion of sources of uncertainties and how these were addressed.

Uncertainty associated with the prediction of potential health risks is mitigated, in part, through the use of conservative exposure assumptions. Using this approach, any health risks identified by the assessment are unlikely to be under predicted; in fact they are likely over predicted. Thus, where health risks are predicted, it is important that the conservative assumptions in the assessment be considered. Sources of uncertainty and the means through which these were addressed using conservative assumptions are documented in Section 3.2.4 (Risk Characterization).

Each of the steps of the risk assessment paradigm is described in Figure 3.1**Error! Reference source not found.** and in detail in the following sections.

3.2.1 Problem Formulation

Problem formulation is the initial step of the assessment, in which all chemicals associated with Project emissions or releases are identified, people potentially at risk are characterized, and relevant exposure pathways are identified. The problem formulation step "sets the stage" for the detailed analysis of the HHRA.

3.2.1.1 Identification of Chemicals of Potential Concern

The COPCs for the Project were identified through the development of a comprehensive inventory of chemicals that could be emitted by the Project and to which people might be exposed. Development of the initial chemical inventory considered both possible Project air emissions and water releases.

The selection of COPCs for this Project also took into consideration whether or not sufficient toxicological information is available to assess the potential health risks; and, the availability of

chemical surrogates to represent any of the substances or groups of substances for which limited toxicological information is available.

Only Project emissions or releases resulting in potential changes to environmental quality were considered as COPCs within the HHRA. As the Project will not release any chemicals into groundwater or surface water, the COPCs for the HHRA were based on air emissions only.

Project Emissions to Air

The identification of COPCs began with the air quality team's development of a comprehensive inventory of chemicals that could be emitted by the Project and to which people might be exposed. As described in the Air Quality assessment (MEMS 2011a) atmospheric emissions associated with the Project include:

- Regulated contaminants or criteria air contaminants (CACs) - (sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), and particulate matter (PM));
- Petroleum Hydrocarbons (PHCs) consisting of various aromatic and aliphatic fractions;
- Volatile Organic Compounds (VOCs);
- Polycyclic Aromatic Hydrocarbons (PAHs); and
- Hydrogen sulphide and reduced sulphur compounds (RSCs).

The Air Quality report (MEMS 2011a) has identified the potential for the photochemical production of ground level ozone (O_3) from emissions of anthropogenic NO_x, anthropogenic VOC and biogenic VOC. Based on model results, the Project is estimated to increase NO_x emissions by 0.7% in region, with an estimated contribution to regional ozone of approximately 0.02%. As such, emissions of NO_x and VOCs from the Project are not predicted to have a material impact on ground level O_3 concentrations (MEMS 2011a).

The COPCs that were included in the HHRA are listed in Appendix A. All of the COPCs emitted to air from the Project were evaluated using a toxic potency screen in order to determine which COPCs would most likely pose a potential health hazard and contribute the majority of the total toxic potential of the air emissions. A number of screening methods can be used to narrow a list of chemicals for further analysis. These include:

- using the COPCs' emission rates and exposure limits to determine their relative toxic potencies;
- identifying COPCs viewed as a concern by regulatory authorities for the oil sands region; and,
- identifying those COPCs for which elevated risks were predicted in previous HHRAs.

The screening was based, in part, on relative toxic potency determinations using emission rates and exposure limits. The quantitative screening process was based on two primary considerations:

- the potential toxicity of each chemical on an acute and chronic basis; and,
- the potential for exposure to each chemical.

Potential exposure was based on the estimated emission rate for each chemical from the proposed Project. The potential toxicity of each chemical was represented by acute and chronic exposure limits developed by recognized regulatory agencies such as Health Canada and the US EPA (U.S. Environmental Protection Agency). The relative toxic potency of each chemical is calculated by dividing the emission rate by its exposure limit and determining the relative

contribution of each chemical to the total toxic potential (sum of individual toxic potentials). When combined, those chemicals that contributed 99% to the overall toxic potency were included as COPCs in the HHRA. COPCs can be defined as the chemicals likely to contribute to the majority of the total toxic potential of the air emissions. Appendix A provides a detailed description of the methods and results of the toxic potency screening for the COPCs.

Certain COPCs that may deposit to the surrounding terrestrial environment and possibly persist or accumulate in the environment was identified. People could be exposed to these COPCs via secondary pathways, related to soil, food and water.

For this purpose, the list of COPCs will be divided into two groups:

- Gaseous COPCs (e.g., CO, H2S, NO2 and SO2), are not likely to contribute to human exposure via non-inhalation pathways.
- Non-gaseous COPCs (e.g., PAHs, VOCs and some petroleum hydrocarbon fractions) may deposit in the vicinity of the Project and persist or accumulate in the environment in sufficient quantities for humans to be exposed via soil, food and water pathways.

Consideration was given to the inherent physical/chemical properties of each COPC that would influence its fate and persistence in the environment, and subsequently its potential presence in secondary pathways of exposure. This was accomplished by comparing the physical/chemical properties of the chemicals (i.e., molecular weight, vapour pressure, and Henry's Law constant) against pre-established criteria to identify those substances that could deposit from the air onto nearby lands and/or surface waters. The screening criteria used to determine whether a chemical is non-volatile, and therefore exhibits the potential to persist in environmental media other than air, are defined by the US EPA and California EPA (US EPA 2003).

In summary, the HHRA used toxic potency screening to determine which chemicals in the emission inventory would most likely pose a potential health hazard via direct exposure (i.e., inhalation). In addition, the HHRA used physical/chemical screening to determine which chemicals in the emission inventory would most likely pose a potential health hazard via secondary pathways (i.e., ingestion). Table 3-1 provides a summary of the COPCs assessed in the HHRA.

Table 3-1 Summary of COPCs Assessed in HHRA

Emission Constituent	*COPC Based on Toxic Potency Screening*		*COPC Based on Physical and Chemical Screening*
	Acute Inhalation	*Chronic Inhalation*	*Multiple Pathway*
PAHs			
7,12-Dimethylbenz(a)anthracene [2]	NA	COPC	COPC
Acenaphthene	NA	NA	COPC
Acenaphthylene	NA	NA	COPC
Anthracene	NA	NA	COPC
Benzo(a)anthracene [2]	NA	COPC	COPC
Benzo(a)pyrene [1,2]	NA	COPC	COPC
Benzo(b)fluoranthene [2]	NA	COPC	COPC
Benzo(g,h,i)perylene [2]	NA	COPC	COPC
Benzo(k)fluoranthene [2]	NA	COPC	COPC
Chrysene [2]	NA	COPC	COPC

Emission Constituent	*COPC Based on Toxic Potency Screening*		*COPC Based on Physical and Chemical Screening*
	Acute Inhalation	*Chronic Inhalation*	*Multiple Pathway*
Dibenzo(a,h)anthracene [2]	NA	COPC	COPC
Fluoranthene [2]	NA	COPC	COPC
Fluorene	NA	NA	COPC
Indeno(1,2,3-cd)pyrene [2]	NA	COPC	COPC
Phenanthrene [2]	NA	COPC	COPC
Pyrene	NA	NA	COPC
Petroleum Hydrocarbon Fractions (PHCs)			
C_5-C_8 Aliphatic	NA	NA	NA
C_9-C_{18} Aliphatic	NA	NA	NA
C_9-C_{18} Aromatic	NA	NA	COPC
RSCs			
CS_2	NA	NA	NA
H_2S	NA	NA	NA
Mercaptans	NA	NA	NA
Thiophenes	NA	NA	NA
VOCs			
1,3-Butadiene	NA	NA	NA
2-Methylnaphthalene	NA	NA	COPC
3-Methylcholanthrene	NA	NA	COPC
Acetaldehyde	COPC	COPC	NA
Acrolein	COPC	COPC	NA
Benzene	NA	COPC	NA
Dichlorobenzene	NA	NA	NA
Ethyl Benzene	NA	NA	NA
Formaldehyde	COPC	COPC	COPC
Naphthalene	NA	NA	NA
n-Hexane	NA	COPC	NA
n-Pentane	NA	NA	NA
Toluene	NA	NA	NA
Xylenes	NA	NA	NA
CACs [3]			
Carbon Monoxide (CO)	COPC	COPC	NA
Nitrogen dioxide (NO_2)	COPC	COPC	NA
$PM_{2.5}$ [4]	COPC	COPC	NA
Sulphur dioxide (SO_2)	COPC	COPC	NA

Notes:
(1) Benzo(a)pyrene evaluated in HHRA as a surrogate representative of a PAH mixture (WHO 2000) and potency equivalency (Health Canada 2009a).
(2) PAH evaluated in HHRA as benzo(a)pyrene equivalent based on potency equivalency approach (Health Canada 2009a).
(3) Criteria air contaminants were not included as part of toxic potency screening, but automatically included in the inhalation assessment of the HHRA and excluded from the multiple pathway assessment (see Appendix A for details).
(4) Includes formation of secondary particulates.

NA: Not assessed because chemical did not pass toxic potency screening and/or physical and chemical screening (see Appendix A for details).

Potential Project Water Effluents

Overall, the Aquatic Resources (Hatfield 2011) and Hydrogeology (MEMS 2011b) assessments concluded that Project activities would not affect surface water or groundwater quality. Although no direct discharges of effluents to surface water will occur, there will be some deposition of COPCs onto surface water bodies in the LSA. Therefore, the HHRA assessed human health risks associated with exposure to surface water that may have COPCs deposited onto them.

The LSA contains the upper MacKay River, streams that feed the MacKay River and small beaver ponds. The Aquatic Resources assessment evaluated Project activities that have the potential to affect surface water quality, fish health and fish tissue, and alter fish resources and fish habitat. Surface water quality was characterized by measuring conventional variables, major ions, nutrients, organics and hydrocarbons and metals. Fish resources were characterized by an assessment of the inventory of fish populations and a fish habitat assessment in the LSA. The aim was to identify presence of fish, distribution and probability of occurrence within the LSA. Potential impacts and effects of the Project were determined to be insignificant. The Project will implement a number of mitigation measures that will prevent or reduce the effects on aquatic resources from the Project's surface disturbance activities. Finally, an aquatic resources environmental monitoring program will be implemented to monitor construction and operation activities.

For the HHRA it was assumed that people drank untreated surface water from ponds and streams within the LSA. These water bodies were selected as they represent nearby standing water bodies that airborne emissions may deposit onto. In addition, the predicted surface water concentrations in the HHRA were used to estimate fish tissue concentrations for the human consumption pathway.

Groundwater well records in the Alberta Environment database were reviewed within the Hydrogeology Regional Study Area, which extends more than 30 km from the Project area (MEMS 2011b). The nearest domestic well is located approximately 13 km to the west of the Project Area. The status of this well is uncertain. Water demands for the Project include steam generation, sanitary services and potable water. All water requirements are expected to be sourced from groundwater supply wells. The operation of the production and injection wells is not expected to have an impact on groundwater quality in non saline aquifers. An operational (i.e., facility) and groundwater monitoring program will be implemented to detect changes in groundwater quality in the event of upset conditions (e.g., failure of cap rock or casing integrity). Changes in groundwater quality due to thermal propagation along the injection wells are expected to be localized and primarily contained within the development area. .

Water for the worker camps will meet Canadian drinking water quality guidelines. As such, potential health risks associated with water consumption from groundwater sources by workers was not assessed in this HHRA.

3.2.1.2 People Potentially at Risk

The HHRA was structured to characterize the potential health risks to people who reside in the area over the long-term or use the LSA for traditional (e.g., hunting and gathering) or recreational (e.g., fishing and snowmobile) activities. In this regard, consideration was given to:

- the people who are known or anticipated to spend time near the Project or within the study areas;

- the physical characteristics of the people in the region that could result in increased exposure;
- the lifestyles of the individuals in the region that could result in increased exposure (e.g., local and traditional food consumption patterns, portion of diet obtained locally); and,
- the sensitivity or susceptibility of individuals in the region (e.g., infants and young children, the elderly, individuals with compromised health).

Additional information regarding values and approaches used to characterize human exposure are provided below and in Appendix C (HHRA Exposure Model).

Locations Assessed in the HHRA

Twelve discrete locations within the RSA were selected for consideration in the HHRA. Of these twelve locations, two are worker camps (i.e., Phase 1 and Phase 2), as workers will be residing in local housing camps within the principal development area during both construction and operation phases. The discrete locations are shown on Figure 3.2. Most of the discrete receptor locations are cabins located within the LSA, while two community locations (i.e., Fort McMurray and Fort McKay) are found outside the LSA.

- R1-Cabin (LSA)
- R2-Cabin (LSA)
- R3-Cabin (LSA)
- R4-Cabin (LSA)
- R5-Cabin (LSA)
- R6-Cabin (LSA)
- R7-Cabin (LSA)
- R8-Cabin (LSA)
- R9-Fort McMurray (RSA)
- R10-Fort McKay (RSA)
- STP Phase 1 Operator or Worker Camp (LSA)
- STP Phase 2 Operator or Worker Camp (LSA)

In addition to the discrete locations, the air quality assessment evaluated three maximum points of impingement (MPOIs) or maximum ground level air concentrations. These include the regional MPOI and two LSA MPOI locations (i.e., fence line MPOI and local MPOI).

The HHRA only assessed the MPOI in the LSA (i.e., fence line and local MPOI). The regional MPOI included in the Air Quality assessment was not assessed in this HHRA, as this location is too far away to be noticeably impacted by Project air emissions (Section D.1). The regional MPOI is outside the LSA, over 45 km away and found either in the Athabasca Valley near Fort McMurray, along transportation corridors, or near surface mining areas. The air quality assessment determined the potential maximum radius of impact for Project emissions based on hourly maximums. The radius of impact is also dependent on the COPCs. Table 3-2 provides the radius of impact for NO_2, benzene and $PM_{2.5}$ based on air quality modelling. The COPCs were selected as surrogate compounds for criteria air contaminants, volatile organic compounds and polycyclic aromatic hydrocarbons. The information in Table 3-2 shows that the influence of the Project's air emissions is largely restricted to the LSA.

The two LSA MPOIs were assessed since people may be exposed at these locations on an infrequent basis. As people will not be living at these locations, the MPOI was evaluated only for inhalation exposure and only on an acute basis.

Table 3-2 Radius of Influence for Project Emissions to Air

COPC	*Surrogate for*	*Radius of Impact [km]*	
		10% of AAQO [1]	*Background [2]*
Nitrogen dioxide	Criteria air contaminants	16.5	46
Benzene	Volatile organic compounds	0	0
$PM_{2.5}$	PM and polycyclic aromatic hydrocarbons	0	3.8

Notes:
(1) 10% of Alberta Ambient Air Quality Objective (AAQO): NO_2 (30 μg/m^3); $PM_{2.5}$ (8 μg/m^3); benzene (3 μg/m^3).
(2) Background based on MEMS (2011a): NO_2 (7.5 μg/m^3); $PM_{2.5}$ (5.3 μg/m^3); benzene (4.1 μg/m^3).

HHRA Receptor Groups

The 12 locations included in the HHRA were grouped according to their assumed land-use. It was assumed that the lifestyles and behaviours of people in each group were generally similar. Established residential communities, seasonal aboriginal cabins and employees of Project operations were included, such that a full range of lifestyles and exposure potential were captured in the HHRA. In addition, it was recognized that people may visit the immediate vicinity of the Project for recreational or traditional activities such as hunting, snowmobiling, trapping or plant/berry gathering. The two LSA MPOI locations were also included in the HHRA to predict the potential risks to people who may occasionally visit this area.

The general types of individuals who were evaluated in the HHRA include:

- **LSA-MPOI:** includes the fence line MPOI and local MPOI and includes people who may be present at the locations where the highest COPC concentration could occur.
- **Residents**: This group of locations represents known aboriginal or urban communities within the study area (i.e., Fort McKay and Fort McMurray). It was assumed that these individuals live permanently in the area, and practice a lifestyle that involves a high level of consumption of local country foods, garden vegetables and traditional plants.
- **Cabins**: includes individuals who may use the cabins located near the Project area as a temporary shelter while engaged in activities such as hunting, fishing or trapping. Although the exact frequency of use is not documented, for the purposes of the HHRA, it was assumed that these individuals use these cabins on a regular basis for several months per year.
- **Workers**: this group includes STP workers staying at camps (i.e., Phase 1 and Phase 2) during both construction and operation phases.

Table 3-3 lists the receptor locations included in each receptor group.

Table 3-3 Receptor Groups and Corresponding Locations

Receptor Group (Name)	*Receptor Location*	
	Inhalation Assessment	*Multiple Pathway Assessment*
Permanent community residents or traditional lifestyle (Residents)	R9 and R10	R1 to R10
Seasonal aboriginal residents or Cabins (Cabins)	R1 to R8	Not assessed explicitly via multiple pathways, but included in “Residents” group
Project employees or worker	Phase 1 and 2 Camp	Phase 1 and 2 Camp

camps (Workers)		
LSA-MPOI	Fence line MPOI and local MPOI	Not assessed via multiple pathways

Assumed Characteristics of Potentially Chronically Exposed People

It was assumed that temporary visitors would only be near the Project on a short-term (acute) basis and that they could be exposed to concentrations equivalent to the LSA MPOI along the Project boundary (i.e., fence line) or within the LSA. Inhalation of the COPCs emitted from the Project to the air was deemed to be the only potential exposure pathway for this group.

Potentially chronically exposed individuals residing in the RSA include additional exposure pathways and include both aboriginals and non-aboriginal people. All age classes (life stages) were considered in a multiple pathway exposure assessment. The five receptor life stages that were included in the HHRA are consistent with Health Canada guidance (Health Canada 2009a):

- Infant (0 to 6 months = 0.5 years);
- Toddler (7 months to 4 years = 4.5 years);
- Child (5 to 11 years = 7 years);
- Adolescent (12 to 19 years = 8 years);
- Adult (20 to 80 years = 60 years).

For the assessment of carcinogens, a "composite individual" who represents all life stages (e.g., from infant to adult) was used to represent cumulative exposure over an 80-year lifetime.

General physical characteristics were obtained from documents published by Health Canada (2009a), CCME (2006) and Richardson and O'Connor (1997). General characteristics that were common to all individuals are summarized in Table 3-4.

Table 3-4 General Characteristics Assumed for Chronically Exposed Individuals in the Multiple Pathway Exposure Assessment

Physical Characteristic[1]	*Life Stage*					*Source*
	Infant	*Toddler*	*Child*	*Adolescent*	*Adult*	
Resident, cabin and worker body weight (kg)	8.2	16.5	32.9	59.7	70.7	Health Canada 2009a
Resident and cabin inhalation rate (m^3/d)	2.2	8.3	14.5	15.6	16.6	Health Canada 2009a
Worker inhalation rate (m^3/d)	n/a	n/a	n/a	n/a	33.6	Health Canada 2009a
Resident and cabin soil ingestion rate (g/d)	0.02	0.08	0.02	0.02	0.02	Health Canada 2009a
Worker soil ingestion rate (g/d)	n/a	n/a	n/a	n/a	0.1	Health Canada 2009a
Resident and cabin water ingestion rate (L/d)	0.3	0.6	0.8	1.0	1.5	Health Canada 2009a
Worker water ingestion rate (L/d)	0	0	0	0	0	Assumed; drinking water provided from an alternative source
Resident, cabin and worker arms and legs body surface area (cm^2)	1,460	2,580	4,550	7,200	8,220	Health Canada 2009a
Resident, cabin and worker	320	430	590	800	890	Health Canada 2009a

Physical Characteristic[1]	Life Stage					Source
	Infant	Toddler	Child	Adolescent	Adult	
hand surface area (cm^2)						
Resident, cabin and worker total surface area (cm^2)	3,620	6,130	10,140	15,470	17,640	Health Canada 2009a
Resident and cabin soil adherence factor ($g/cm^2/d$)	0.00001	0.00001	0.00001	0.00001	0.00001	CCME 2006; Health Canada 2009a
Resident and cabin soil adherence factor – hands only ($g/cm^2/d$)	0.0001	0.0001	0.0001	0.0001	0.0001	CCME 2006 Health Canada 2009a
Worker soil adherence factor ($g/cm^2/d$)	n/a	n/a	n/a	n/a	0.0001	CCME 2006; Health Canada 2009a
Worker soil adherence factor – hands only ($g/cm^2/d$)	n/a	n/a	n/a	n/a	0.001	CCME 2006 Health Canada 2009a

Notes:
(1) Food consumption rates are described in the section below.
n/a - not applicable

Specific characteristics of the individuals within the groups are provided in the sections below.

Maximum Point of Impingement (MPOI)

Chronic, non-inhalation related routes of exposure were not considered for the MPOI as people do not live where the MPOIs for the COPCs were predicted to occur.

Residents

The Resident group represents individuals living seasonally or permanently in the areas located in the RSA. For the purposes of the HHRA it was assumed that Aboriginals remained in these locations continuously over an entire 80-year lifetime. As such, potential health risks for these individuals were assessed on both an acute and chronic basis.

It was determined that Aboriginal individuals would potentially be exposed to the COPCs via direct inhalation and that they obtained 100% of their foods locally (e.g., plants, vegetables, wild game, and fish). It was also assumed that surface water would be their primary source of drinking water, and that they would be exposed to COPCs deposited onto local surface water via dermal contact and incidental water ingestion while swimming.

Recent Health Canada (2007) guidance has recommended an adult fish consumption rate of 40 grams per day for subsistence consumers, based on recent surveys of populations. This value was obtained from a Market Facts of Canada (1991) study on national seafood consumption and a Bureau of Chemical Safety study of current intake rates for Canadian consumers (BCS 2004). Table 3-5 provides the fish consumption rates that were used in the HHRA. The Health Canada (2007) fish consumption rate was used in the HHRA since it represents the amount of food consumed by subsistence consumers and based on a recent and thorough survey of consumption information.

Consumption rates for wild game for the Aboriginal resident were based on Health Canada's food ingestion rates for Canadian First Nations populations in combination with the frequency of consumption reported for Aboriginal Canadians near Wood Buffalo National Park by Wein (1991). For example, Health Canada (2009a) recommends an adult ingestion rate of 270 grams

per day of wild game. According to Wein (1991), large mammals constituted 76% of the wild game consumed by the 120 households interviewed, small mammals constituted 16%, and upland birds constituted 8%. These adjustments have been taken into consideration in the HHRA. The wild game consumption rates for all life stages are listed in Table 3-5.

Plant consumption rates were segregated into traditional above-ground plants (e.g., wild mint and Labrador tea leaves) and below-ground plants (e.g., cattail), as well as garden above-ground vegetables (e.g., spinach) and below-ground root vegetables (e.g., potatoes). Wein (1989) reported an average plant consumption rate of 134 grams per day, which was adjusted by the frequency of 2% (i.e., 7 days in 365 days) for wild mint and Labrador tea leaves in Aboriginal households (Wein et al. 1991). From this, an adult consumption rate of 3 grams per day was assumed for traditional above-ground plants (e.g., wild mint and Labrador tea leaves). Wein et al. (1991) reported that wild roots were seldom used in the households interviewed and did not provide any consumption data for wild roots. As a result, the HHRA assumed that the consumption rates for traditional below-ground and above-ground plants were equivalent (i.e., 3 g/d). The vegetable consumption rates were obtained from Health Canada (2009a). The fruit or berry consumption rates were based on information presented in Wein (1989) that estimated adult populations in the area consumed 23 grams per day. Fruit or berry consumption rates for earlier life stages were based on the body weight ratios. For example, the child fruit consumption rate is based on ratio of the child to adult body weight (i.e., 0.47 = 32.9kg/ 70.7kg) multiplied by the adult consumption rate (i.e., 0.47 x 23 g/d = 11 g/d). The plant consumption rates assumed for all life stages are listed in Table 3-5.

Table 3-5 Local Food Consumption Rates (g/d) Assumed for the Resident Group

Local Foods	*Life Stage*					*Source*
	Infant[1]	*Toddler*	*Child*	*Adolescent*	*Adult*	
Large game (*i.e.*, moose)	0	65	95	133	205	Health Canada 2009a; Wein et al. 1991
Small game (*i.e.*, snowshoe hare)	0	14	20	28	43	Health Canada 2009a; Wein et al. 1991
Game birds (*i.e.*, ruffed grouse)	0	7	10	14	22	Health Canada 2009a; Wein et al. 1991
Fish	0	20	33	40	40	Health Canada 2007
Berries / fruit	0	5	11	13	23	Wein (1989)
Cattail	0	1	1	3	3	Wein (1989, 1991)
Labrador tea	0	1	1	3	3	Wein (1989, 1991)
Leafy vegetables	0	67	98	120	137	Health Canada 2009a
Root vegetables	0	105	161	227	188	Health Canada 2009a

Notes:
(1) Infants were assumed to consume 664g of breast milk per day (Richardson and O'Connor 1997)

Cabins

Several seasonal cabins were identified in the LSA. As it is possible that people may use these cabins on both a short-term and long-term basis, it was assumed that individuals at these locations were exposed for 24-hours/day, 7-days/week for 365-days/year over an 80-year lifetime. The cabin group was included in both the acute and chronic inhalation assessments.

The cabin group was combined with the residential group for the chronic multiple exposure pathway assessment. The consumption rates outlined for the residents group were conservatively used to represent the consumption patterns of all cabin receptors.

Workers

There is one existing work camp for the Phase 1 Project and another one proposed for the Phase 2 Project where people will live during the construction and operation of the Project. It was conservatively assumed that people at these locations would be exposed to emissions 24-hours/day, 7-days/week, for 52-weeks/year over 60 years (equivalent to the adult life stage, as it is reasonable to assume that only adults would be present in worker camp communities).

As the worker locations do not represent permanent residences, the food and water consumption pathways were not considered to be relevant to this group.

3.2.2 Exposure Assessment

The following exposure pathways were included in this HHRA (also see Figure 3.3**Error! Reference source not found.** and Figure 3.4):

- inhalation of air;
- inhalation of dust;
- ingestion of soil (inadvertent);
- ingestion of water;
- ingestion of local above-ground plants (including fruit and vegetables);
- ingestion of local below-ground plants (root vegetables);
- ingestion of local traditional plants (Labrador tea and cattail);
- ingestion of local fish;
- ingestion of local wild game;
- ingestion of water while swimming;
- dermal contact with water; and
- dermal contact with soil.

Table 3-6 summarizes the exposure pathways assessed for each of the groups. For modelling assumptions relating to the multiple exposure pathway assessment, see Appendix D (Human Health Exposure Model).

Table 3-6 Exposure Pathways Assessed for the Human Receptor Groups

Exposure Pathway	*Receptor*		
	Cabin	*Resident*	*Workers*
Inhalation			
Inhalation of air	√	√	√
Inhalation of dust	√	√	√
Ingestion			
Ingestion of soil (inadvertent)	√	√	√
Ingestion of surface water	√	√	x
Ingestion of traditional plants	√	√	x
Ingestion of local leafy vegetables	√	√	x

Ingestion of local root vegetables	√	√	x
Ingestion of local fish	√	√	x
Ingestion of local wild game	√	√	x
Dermal Contact			
Dermal contact with water	√	√	x
Dermal contact with soil	√	√	√

3.2.2.1 Inhalation Assessment

Inhalation exposure estimates were based on the results of the air dispersion modeling that was described in the Air Quality Assessment (MEMS 2011a) and focused on those COPCs identified in the toxic potency screening (Appendix A). Predicted air concentrations were presented over different averaging periods (e.g., 10-minute, 1-hour, 8-hour, 24-hour and annual) to allow for the assessment of both acute and chronic health risks. In addition, predicted air concentrations were presented for various assessment cases (i.e., Base Case, Application Case and PDC) to characterize risks from the Project in combination with existing, approved and proposed sources. The inhalation assessment focused on the following COPCs:

- Acetaldehyde (both acute and chronic health risks)
- Acrolein (both acute and chronic health risks)
- Benzene (chronic health risks only)
- Benzo(a)pyrene (chronic health risks only)
- Benzo(a)pyrene equivalent (chronic health risks only)
- Criteria air contaminants (i.e., CO, NO2 and SO2 acute health risks only);
- Criteria air contaminants (i.e., NO2 and PM2.5 acute and chronic health risks);
- Formaldehyde (both acute and chronic health risks)
- N-Hexane (chronic health risks only)

The benzo(a)pyrene equivalent consists of the following PAHs:

- 7,12-Dimethylbenz(a)anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Dibenzo(a,h)anthracene
- Fluoranthene
- Indeno(1,2,3-cd)pyrene
- Phenanthrene

3.2.2.2 Multiple Exposure Pathway Assessment

For the assessment of exposure pathways other than inhalation, physical and chemical screening was performed to identify COPCs emitted from the Project that may deposit to the surrounding terrestrial environment and possibly persist or accumulate in sufficient quantities for people to be exposed via soil, food and water pathways (as described in Appendix A). Based on the results of the physical and chemical screening, the list of COPCs included in the multiple pathway assessment is identified in Table 3-7.

Table 3-7 Summary of COPC Evaluated in the Multiple Pathway Assessment

COPC In Multiple Pathway Assessment	*Constituent or Surrogate*
Benzo(a)pyrene Equivalent	• 7,12-Dimethylbenz(a)anthracene • Benzo(a)anthracene • Benzo(a)pyrene • Benzo(b)fluoranthene • Benzo(g,h,i)perylene • Benzo(k)fluoranthene • Chrysene • Dibenzo(a,h)anthracene • Fluoranthene • Indeno(1,2,3-cd)pyrene • Phenanthrene
Acenephthene	Evaluated in the C_9-C_{18} aromatics group
Acenaphthylene	Evaluated in the C_9-C_{18} aromatics group
Anthracene	Evaluated in the C_9-C_{18} aromatics group
Fluorene	Evaluated in the C_9-C_{18} aromatics group
Pyrene	Evaluated as individual COPC and in the C_9-C_{18} aromatics group
2-methylnaphthalene	Evaluated as individual COPC and evaluated in the C_9-C_{18} aromatics group
3-methylcholanthrene	Evaluated as individual COPC with CCME C_{19}-C_{34} aromatic exposure limit
C_9-C_{18} aromatics	Evaluated as the C_9-C_{18} aromatics group
Formaldehyde	Evaluated as individual COPC

3.2.2.3 Environmental Media Concentrations

Ambient measurements in the area of the Project were included where available to characterize the background or ambient concentrations of COPCs in environmental media. When measured data were not available or analytical results were equivalent or below analytical method detection limits, exposure models were used to predict environmental media concentrations. Appendix C provides a worked example for the HHRA, while the exposure models are provided in Appendix D for the HHRA and Appendix E for the terrestrial wildlife exposure model.

Available concentrations of the COPCs were measured in soil, vegetation and surface water samples and are described below.

Air

Ambient measured air data was not used in the assessment, as the Air Quality assessment took all existing continuous sources into account in the modelling domain. As such, adding measured background data to the estimated air concentrations was not necessary in the HHRA.

Soil and Vegetation

The soil and vegetation data used to characterize baseline or ambient concentrations of PAHs for the Project are based on the AOSC MacKay River Commercial and Dover Commercial

Project baseline sampling programs. The historical baseline sampling programs were determined to be representative of the environmental conditions within the Project area (Intrinsik 2011). Baseline sample data was not collected for the Project.

As part of the MacKay River Commercial (AOSC 2009) and Dover Commercial Project (DOC 2010) baseline programs, samples of soil and vegetation were collected from their respective lease areas and analyzed for concentrations of PAHs (Table 3-9). The vegetation samples consisted of types of vegetation that are known to be consumed traditionally by humans (e.g., berries and Labrador tea leaves) and one type that represents forage vegetation consumed by wildlife (alder leaves). In total, 60 samples of soil, 20 samples of berries, 22 samples of Labrador tea leaves, 17 samples of cattail roots, and 20 samples of alder leaves have been collected from the area and analyzed for concentrations of PAHs. The combined data set was used for the Project HHRA to provide better characterization of ambient concentrations of COPCs in the environment.

The 95th upper confidence level on the mean (95UCLM) was selected when sufficient data were available for its calculation (i.e., sample size greater than 10 with less than 25% of the samples below the method detection limit (MDL)). If insufficient data were available for the calculation of the 95UCLM, but the data set included at least one detected value greater than the MDL, the maximum measured concentration was assumed. For sample sets where all of the data were non-detect, a concentration was estimated using the HHRA's multimedia exposure model. However, if the estimated concentration was higher than the MDL, it was deemed to be unrepresentative of actual concentrations in the Project area and the concentration was assumed to be equal to the detection limit.

The 95UCLM was not calculated when:

- sample sizes were less than 10
- more than 80% of the chemical concentrations were non-detect (i.e., less than 20% were detected above the MDL)

When non-detects exceed 60 to 80% of the data, Alberta Environment (AENV 2006) and Helsel (2005) state that any statistical analysis is likely to result in unacceptably high error rates. Table 3-8 provides the method used in the HHRA for selecting concentration summary statistics.

Table 3-8 Method for Selecting Summary Statistics

% Non-detects	***Amount of Available Data***	
	< 10 Samples available	***≥ 10 Samples available***
≤ 80%	Maximum concentration used	95UCLM used
>80% but <100%	Maximum concentration used	Maximum concentration used
100%	Predicted concentration used[1]	Predicted concentration used[1]

Notes:
(1) Predicted concentration must be lower than detection limit or concentration assumed to be equal to MDL.

Table 3-9 Summary of Baseline Soil and Vegetation Sampling Programs for Historical Projects Used in the HHRA

Project	*Sample Size*					*Sample Period*
	Soil	*Berries*	*Labrador Tea Leaves*	*Cattail Roots*	*Alder Leaves*	
MacKay River Commercial Project (AOSC 2009)	36	12	12	12	12	August 2008
Dover Commercial Project (DOC 2010)	24	8	10	5	8	August 2010
Total	*60*	*20*	*22*	*17*	*20*	*139*

Soil and vegetation samples were collected and analysed for metals and PAHs as part of the MacKay River Commercial (AOSC 2009) and Dover Commercial Project (DOC 2010) baseline programs. As metals were not identified as COPCs for the Project, only the PAH data were evaluated in support of the HHRA. Most soil and vegetation samples contained PAH concentrations below the analytical MDL of 0.01 to 0.05 mg/kg for the MacKay River Commercial Project (AOSC 2009) baseline sampling program and 0.01 to 1 mg/kg for the Dover Commercial Project (DOC 2010) baseline program. Less than 2% of the sample data recorded a detectable concentration for a PAH. Table 3-10 provides a summary of the reported PAH MDLs reported for the baseline sampling programs and maximum detected concentrations for PAHs that were used in the HHRA for each media. Given that most of the available data for the COPCs were uniformly non-detect, soil and plant concentrations were predicted with exposure models for all assessment cases (see Appendix D and E).

Table 3-10 Summary of Baseline Sampling Program Detection Limits and Maximum Detected Concentrations for PAHs [mg/kg-dry weight]

Sample Media	*Chemical or Group*	*Baseline Sampling Program*	
		MacKay River Commercial Project	*Dover Commercial Project*
Alder [1]	All PAHs Detection Limit	<0.01 to <0.04	<0.1
	Phenanthrene	0.01 to 0.02	<0.1 to **0.16**
	Methylnaphthalene	<0.01 to 0.02	<0.1 to **0.11**
Berries	All PAHs Detection Limit	<0.01 to <0.04	<0.1 to <0.2
	Phenanthrene	<0.01 to **0.03**	<0.1 to <0.2
Cattail	All PAHs Detection Limit	<0.01 to <0.04	<0.1 to <0.2
	Phenanthrene	<0.01 to **0.03**	<0.1 to <0.2
Labrador tea [2]	All PAHs Detection Limit	<0.01 to <0.04	<0.1
	Phenanthrene	<0.01 to 0.02	<0.1 to **0.16**
	Methylnaphthalene	<0.01 to 0.04	<0.1 to **0.12**
Soil [3]	All PAHs Detection Limit	<0.01 to <0.05	<0.01 to <1
	Fluorene	<0.01 to **0.04**	<0.01 to <1
	Phenanthrene	<0.01 to **0.11**	<0.01 to <1
	Methylnaphthalene	<0.01 to **0.04**	<0.01 to <1

Notes:
(1) In one alder sample from the Mackay River Commercial Project, dibenzo(a,h)anthracene was presented at the detection limit (<0.01 mg/kg) and therefore it was considered all non-detect.
(2) In one Labrador tea sample from the Mackay River Commercial Project, acenaphthene was presented at the detection limit (<0.01 mg/kg) and therefore it was considered all non-detect.
(3) In the soil samples for the Mackay River Commercial Project, fluorene and methyl naphthalenes both had one detected value each of 0.04 mg/kg within the range of detection limits of <0.01 to <0.05 mg/kg, therefore the sample was used in the HHRA as it was greater than the lowest detection limit.

Bold indicates value used in the assessment.

Surface Water

Surface water samples were obtained for the baseline assessment. Surface water quality was characterized by measuring conventional variables, major ions, nutrients, organics and hydrocarbons and metals. Due to the lack of detected data for PAH, surface water concentrations of the COPCs were predicted for all assessment cases.

Multiple Exposure Pathway Assessment

The multiple exposure pathway assessment depended on models to predict concentrations in environmental media for which measured data were not available. These models rely upon the use of mathematical equations (algorithms) that describe the movement of the COPCs from their point of release into the environment to the point of contact with humans. Data required for the model included:

- concentration of each chemical in all environmental media (e.g., air, soil, water);
- physical–chemical properties of the chemical (e.g., vapour pressure, solubility);
- the chemical's behaviour in the environment (e.g., uptake and distribution);
- local environmental conditions (e.g., soil characteristics, meteorology);
- source characteristics (e.g., operational life of the Project); and,
- physiological human characteristics (e.g., body weight, breathing rate).

Two different models were used in the HHRA. The Human Exposure Model (Appendix D) and the Terrestrial Wildlife Exposure Model (provided in Appendix E). These models are described in further detail below and in Appendix C with a worked example or sample calculation.

Terrestrial Wildlife Exposure Model

The objectives of the wildlife exposure model were to:

- predict concentrations of COPCs in environmental media to which wildlife (animals, birds, and invertebrates) might be exposed via multiple routes exposure;
- predict tissue concentrations of game animals and birds to which humans may be exposed; and,
- predict soil and surface water concentrations for the screening-level wildlife risk assessment (SLWRA; Appendix F).

Some information regarding the data inputs and approaches used in the ecological exposure model are provided in Table 3-11. Additional information regarding the inputs and equations utilized is provided within Appendix E.

Table 3-11 Summary of Information used in the Ecological Exposure Model

Media	*Description*
Air	Air dispersion modeling incorporated meteorological data that represented conditions contributing to maximum predicted ground-level air concentrations of the COPCs. The highest annual average air concentrations within the LSA for each COPC were utilized, as it is feasible that game animals and birds move within the Project area over time. These air concentrations were conservatively used to predict exposure via direct inhalation, but also COPC concentrations in terrestrial plants, soils and invertebrates to which the ecological receptors could be exposed through consumption. Finally, the predicted soil and surface water concentrations based on air deposition were used in the SLWRA.
Soil	Most measured soil concentrations of the COPCs in the study area were determined to be below analytical method detection limits. Soil concentrations were predicted using maximum ground level air concentrations. Chemical losses due to degradation and volatilization were also taken into account. It was assumed that the different ecological receptors had regular, direct soil exposure via ingestion in association with food consumption. Concentrations in invertebrates that could be consumed by game birds were predicted from the estimated soil concentrations. Finally, the predicted soil concentrations based on measured plus air deposition were used in the SLWRA.
Vegetation	Most measured plant concentrations of the COPCs in the study area were below analytical method detection limits. Concentrations of the COPCs in above-ground forage were predicted from maximum air concentrations, taking into account the following factors: • the direct deposition of the COPCs from air; • direct vapour uptake from the atmosphere; and • root uptake from soil.
Water	Measured data for the COPCs in surface water were not available, and concentrations were predicted from air deposition. Maximum air concentrations were assumed to deposit on surface water bodies near the Project site, and surface water concentrations were predicted, taking into account the following factors: • the direct deposition; • the physical characteristics of the pond; and • chemical losses due to degradation and volatilization. It was assumed that the ecological receptors consumed water from this source as drinking water. In addition, these predicted water concentrations were used to estimate concentrations in aquatic plants that were assumed to be consumed by moose in the area. Finally, the predicted surface water concentrations based on air deposition were used in the SLWRA.
Wild game	Concentrations of the COPCs in wild game tissues (i.e., moose, snowshoe hare and ruffed grouse) were predicted, taking into account the following: • the highest annual average air concentrations predicted out of all locations where the animals may be present within the LSA; • predicted soil, invertebrate and forage concentrations to which animals could be exposed; • ingestion of water and aquatic plants obtained from ponds located within the Project area; and • chemical loss due to elimination (i.e., depuration) of the COPCs within wildlife.

Human Exposure Model

Total exposures to the COPCs were predicted using the human exposure model.

The objectives of the human exposure model were to:

- predict concentrations of COPCs in environmental media to which people might be exposed via multiple pathway exposure;

- predict COPC concentrations in country and traditional plants and fish that people might consume;
- use the predicted tissue concentrations from the ecological exposure model for consumption of game animals and birds; and
- estimate total human exposure to the COPCs via all relevant routes of exposure and determine the potential for adverse health impacts.

Some information regarding the data inputs and approaches used in the human exposure model are provided in Table 3-12. Additional information regarding the inputs and equations utilized is provided within the worked example (Appendix C).

Table 3-12 Summary of Information used in the Human Exposure Model

Media	***Description***
Air	For each COPC, the highest predicted annual air concentration out of the resident and cabin groups was used to represent the air concentration to which residents at these locations could be exposed to over a lifetime (80-years) It was assumed that people at the worker camps were exposed to the highest annual average concentrations predicted for the camp locations, over their entire adult life (60 years).
Soil and dust	Most measured soil concentrations of the COPCs were determined to be below analytical method detection limits. Soil and dust concentrations were predicted from the air concentrations for each group (resident, worker) as described above, taking into account: • the direct deposition of the highest annual average air concentrations of the locations within each lifestyle category; and • chemical losses due to degradation and volatilization. People were assumed to have direct exposure to soils via incidental ingestion and to dust via inhalation followed by ingestion. Durations of exposure were 80-years for residents and 60-years for workers.
Vegetation	Most measured vegetation (e.g., berries and Labrador tea) concentrations of the COPCs were below analytical method detection limits. Plant concentrations (root and leafy garden vegetables, traditional plants) were predicted from air concentrations for the resident (resident and cabin) group, taking into account: • the direct deposition onto plant surfaces; • direct vapour uptake from the atmosphere; and • root uptake from soil. The HHRA did not make any adjustments for washing or peeling of garden produce, fruits or berries. It was assumed that local residents had consumed local plants and berries on a regular basis over a lifetime or 80 years. Workers were assumed not to consume local foods.
Water	Measured data for the COPCs in surface water were not available, and concentrations were predicted from air deposition. Maximum air concentrations were assumed to deposit in surface water bodies near the Project site, and surface water concentrations were predicted, taking into account the following factors; • the direct deposition; • the physical characteristics of the pond; and • chemical losses due to degradation and volatilization. The predicted water concentrations were used in the estimation of human exposure to COPCs in drinking water, fish consumption and from recreational or traditional use of surface water (e.g. swimming, bathing). Water pathways only applied to the residents, and exposure was assumed to occur over an 80-year lifetime.
Wild game	Concentrations of the COPCs in wild game tissues (i.e., moose, snowshoe hare and ruffed grouse) were predicted, taking into account the following: • the highest annual average air concentrations predicted out of all locations where the animals may be present within the LSA, and could inhale air or consume soil and vegetation;

Media	Description
	• ingestion of water and aquatic plants from ponds within the Project area; and • chemical loss due depuration of the COPCs. It was assumed that residents (not workers) regularly consume local game as part of their diet over an 80-year lifetime.
Fish	Concentrations of the COPCs in fish were estimated based on predicted surface water concentrations in ponds that may contain sport fish. It was assumed that the residents (not workers) regularly consume local sport fish over an 80-year lifetime.

3.2.3 Toxicity Assessment

The toxicity assessment involves having an understanding of the critical toxicological effects that can result from exposure to the COPCs and the condition in which these effects might occur. Such information is generally obtained from published scientific studies conducted in animals or humans under controlled experimental conditions, or observations from human epidemiological studies that examine the relationship between adverse effects and exposure to individual chemicals or groups of chemicals. Potential health effects associated with exposures to the COPCs (Appendix A), along with the basis and selection of the exposure limits, are described in Appendix B.

When evaluating the toxicological potential for a substance in relation to health, consideration must be given to the dose to which a person is exposed, as the dose determines the type and potentially the severity of any adverse effects that may be observed. In addition, consideration must be given to the route of exposure (i.e., inhalation, oral, or dermal), as the route of exposure influences absorption, distribution and excretion of the toxicant. Specifically, it is the amount of the substance that is absorbed and reaches the toxicological site of interest in the organism that determines the probability of an adverse effect occurring. Substances may differ greatly with respect to the dosage required to result in an adverse effect, as well as in the mechanism(s) by which the adverse effects are elicited.

Two categories of COPCs were assessed based upon their mechanism of toxicity: threshold and non-threshold COPCs. Threshold substances are generally those that require that a certain level of exposure (or minimum dose) be exceeded before toxic effects occur. In general, threshold substances are non-carcinogenic (i.e., non-cancer causing), but there are some chemicals that demonstrate a mode of carcinogenicity that has a threshold. For threshold substances, it is necessary to evaluate the available information to identify effect-levels at which either no effects are observed (e.g., a no-observed-adverse-effect level [NOAEL] or a no-observed-effect level [NOEL]) or adverse effects are first observed (e.g., a lowest observed adverse effect level [LOAEL] or lowest observed effect level [LOEL]). The use of a benchmark doses (BMD), which represent a dose level associated with a specified degree of response (i.e., 5% or 10% incidence within the study population), is becoming more common in risk assessment. All of these types of endpoints (NOAELs, LOAELs and BMDs) provide an indication of exposure levels that are associated with minimal or negligible health risks and are often used in the derivation of exposure limits by both government and non-government organizations. The application of uncertainty or safety factors to an effect level provides an added level of protection, allowing for the derivation of an exposure limit that is expected to be adequately protective of the most sensitive subjects following exposure over a prescribed time period.

Non-threshold substances are carcinogens capable of producing cancer through one or more of a number of possible mechanisms (e.g., mutagenicity, cytotoxicity, inhibition of programmed cell death, mitogenesis [uncontrolled cell proliferation] and immune suppression) that, in theory, do not require the exceedance of a threshold (US EPA OSW 2005). In general, carcinogenic potency data from animals or human epidemiological studies were evaluated by jurisdictional authorities. From these data sets, Unit Risks (URs) or Slope Factors (SFs) are identified, which are in turn used to develop applicable exposure limits (risk specific doses or risk specific concentrations). Regulatory agencies such as Health Canada and the US EPA assume that any level of long-term exposure to carcinogenic chemicals is associated with some "hypothetical cancer risk". As a result, Health Canada and Alberta Environment have specified an incremental lifetime cancer risk (ILCR) (i.e., over and above background) of 1.0 in 100,000, which these agencies consider acceptable, tolerable or essentially negligible (AENV 2009; Health Canada 2009b). The regulatory benchmark of an acceptable cancer risk is policy-based and its interpretation by various regulatory agencies differs (CCME 2006).

3.2.3.1 Exposure Limits

The terminology used to define threshold and non-threshold exposure limits differs according to the source and type of exposure and varies between regulatory jurisdictions. Generic nomenclature has been developed, with the following terms and descriptions commonly used:

- ***Reference Concentration (RfC)**:* refers to the safe level of an airborne chemical for which the primary avenue of exposure is inhalation. It is expressed as a concentration of the chemical in air (i.e., µg/m³) and applies only to threshold chemicals.
- ***Reference Dose (RfD):*** refers to the safe level or dose of a chemical for which exposure occurs through multiple pathways (i.e., inhalation, ingestion and dermal). It is most commonly expressed in terms of the total intake of the chemical per unit of body weight (i.e., µg/kg bw/d). This term applies only to threshold chemicals.
- ***Risk-Specific Concentration (RsC***): reserved for carcinogens and refers to the level of an air-borne carcinogen for which the primary route of exposure is inhalation that results in a "regulatory acceptable" incremental increase in cancer (typically one in 100,000). It is expressed as a concentration of the chemical in air (i.e., µg/m³).
- ***Risk-Specific Dose (RsD):*** reserved for carcinogens and refers to the dose of a carcinogen for which exposure occurs through multiple pathways that results in a "regulatory acceptable" increased incidence of cancer (typically one in 100,000). It is expressed in terms of the total intake of the chemical (i.e., µg/kg bw/d).

Exposure limits (also known as toxicological reference values or TRVs) that have been developed by scientific and/or regulatory agencies aimed at the protection of human health were identified for each of the COPCs on both an acute and chronic basis.

Separate assessments were completed for both the acute and chronic exposure scenarios in recognition of the fact that the toxic response produced by chemicals and the target tissues affected can change, depending on whether exposure is short term or long term.

As a result, different exposure limits were selected for each chemical included in the acute and chronic assessments.

The two exposure limit durations assessed included:

- ***Acute Exposure Limit****:* the amount or dose of a chemical that can be tolerated without evidence of adverse health effects on a short term basis. These limits are routinely applied to conditions in which exposures extend over several hours or days; and
- ***Chronic Exposure Limit:*** the amount of a chemical that is expected to be without effect, even when exposure occurs continuously or regularly over extended periods, lasting for periods of at least a year and possibly extending over an entire lifetime.

Within the context of the chronic assessments, further distinction must be made between the exposure limits developed for the primary inhalation pathway and secondary exposure pathways. Consideration is also given to chronic limits that are based on non-carcinogenic effects and carcinogenic effects.

For the purposes of the HHRA, reliance was placed on exposure limits developed by regulatory or reputable scientific agencies as criteria (i.e., objectives, guidelines or standards) for the protection of air quality and human health. Exposure limits were sourced from:

- Alberta Environment (AENV)
- Agency for Toxic Substances and Disease Registry (ATSDR)
- American Conference of Governmental Industrial Hygienists (ACGIH)
- Canadian Council of Ministers of the Environment (CCME)
- Health Canada and Environment Canada
- Netherlands National Institute of Public Health and the Environment (RIVM)
- California Office of Environmental Health Hazard Assessment (OEHHA)
- Ontario Ministry of the Environment (OMOE)
- Texas Commission on Environmental Quality (TCEQ)
- U.S. Environmental Protection Agency (US EPA)
- World Health Organization (WHO)

By definition, exposure limits may include standards, guidelines, objectives, reference concentrations or doses, cancer risk estimates, etc. that have been derived for the protection of human health.

These exposure limits typically incorporate a high level of conservatism, in view of the mandate of the authorities to offer guidance aimed at the protection of public health. That said, the basis of these exposure limits might differ depending on the responsible regulatory jurisdiction or scientific authority charged with developing the safe or acceptable level of exposure. The limits also might differ in terms of the primary determinant(s) of concern (e.g., direct health effects versus odour) and the level of protection required. For inclusion in the HHRA, exposure limits were required to be:

- established or recommended by a reputable scientific or regulatory agency;
- protective of the health of the general public based on current scientific knowledge of the health effects associated with exposure to the COPCs;
- protective of sensitive individuals (i.e., children and the elderly) through the incorporation of uncertainty or safety factors; and
- supported by adequate documentation that is readily available.

Emphasis was generally given to those limits, which had adequate supporting documentation, so that the limits could be evaluated to ensure that their basis was relevant and sufficient. When

these criteria were satisfied by more than one objective, guideline or standard, the most scientifically defensible limit was selected.

For those chemicals for which exposure limits have not been developed or recommended by the various regulatory or reputable scientific agencies either as individuals or as pre-defined chemical groups, surrogate chemicals were identified if possible. This step relied on the toxicological principle that states that the molecular structure of a chemical has a distinct bearing on its reactivity, biological activity and toxicity. The principle allows for the toxicity of a chemical for which little or no toxicological information exists to be predicted on the basis of information available on another chemical of similar molecular structure. The second chemical is termed a "surrogate". Depending on the amount of information available for the various constituents of the group and the relative defensibility of the values, different surrogates for a group may be identified on an acute and chronic basis.

A complete list of the exposure limits identified in the toxicity assessment is presented in Table 3-13, Table 3-14 and Table 3-15. Additional information regarding the approaches used for identifying and selecting exposure limits on an acute and chronic basis, as well as details regarding the available limits for each of the COPCs that were evaluated as part of the limit selection process, are provided within Appendix B (toxicity profiles). Information regarding any surrogate compounds used to represent groups of chemicals is also presented in the individual profiles of Appendix B, where relevant.

3.2.3.2 Exposure Limits Adopted for the HHRA

The exposure limits selected for use in the acute inhalation, chronic inhalation and chronic multiple pathway exposure assessments are provided in Table 3-13, Table 3-14 and

Table 3-15, respectively.

Table 3-13 Acute Inhalation Exposure Limits for the COPCs

COPC	*Averaging Period*	*Value (µg/m³)*	*Source*
CO	1-hour	40,000	US EPA
	8-hour	10,000	US EPA
NO_2	1-hour	188	US EPA
$PM_{2.5}$	24-hour	30	CCME
SO_2	10-minute	500	WHO
	1-hour	196	US EPA
Acetaldehyde	1-hour	470	OEHHA
Acrolein	1-hour	2.5	OEHHA
Formaldehyde	1-hour	50	ATSDR

Table 3-14 Chronic Inhalation Exposure Limits for the COPCs

COPC	*Type*	*Value (µg/m³)*	*Source*
NO_2	RfC	100	US EPA
$PM_{2.5}$	RfC	12	CARB
Benzo(a)pyrene	RsC	0.00012	WHO
Benzo(a)pyrene Equivalent	RsC	0.32	Health Canada
Acetaldehyde	RsC	17.2	Health Canada
Acrolein	RfC	0.35	OEHHA
Benzene	RsC	1.3	US EPA
Formaldehyde	RfC	11	TCEQ
n-Hexane	RfC	670	TCEQ

Table 3-15 Chronic Oral Exposure Limits for the COPCs

COPC	*Value (µg/kg bw/d)*	*Source*
2-methylnaphthalene	4	US EPA
3-methylcholanthrene (C_{17}-C_{34} aromatic group) [1]	30	CCME
Benzo(a)pyrene Equivalent [2]	0.0014	US EPA
Pyrene	30	US EPA
C_9-C_{18} aromatic group [3]	40	TPHCWG
Formaldehyde	150	Health Canada

Notes:
(1) 3-methylcholanthrene was the only constituent of the aromatic C_{17}-C_{34} group in this assessment. As no exposure limit is available for this substance, an available limit for the aromatic C_{17}-C_{34} group was assumed as a surrogate.
(2) Comprised of 7,12-Dimethylbenz(a)anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene and Phenanthrene.
(3) C_9-C_{18} aromatic group consists of: C_9-C_{18} aromatic, 2-methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Fluorene and Pyrene.

3.2.3.3 Chemical Mixtures

Given that chemical exposures rarely occur in isolation, the potential health effects associated with mixtures of the COPCs were assessed in the HHRA. In accordance with Health Canada guidance, additive interactions were assumed for the HHRA (Health Canada 2009a). Additive interactions apply most readily to chemicals that are structurally similar, act toxicologically through similar mechanisms or affect the same target tissue in the body (i.e., share commonality in effect) (Health Canada 2009a).

Potential additive interactions were identified for specific COPCs that may cause:

- Eye irritation
- Nasal irritation
- Respiratory irritation
- kidney toxicity

An individual chemical's inclusion in a chemical mixture was determined based on the endpoint upon which the exposure limits selected in the HHRA were based. For example, the acute inhalation exposure limit for acrolein is based on its ability to cause eye, nasal and respiratory tract irritation, thus acrolein was included in the acute inhalation eye irritant mixture, nasal irritant mixture and respiratory irritant mixture. For details concerning the critical endpoints of the chemicals included in each of the mixtures, see Appendix B.

The assumed chemical constituents of the individual mixtures are listed in Table 3-16.

Table 3-16 Summary of Chemical Mixture Composition for the HHRA

Exposure Characteristics	*Toxicant Designation*	*COPCs*
Acute Inhalation Exposure	Eye irritants	acetaldehyde, acrolein, formaldehyde
	Nasal irritants	acetaldehyde acrolein, formaldehyde
	Respiratory irritants	acetaldehyde, acrolein, nitrogen dioxide, sulphur dioxide(1)
Chronic Inhalation Exposure	Nasal irritants	acrolein, formaldehyde
	Respiratory irritants	formaldehyde, nitrogen dioxide
Chronic Oral Exposure	Renal toxicants	3-methylcholanthrene, aromatic C_9-C_{18} group, formaldehyde

Notes:
(1) The highest risk estimate of the different averaging times for SO_2 (i.e., 10-minute and 1-hour) was used in the prediction of potential health risks for the acute respiratory irritants mixture.

3.2.4 Risk Characterization

This final step of the risk assessment involves comparing estimated exposures (identified in the exposure assessment) with exposure limits (identified in the toxicity assessment) to determine potential health risks for the different assessment cases. Sources of uncertainty and how uncertainties were addressed is also discussed below (Section 3.2.4.3).

3.2.4.1 Non-Cancer Risks

Risk quotient (RQ) values were calculated by comparing the predicted levels of exposure for the non-carcinogenic COPCs to their respective exposure limits (Appendix B) that have been developed by regulatory and scientific authorities. Risk quotient values were calculated using Equation 1:

$$RQ = \frac{\text{Predicted Exposure (µg/kg/d or µg/m}^3\text{)}}{\text{Exposure Limit (µg/kg/d or µg/m}^3\text{)}} \qquad \textit{Equation 1}$$

Interpretation of the RQ values proceeded as follows:

- **RQ ≤ 1.0** Indicates that the estimated exposure is less than or equal to the exposure limit (i.e., the assumed safe level of exposure). RQ values less than or equal to 1.0 are associated with negligible health risks, even in sensitive individuals given the level of conservatism incorporated in the derivation of the exposure limit and exposure estimate.

- **RQ > 1.0** Indicates that the exposure estimate exceeds the exposure limit. This suggests an elevated level of risk, the significance of which must be balanced against the high degree of conservatism incorporated into the risk assessment (i.e., the margin of safety is reduced but not removed entirely).

The predicted RQ values in this HHRA are presented in scientific notation as many of the calculated numerical values are well below 1. Therefore, an RQ value of 1.0 is equivalent to 1.0E+00. RQ values less than 1 are presented with a negative sign or 5.0E-01, which is numerically equivalent to 0.5. Scientific notation provides an efficient manner to control significant digits and accuracy with predicted results.

3.2.4.2 Cancer Risks

Regulatory agencies such as Health Canada and the US EPA assume that any level of long term exposure to carcinogenic chemicals is associated with some hypothetical cancer risk. Some individuals may be more susceptible to developing cancer than others, and background exposures alone may exceed reasonably safe exposure levels and may result in the development of cancer in such sensitive individuals (Graham 1993). Health Canada and AENV have specified an incremental (i.e., over and above background) lifetime cancer risk of one in 100,000, which these agencies consider acceptable, tolerable or essentially negligible (AENV 2009; Health Canada 2009a). An assumed incremental cancer risk of 1.0 or 1.0E+00 in 100,000 increases a person's lifetime cancer risk from 0.40000 for women (based on the 40% lifetime probability of developing cancer in Canada) to 0.40001, and 0.45000 for men (based on the 45% lifetime probability of developing cancer in Canada) to 0.45001 (CCS 2010). Because this assumed "acceptable" cancer risk level was specifically developed to address cancer risks over and above background cancer incidence, a portion of which includes background exposure to environmental pollutants, background exposures were not included in the assessment of potential cancer risks for non-threshold (i.e., carcinogenic) chemicals (Wilson 2005).

Further, Health Canada (2009a) specifies that carcinogens be assessed on an incremental basis, and mandate an "acceptable" incremental lifetime cancer risk (ILCR) of 1.0 in 100,000. For the purposes of this assessment, ILCR estimates have been determined for the Project alone as well as the incremental contribution of the future emission sources. The future scenario was calculated by subtracting the Baseline case from the PDC and represents the cumulative increase in exposures over Baseline. Interpretation of these ILCR values was based on comparison of the ILCR associated with the Project and future scenario against the Health Canada (2009a) *de minimus* risk level of 1.0 in 100,000 (i.e., one extra cancer case in a population of 100,000 people).

Background exposures were not included in the ILCR calculation such that the potential incremental impact on health due the Project alone and in association with other proposed projects (i.e., future case) could be assessed. The ILCR values were calculated using Equation 2.

$$\textbf{ILCR} = \frac{\textbf{Project-related exposure (µg/kg/d or µg/m}^3\textbf{)}}{\textbf{Carcinogenic Exposure Limit (µg/kg/d or µg/m}^3\textbf{)}} \qquad \textit{Equation 2}$$

Interpretation of the ILCR values proceeded as follows:

- **ILCR ≤ 1.0** Denotes an incremental lifetime cancer risk that is below the benchmark ILCR of 1.0 in 100,000 (i.e., within the accepted level of risk set by Alberta Environment and Health Canada).
- **ILCR > 1.0** Indicates an incremental lifetime cancer risk that is greater than the *de minimus* risk level of 1.0 in 100,000, the interpretation of which must consider the conservatism incorporated into the assessment.

3.2.4.3 Major Assumptions of the Human Health Risk Assessment

There is always some degree of uncertainty that surrounds the prediction of any health risks, regardless of type or source. This uncertainty can take several forms, including: uncertainty due to lack of information; uncertainty due to the variability intrinsic to living systems; and, uncertainty due to experimental and measurement error. These and other forms of uncertainty can confound the interpretation of the meaning and significance of any health risks that might be revealed by the work. By convention, the uncertainty is accommodated, in part, through the use of assumptions which embrace a degree of conservatism and are often intentionally selected to represent worst-case conditions. Using this approach, any health risks identified by the assessment are unlikely to be understated, but may be considerably overstated.

A summary of the various assumptions that were incorporated into the HHRA is provided in Table 3-17.

Table 3-17 Assumptions and Uncertainty in the HHRA

Risk Assessment Paradigm	*Assumption*	*Discussion of Uncertainty and Conservatism*
Exposure Assessment	Air dispersion modeling incorporated five years of meteorological data and the HHRA focused on maximum predicted ground-level air concentrations of COPCs.	Air quality models incorporate multiple continuous emission sources (i.e., industrial, community and transportation) within the modelling domain and exclude infrequent and non-continuous emissions sources (e.g., forest fires). Predicted air quality concentrations are validated with ambient measurements at specific monitoring stations for key parameters. The air quality assessment determined that the air quality results are reasonably accurate and robust. However, the use of the maximum predicted ground-level air concentrations of the COPCs likely contributed to the exaggeration of the exposures that might be received by people residing or visiting the area under most circumstances.
	The people with the highest predicted exposures within each receptor group (i.e., cabin, resident, worker) were used to characterize the potential exposures for all people represented by the group as a whole.	Potential exposures assumed for each receptor group represents a 'reasonable worst-case' scenario. This contributes to a potential overestimation of risks for people located in areas other than where the highest concentration for the group occurs.
	Predicted chronic exposures were based on the assumption that individuals would be exposed 24 hours per day for 365 days per year to the maximum predicted ground-level air concentrations of the COPCs over a lifetime (i.e., 80 years).	The operating life of the Project was assumed to be 80 years (equivalent to a human lifetime). The assumption of 80-years of deposition in the environment from the Project likely results in an overestimation of risk. The actual life of the Project is closer to 25 years.
	Predicted chronic multiple pathway exposures were estimated for all life stages, but only the results of the most sensitive age groups were reported for non-carcinogens. Cancer risks were expressed for a composite receptor that takes all life stages into account.	Exposures for the other life stages are predicted to be lower than those reported for non-carcinogens. The RQs presented in the HHRA represent maximums, and are conservative estimates for life stages other than the sensitive life stage (i.e., typically toddlers, who have a higher exposure to body weight ratio). It is standard practice to amortize exposures for the assessment of carcinogens, especially in instances where an individual is assumed to reside in the area of interest over a lifetime. For the residents, an 80-year lifetime was considered in the amortization with consideration being given to each individual life stage (infant to adult). For the workers, risk amortization for carcinogens was completed only over the 60-year adult life stage.
	The residents (resident and cabin) were assumed to obtain 100% of their food from local, natural food sources (e.g., wild game, fish, berries, and plants) and drinking water from local water bodies.	The assumption that all residents obtain all of their food and drinking water from the area likely contributes to an overestimation of actual exposures. It is feasible that food from non-local sources (e.g., supermarkets or other areas) is purchased and consumed to some degree, and that some individuals consume water and beverages from other sources.

Risk Assessment Paradigm	*Assumption*	*Discussion of Uncertainty and Conservatism*
	Tissue concentrations of wild game (i.e., moose, snowshoe hare, and ruffed grouse) were based on the maximum predicted ground-level air concentrations out of all locations. In addition, maximum measured media concentrations were used when available.	It is unlikely that wild game animals and birds will forage at one discrete location over their entire lifetime. As such, the assumption that wild game will forage at the location where the maximum concentrations are predicted is likely over conservative.
Toxicity Assessment	Possible interactions of the COPCs released by the Project, which might lead to enhanced toxicity, were adequately addressed in the assessment.	COPCs with the same toxicological endpoints (as determined by the exposure limit selected) were evaluated on an acute and chronic basis, with assignment to chemical mixtures being dependent upon the toxicological effect underlying the exposure limits selected. Consistent with Health Canada (2009a) guidance, substances were considered to be additive if they have the same endpoint. In some instances, it is possible that components of a mixture may have different mechanisms of effect, contributing some uncertainty to the mixture RQs. Also, the uncertainty 'built in' to each of the individual exposure limits involved in the mixtures assessments compounds with the addition of the RQ values.
	Exposure limits that were developed to be protective of the sensitive and more susceptible individuals within the general population (e.g., infants and young children, the elderly, individuals with compromised health) were used in the HHRA.	A considerable amount of conservatism is incorporated in the exposure limits. Exposure limits selected for use in the HHRA have incorporated an uncertainty factor to account for potential inter-individual differences in sensitivity, with the factor generally ranging from 3 to 10. As a result, these limits represent concentrations much lower than those where people could experience adverse effects.
	The findings from toxicity studies with laboratory rodents can be used to gauge the types of responses and health effects that the chemicals may cause in humans and the findings from the laboratory rodent studies can be used, in part, to determine exposure limits for the chemicals.	Laboratory rodents have traditionally served as suitable surrogate species for humans. The use of uncertainty factors accounts for the possible differences in responses to chemicals that might be observed between laboratory rodents and other species, such as humans (see Appendix B). However, recent evidence suggests that rodents might be more sensitive to nasal effects than humans as a result of higher doses reaching the critical target site or tissue in rodents. In some instances, these differences contribute uncertainty to the predicted results with respect to COPCs with nasal effects as the critical toxicological effect.

4.0 HHRA RESULTS

The results of the acute and chronic effects assessments are provided in Section 4.1 through 4.5. As the potential toxicity of a chemical may vary according to route of exposure, the results of the chronic inhalation assessment and chronic multiple pathway assessment are provided separately. The chronic inhalation assessment is provided in Section 4.3 for carcinogenic and non-carcinogenic chemicals, and the results of the multiple pathway assessment are provided in Section 4.4. Upset conditions were evaluated in the local study area for a short-term emergency shutdown scenario and this analysis is presented in Section 4.2. The chemical mixture assessment (Section 4.5) is presented separately for the acute and chronic inhalation exposures, and for the multiple pathway assessment.

4.1 Acute Inhalation Results

The results of the acute inhalation assessment are presented in Table 4-1, Table 4-2, Table 4-3 and Table 4-4. These tables present the maximum RQ value calculated for each group of locations identified in the exposure assessment. Results are only presented for those COPCs that have exposure limits available. Calculated RQ values are also presented for the LSA MPOI.

Table 4-1 Acute Inhalation RQs for the LSA-MPOI

COPC	*Averaging Period*	*Assessment Case*		
		Baseline	*Application*	*PDC*
Acetaldehyde	1h-Max	3.8E-02	3.8E-02	4.1E-02
Acrolein	1h-Max	6.0E-01	6.0E-01	7.5E-01
CO	1h-Max	3.8E-02	3.8E-02	4.1E-02
CO	8h-Max	1.1E-01	1.1E-01	1.2E-01
Formaldehyde	1h-Max	2.0E-01	2.0E-01	2.7E-01
NO_2 (1)	EPA Stat Max	8.7E-01	8.7E-01	6.9E-01
$PM_{2.5}$	24h-8th	8.4E-01	8.4E-01	8.6E-01
SO_2	10min (1h-Max)	1.9E+00	1.9E+00	1.9E+00
SO_2	EPA Stat Max	1.3E+00	1.3E+00	1.3E+00

Notes:
(1) Predicted decrease in PDC RQ values due to future changes at existing facilities north of Fort McMurray and reductions associated with the transition to Tier 4 emission factors for mine fleets.

Table 4-2 Acute Inhalation RQs for the Cabin Group

COPC	*Averaging Period*	*Assessment Case*		
		Baseline	*Application*	*PDC*
Acetaldehyde	1h-Max	2.2E-02	2.2E-02	2.5E-02
Acrolein	1h-Max	3.4E-01	3.4E-01	3.8E-01
CO	1h-Max	2.9E-02	2.9E-02	3.1E-02
CO	8h-Max	8.2E-02	8.2E-02	9.5E-02
Formaldehyde	1h-Max	1.1E-01	1.1E-01	1.3E-01
NO_2 (1)	EPA Stat Max	5.5E-01	5.5E-01	5.2E-01
$PM_{2.5}$	24h-8th	6.1E-01	6.1E-01	6.9E-01

COPC	Averaging Period	Assessment Case		
		Baseline	Application	PDC
SO_2	10min (1h-Max)	1.7E+00	1.7E+00	1.7E+00
SO_2	EPA Stat Max	1.2E+00	1.2E+00	1.2E+00

Notes:
(1) Predicted decrease in PDC RQ values due to future changes at existing facilities north of Fort McMurray and reductions associated with the transition to Tier 4 emission factors for mine fleets.

Table 4-3 Acute Inhalation RQs for the Resident Group

COPC	Averaging Period	Assessment Case		
		Baseline	Application	PDC
Acetaldehyde	1h-Max	3.2E-02	3.2E-02	3.3E-02
Acrolein	1h-Max	4.9E-01	4.9E-01	5.1E-01
CO	1h-Max	6.7E-02	6.7E-02	7.1E-02
CO	8h-Max	1.4E-01	1.4E-01	1.6E-01
Formaldehyde	1h-Max	1.5E-01	1.5E-01	1.7E-01
NO_2 (1)	EPA Stat Max	8.0E-01	8.0E-01	7.6E-01
$PM_{2.5}$	24h-8th	8.7E-01	8.7E-01	8.9E-01
SO_2	10min (1h-Max)	4.5E-01	4.5E-01	6.5E-01
SO_2	EPA Stat Max	5.0E-01	5.0E-01	6.2E-01

Notes:
(1) Predicted decrease in PDC RQ values due to future changes at existing facilities north of Fort McMurray and reductions associated with the transition to Tier 4 emission factors for mine fleets.

Table 4-4 Acute Inhalation RQs for the Worker Group

COPC	Averaging Period	Assessment Case		
		Baseline	Application	PDC
Acetaldehyde	1h-Max	8.0E-03	8.0E-03	7.6E-03
Acrolein	1h-Max	1.2E-01	1.2E-01	1.5E-01
CO	1h-Max	1.7E-02	2.0E-02	2.0E-02
CO	8h-Max	5.9E-02	5.9E-02	6.5E-02
Formaldehyde	1h-Max	3.7E-02	3.7E-02	5.5E-02
NO_2	EPA Stat Max	4.0E-01	4.0E-01	4.0E-01
$PM_{2.5}$	24h-8th	5.3E-01	5.4E-01	5.6E-01
SO_2	10min (1h-Max)	5.4E-01	5.4E-01	5.5E-01
SO_2	EPA Stat Max	4.6E-01	4.6E-01	5.1E-01

With the exception of SO_2, all acute RQ values were less than 1, suggesting a low probability of adverse health effects attributable to air emissions. In general, the predicted RQ values for the Application Case were identical to those predicted in the Baseline Case, indicating that the Project emissions are expected to have a negligible impact on predicted health risks.

The predicted 10-minute and 1-hour SO_2 RQ values exceed health-based exposure limits only at the LSA MPOI and two cabin locations (i.e., R2 and R3) in the Baseline, Application and PDC. All other RQ values for SO_2 are less than 1.0.

At the LSA MPOI, the predicted 10-minute SO_2 concentration was predicted to be approximately950 µg/m³ for the Baseline and Application Cases and approximately 960 µg/m³ for the PDC. The 10-minute SO_2 concentrations were estimated based on the hourly maximums multiplied by a factor of 1.65 (MEMS 2011a). The maximum predicted 1-hour SO_2 concentrations in the three assessment cases for the LSA MPOI were between 570 and 580 µg/m³. There is no apparent change in the air concentrations between the Baseline, Application and PDC. In addition, further evaluation of the isopleth figures for hourly SO_2 concentrations in the Air Quality assessment (MEMS 2011a) show that maximum concentrations are found in the easterly region of the LSA and existing and approved sources of SO_2 within the Athabasca Valley north of Fort McMurray are largely responsible for the predicted concentrations. There is minimal contribution from the Project or proposed future developments in the LSA. Review of ambient air quality data from the Fort MacKay and Fort McMurray Athabasca Valley monitoring stations indicate that, from 2003 to 2009, maximum hourly SO_2 concentrations historically have ranged from approximately 99 to 481 µg/m³. Ambient air quality monitoring stations located near mines (not in communities) have recorded maximum 1-hour SO_2 concentrations ranging from 84 to 764 µg/m³ from 2003 to 2009. The predicted maximum hourly Baseline SO_2 concentrations at the LSA MPOI appear to fall within these historical concentration ranges. Table 4-5 provides a summary of measured hourly ambient SO_2 concentrations and the calculated EPA Statistic in Fort McKay and Fort McMurray stations for 2003 to 2009.

Table 4-5 Summary of Measured Maximum Hourly Ambient SO_2 Concentrations in Fort McKay and Fort McMurray Monitoring Stations [µg/m³]

Station and Statistic	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Fort McKay							
Maximum	249	225	330	256	481	280	144
EPA Statistic (1)	215	195	233	200	227	186	117
Fort McMurray (Athabasca Valley)							
Maximum	115	201	183	99	201	170	162
EPA Statistic (1)	88	91	91	62	101	115	85

Notes:
(1) EPA Stat represented by 99th percentile of daily maximums.

An analysis of five-years of predicted time series data for SO_2 was completed and Table 4-6 presents the estimated number of instances at the LSA MPOI where the hourly air concentrations were predicted to be above the 1-hour EPA Air Quality Standard of 196 µg/m³.

Table 4-7 presents the estimated number of instances at the LSA MPOI where the 10-minute air concentrations were predicted to be above the 10-minute World Health Organization guideline of 500 µg/m³. The analysis focused on the LSA MPOI only where the highest concentrations were predicted. Predicted risks at the two cabin locations (i.e., R2 and R3) are lower than the LSA MPOI. Over 97% of the time, the predicted 1-hour and 10-minute SO_2 concentrations at the LSA MPOI are predicted to be less than the corresponding exposure limits. As shown, the Project is not expected to increase the likelihood of the SO_2 acute exposure limits being exceeded at the LSA MPOI.

Table 4-6 Predicted Number of Daily Maximum Exceedances and Percent of Time Below US EPA SO_2 Standard at the LSA MPOI [Days per Year]

Year of Meteorological Data	*Exceedances (Percent of Time Below Standard)*		
	Baseline	*Application*	*PDC*
2002	12 (97%)	12 (97%)	12 (97%)
2003	6 (98%)	6 (98%)	7 (98%)
2004	10 (97%)	10 (97%)	10 (97%)
2005	7 (98%)	7 (98%)	7 (98%)
2006	9 (98%)	9 (98%)	9 (98%)

Table 4-7 Predicted Number of Hourly Exceedances and Percent of Time Below WHO 10-minute Guideline at the LSA MPOI [Hours per Year]

Year of Meteorological Data	*Exceedances (Percent of Time Below Guideline)*		
	Baseline	*Application*	*PDC*
2002	5 (99%)	5 (99%)	5 (99%)
2003	0 (100%)	0 (100%)	0 (100%)
2004	1 (99%)	1 (99%)	1 (99%)
2005	1 (99%)	1 (99%)	1 (99%)
2006	0 (100%)	0 (100%)	0 (100%)

The degree of conservatism incorporated into the exposure limits must be considered in the interpretation of the likelihood of potential adverse health effects. A review of the scientific literature indicates that clear respiratory responses have not been observed in healthy individuals exposed to brief periods of concentrations of SO_2 less than 530 µg/m³ (see Table 4-8). The maximum predicted hourly SO_2 concentrations at the LSA MPOI (570 to 580 µg/m³, MEMS 2011a) are within the range of air concentrations where increased airway resistance and potential bronchoconstriction in asthmatic or sensitive individuals engaged in moderate exercise may be observed, depending on the severity of the asthmatic condition (see Table 4-8). All of the predicted hourly SO_2 concentrations in this HHRA are below the level of 1,300 µg/m³, above which healthy individuals have been reported to experience mild effects.

Based on the low likelihood of SO_2 concentrations exceeding guidelines, the conservatism incorporated in the exposure limits and the low likelihood that an individual will be present at the MPOI or cabin at the exact time when maximum concentrations are reached, the predicted acute SO_2 risks are likely overstated and adverse impacts from short-term exposures to SO_2 at the LSA MPOI, R2 or R3 are not expected.

Table 4-8 Potential Acute Health Effects Associated with SO_2

Concentration in Air		*Description of Potential Health Effects*[3]
ppm	*µg/m³*[1]	
<0.1	<250	No documented reproducible evidence of adverse health effects among healthy individuals or susceptible individuals[2] following short-term exposure.

0.1 to 0.2	250 to 530	Possible modest, transient changes in lung function indices, detectable by spirometry, among asthmatics during moderate to strenuous exercise. Changes characterized by increased airway resistance and/or reduced air conductance. All changes fully reversible and strictly sub-clinical in nature, with no evidence of wheezing, shortness of breath or other clinical signs. No documented effects among healthy individuals.
0.2 to 0.5	530 to 1,300	Increased airway resistance and potential bronchoconstriction in asthmatic or sensitive individuals engaged in moderate exercise. Bronchoconstriction with or without attendant clinical signs depending on severity of asthmatic condition. Typically no effects on lung function in normal individuals.
0.5 to 1	1,300 to 2,600	Increased resistance in airways and difficulties breathing may be experienced by normal individuals (in addition to asthmatics and sensitive individuals). Sore throat and the ability to taste and smell SO_2 may also be apparent. Effects in asthmatics and other sensitive individuals may also include wheezing, dyspnea, and bronchoconstriction.
1 to 5	2,600 to 13,000	Odour is detectable. Increased resistance in airways, decreased lung volume, reduced bronchial clearance, and evidence of lung irritation (increased macrophages in lung fluid) were observed at this exposure level. Headache, coughing, throat irritation, nasal congestion, increased salivation may be evident, and some symptoms may persist for several days after exposure. Mucociliary transport in the nasal passages may also be impaired, potentially leading to nasal congestion. Respiratory effects may be more severe in asthmatics and sensitive individuals.
5 to 10	13,000 to 26,000	Increased resistance in airways, decreased respiratory volume, difficulties breathing, and lung irritation were reported at this exposure level. Nasal, throat, and eye irritation, nosebleeds, coughing, potentially accompanied by erythema of trachea and bronchi may occur. Respiratory effects may be more severe in asthmatics and sensitive individuals.
10 to 50	26,000 to 130,000	Symptoms of more severe respiratory irritation may appear, such as burning of nose and throat, sneezing, severe airway obstruction, choking, and dyspnea. Exposure may result in damage to airway epithelium that may progress to epithelial hyperplasia, an increased number of secretory goblet cells, and hypertrophy of the submucousal glands. A condition known as Reactive Airway Dysfunction Syndrome (RADS) may arise in the concentration ranges (as well as above) as a result of bronchial epithelial damage. Chronic respiratory effects may develop. Eye irritation, watery eyes, and skin eruptions (rashes) may be evident. Respiratory effects may be more severe in asthmatics and sensitive individuals.
50 to 100	130,000 to 260,000	Symptoms of severe respiratory irritation may occur, such as bronchitis, intolerable irritation of mucous membranes in addition to other effects described above, such as decreased lung capacity and breathing difficulties, runny nose, eye and skin irritation.
>100	>260,000	Immediately dangerous to life and health. Chemical bronchopneumonia and asphyxia were reported at high levels of exposure. Death may result from severe respiratory depression at concentrations of about 2 600 000 µg/m³.

Notes:
(1) ppm SO_2 converted to $\mu g/m^3$ by multiplying by conversion factor of 2,600.
(2) Includes individuals suffering from respiratory disorders, such as asthma, bronchitis, and chronic obstructive pulmonary disease (COPD).
(3) Note that the descriptions pertain largely to the types of health effects that might be experienced among normal, healthy individuals following acute exposure to SO_2. Some descriptions refer to the types of symptoms that might occur among individuals with pre-existing eye and/or breathing disorders, such as asthma, bronchitis or COPD. The exact nature and severity of responses that might occur among these latter individuals will depend on several factors, including: i) the severity of the person's condition; ii) the age of the individual; iii) the level of management of the disorder, including the availability and use of medications; iv) the person's level of physical activity; and/or, v) external environmental factors such as temperature and humidity. The symptoms that could be experienced by these individuals could be more or less severe that those described because of these factors.

References: NIOSH (1974), WHO (1979), ATSDR (1998), HSDB (2010), Cal EPA (1999), WHO (2000).

4.2 Facility Upset Flaring Event: Acute Inhalation Assessment

The air quality assessment (MEMS 2011a) determined that emergency flaring would occur if there was blockage in the vapour recovery unit. In the event of a blocked vapour recovery unit, gas volumes will be bypassed to the flare stack and ignited. The air quality assessment

assumed that the flaring event is concurrent with normal operations and includes regional sources or background air concentrations. Predicted acute SO_2 concentrations are presented in Table 4-9 for the Application Case and upset scenario. Comparison of the predicted hourly maximum concentrations of the Application Case to the upset scenario indicates that there are no differences, indicating that an emergency flaring event is not discernable from normal operations. The maximum predicted hourly SO_2 concentrations at the LSA MPOI (573 µg/m³) are within the range of air concentrations where increased airway resistance and potential bronchoconstriction in asthmatic or sensitive individuals engaged in moderate exercise may be observed, depending on the severity of the asthmatic condition (see Table 4-8). The predicted hourly SO_2 concentrations in the upset scenario are below the level of 1,300 µg/m³, above which healthy individuals have been reported to experience mild effects. In addition, the predicted hourly 9th highest SO_2 concentrations at receptor locations are largely below the range (i.e., <250 µg/m^3) where there is no documented reproducible evidence of adverse health effects among healthy individuals or susceptible individuals following short-term exposure.

Table 4-9 Upset Scenario (Emergency Flaring), Predicted 1-hour Concentrations at the MPOI and Receptor Cabins within the LSA

Receptor Location	*Predicted Hourly Maximum SO_2 Concentrations During the Application Case (µg/m^3)*	*Predicted Maximum SO_2 Concentrations During the Upset Scenario (µg/m^3) (1)*	
		Hourly Maximum	*1-Hour 9th Highest*
LSA MPOI	573	573	295
R1	130	130	81
R2	523	523	195
R3	398	398	179
R4	257	257	134
R5	130	130	62
R6	171	171	106
R7	138	138	84
R8	174	174	83

Notes:
(1) Includes regional emission sources. Flaring event is concurrent with normal operations.

4.3 Chronic Inhalation Results

This section focuses on the predicted effects of long-term exposure to the COPCs. Separate assessments of non-carcinogenic and carcinogenic effects were conducted (depending on the exposure limit selected for the COPCs) due to the differences in calculating and interpreting risk estimates.

Chronic inhalation risks were evaluated for the cabin, resident and worker groups only. The MPOI location was not evaluated on a chronic basis since it is intended to reflect worst-case exposure to a transient, hypothetical person who might be in the area when worst case emissions and meteorological conditions are occurring. As such, the chronic inhalation pathway is not considered relevant to the LSA MPOI.

4.3.1 Non-Carcinogens

The results of the non-carcinogenic assessment are expressed as risk quotients (RQs). The maximum RQ value calculated for each group of individuals is presented within Table 4-10, Table 4-11 and Table 4-12. All chronic RQ values were less than 1, suggesting that the predicted long-term air concentrations of the COPCs are not expected to result in adverse health effects. The predicted RQ values for the Baseline and Application Cases were generally very similar. This suggests that the contributions of the Project with respect to air emissions will likely have a negligible impact on health.

Table 4-10 Chronic Inhalation RQs or the Cabin Group, Non-Carcinogens

COPC	*Assessment Case*		
	Baseline	*Application*	*PDC*
Acrolein	2.5E-02	2.5E-02	4.1E-02
Formaldehyde	5.4E-03	5.4E-03	9.7E-03
n-Hexane (1)	2.5E-03	2.5E-03	1.8E-03
NO_2	1.9E-01	1.9E-01	1.9E-01
$PM_{2.5}$	2.9E-01	2.9E-01	3.1E-01

Notes:
(1) Predicted decrease in PDC RQ values due to future changes at existing facilities north of Fort McMurray and reductions associated with the transition to Tier 4 emission factors for mine fleets.

Table 4-11 Chronic Inhalation RQs for the Resident Group, Non-Carcinogens

COPC	*Assessment Case*		
	Baseline	*Application*	*PDC*
Acrolein	4.2E-02	4.2E-02	5.5E-02
Formaldehyde	9.4E-03	9.4E-03	1.2E-02
n-Hexane (1)	6.6E-03	6.6E-03	4.9E-03
NO_2	3.1E-01	3.1E-01	3.0E-01
$PM_{2.5}$	5.1E-01	5.1E-01	5.8E-01

Notes:
(1) Predicted decrease in PDC RQ values due to future changes at existing facilities north of Fort McMurray and reductions associated with the transition to Tier 4 emission factors for mine fleets.

Table 4-12 Chronic Inhalation RQs for the Worker Group, Non-Carcinogens

COPC	*Assessment Case*		
	Baseline	*Application*	*PDC*
Acrolein	9.1E-03	9.7E-03	1.3E-02
Formaldehyde	2.1E-03	2.5E-03	3.5E-03
n-Hexane (1)	2.0E-03	2.0E-03	1.8E-03
NO_2	1.3E-01	1.4E-01	1.5E-01
$PM_{2.5}$	2.4E-01	2.4E-01	2.6E-01

Notes:
(1) Predicted decrease in PDC RQ values due to future changes at existing facilities north of Fort McMurray and reductions associated with the transition to Tier 4 emission factors for mine fleets.

4.3.2 Carcinogens

Table 4-13, Table 4-14 and Table 4-15 present the calculated ILCR values for the Project alone (Application minus Baseline) as well as the Future incremental scenario (PDC minus Baseline). All values represent predicted incremental lifetime cancer risks per 100,000 individuals in the population. All predicted ILCR values were predicted to be less than 1 in 100,000, indicating that the incremental contributions from the Project and Future emission sources are associated with an essentially negligible degree of risk.

Table 4-13 Chronic Inhalation ILCRs, Cabin Group, Carcinogens

COPC	*Incremental Lifetime Cancer Risks (per 100,000)*	
	Project (Application minus Baseline)	*Future (PDC minus Baseline)*
Acetaldehyde	4.4E-06	3.8E-03
Benzo(a)pyrene Equivalent	2.5E-06	2.9E-05
Benzene	3.4E-04	4.2E-02
Benzo(a)pyrene	4.5E-04	8.4E-03

Table 4-14 Chronic Inhalation ILCRs, Resident Group, Carcinogens

COPC	*Incremental Lifetime Cancer Risks (per 100,000)*	
	Project (Application minus Baseline)	*Future (PDC minus Baseline)*
Acetaldehyde	8.2E-07	1.6E-03
Benzo(a)pyrene Equivalent	4.2E-07	1.6E-04
Benzene	1.8E-05	5.4E-02
Benzo(a)pyrene	9.5E-05	2.2E-01

Table 4-15 Chronic Inhalation ILCRs, Worker Group, Carcinogens

COPC	*Incremental Lifetime Cancer Risks (per 100,000)*	
	Project (Application minus Baseline)	*Future (PDC minus Baseline)*
Acetaldehyde	8.2E-05	8.5E-04
Benzo(a)pyrene Equivalent	6.3E-05	3.1E-05
Benzene	1.5E-02	3.3E-02
Benzo(a)pyrene	3.8E-03	4.0E-03

4.4 Chronic Multiple Pathway Results

As in the chronic inhalation assessment, separate assessments were completed for non-carcinogenic and carcinogenic exposures in the multiple pathway assessment to reflect the different approaches used in calculating and interpreting the risk estimates. Predicted health risks are expressed as RQs for the non-carcinogenic COPCs and as ILCRs for the carcinogenic COPCs. Risk quotients are presented for the Baseline, Application and Planned Development

Cases, while ILCRs are provided only for the two incremental scenarios (i.e., Project and Future).

The HHRA assumed that people living in the area on either a permanent or seasonal basis (i.e. the resident or cabin groups) were exposed to COPCs via multiple exposure pathways over their entire lifetime (80-years). As workers will be adults, only the adult life stage (age 20 to 80 years) was evaluated for the work group. The MPOIs were excluded from the multiple pathway assessment, as these do not represent locations where people are likely to spend extended periods of time.

4.4.1 Non-Carcinogen Results

Risk quotients for the non-carcinogenic COPCs are provided for the most sensitive life stage for the resident group (Table 4-16), and for the adult life stage only for the worker group (Table 4-17). All multiple pathway RQ values for the Baseline, Application and PDC for the resident, cabin and worker groups were less than 1.0. For all of the COPCs, negligible changes in RQ value were predicted between the Baseline and Application Cases, indicating that the incremental change associated with the Project is negligible. Overall, the potential for adverse non-carcinogenic health impacts is anticipated to be low.

Table 4-16 Chronic Multiple Exposure Pathway RQs for Non-Carcinogens for the Resident Group (Resident and Cabin Group Combined)

COPC	*Assessment Case*		
	Baseline	*Application*	*PDC*
2-methylnaphthalene	8.6E-02	8.6E-02	8.6E-02
3-methylcholanthrene	7.9E-06	7.9E-06	8.4E-06
C_9-C_{18} aromatic group	2.3E-02	2.3E-02	3.6E-02
Formaldehyde	5.7E-05	5.7E-05	1.0E-04
Pyrene	3.1E-06	3.1E-06	5.4E-06

Table 4-17 Chronic Multiple Exposure Pathway RQs for Non-Carcinogens for the Worker Group

COPC	*Assessment Case*		
	Baseline	*Application*	*PDC*
2-methylnaphthalene	6.5E-05	6.5E-05	7.5E-05
3-methylcholanthrene	4.1E-09	4.3E-09	4.6E-09
C_9-C_{18} aromatic group	2.7E-03	2.7E-03	5.2E-03
Formaldehyde	2.9E-05	2.9E-05	5.4E-05
Pyrene	3.7E-07	3.7E-07	6.6E-07

4.4.2 Carcinogen Results

The estimated carcinogenic ILCR values for the resident and worker group are presented in Table 4-18 and Table 4-19. Results are presented only for the two incremental scenarios in the

HHRA: the Project scenario (Application minus Baseline), and the Future scenario (PDC minus Baseline). All values represent ILCR per 100,000 people. All ICLR values were less than 1.0, indicating that the Project and the Future sources (in the PDC) are associated with negligible degrees of incremental cancer risks (i.e., less than 1 in 100,000) for the resident, cabin and worker receptor group.

Table 4-18 Chronic Multiple Exposure Pathway ILCRs for Carcinogens for the Resident Group (Resident and Cabin Combined)

COPC	*Incremental Lifetime Cancer Risks (per 100,000)*	
	Project (Application minus Baseline)	*Future (PDC minus Baseline)*
Benzo(a)pyrene Equivalent	2.6E-02	1.2E-01

Table 4-19 Chronic Multiple Exposure Pathway ILCRs for Carcinogens for the Worker Group

COPC	*Incremental Lifetime Cancer Risks (per 100,000)*	
	Project (Application minus Baseline)	*Future (PDC minus Baseline)*
Benzo(a)pyrene Equivalent	2.4E-03	2.6E-03

4.5 Mixture Results

The results of the acute and chronic mixture assessments are provided in Section 4.5.1 to Section 4.5.3. For non-carcinogenic mixtures, the values presented in the tables represent the highest RQ value for each mixture, out of all of the locations within a specific group. No two chemicals had the same carcinogenic endpoint, so there are no carcinogenic mixtures.

4.5.1 Acute Inhalation Mixture Results

Acute RQ values were less than 1.0 for the eye and nasal irritant mixtures at all locations, with the exception of the LSA-MPOI, where RQ values slightly exceeded 1.0 (i.e., RQ value = 1.1) for both eye and nasal irritants in the PDC only. Both mixture groups are comprised of the same chemical components, namely acrolein, acetaldehyde and formaldehyde. The lack of exceedances at all cabin, residential and worker locations indicates that the risk of eye and nasal effects occurring as a result of the combined exposure to COPCs is negligible for these groups (see Table 4-20, Table 4-21, Table 4-22 and Table 4-23).

The respiratory irritants had an RQ value of 2.6 in the PDC, only a slight increase from the Baseline and Application Case RQ value of 2.5. This indicates that the Project itself is a very small contributor to the respiratory irritant risks, and that the exceedances are due to baseline conditions.

The respiratory irritants mixture is comprised of acetaldehyde, acrolein, NO_2 and SO_2. The respiratory irritant mixture RQ values are thought to overstate the actual risks for these COPCs, based on the following rationale:

- The maximum RQ values for acetaldehyde, acrolein and NO_2 were less than 1.0 on an individual basis.
- SO_2 is the only COPC predicted to exceed its exposure limit.
- SO_2 is the primary contributor (i.e., approximately 50 to 70%) to predicted risks at the LSA MPOI, Cabin and Resident locations (see Table 4-24).

The probability that SO_2 maximum hourly concentrations would exceed the respective health-based exposure limits is less than 3% (see Table 4-6 and Table 4-7) Within the LSA, SO_2 is predicted as the primary contributor to the respiratory irritants mixture; however, NO_2 is the primary contributor at the Resident receptor or Fort McKay (i.e., 46%; see Table 4-24). Combined, NO_2 and SO_2 contribute 70% to the respiratory irritants mixture at this location. At Fort McKay, the maximum predicted 1-hour NO_2 concentrations in the Baseline and Application cases are 184 µg/m³. There is no apparent change in the air concentrations between the Baseline and Application cases and the PDC hourly maximum NO_2 concentration at Fort McKay is 174 µg/m³. The concentration decreases in the PDC due to the assumed use of Tier 4 engines in future mine fleets. Review of ambient air quality data from the Fort MacKay monitoring station indicates that, from 2003 to 2009, maximum hourly NO_2 concentrations have ranged from 72 to 100 µg/m³. Ambient air quality monitoring stations located near mines (not in communities) have recorded maximum 1-hour NO_2 concentrations ranging from 62 to 327 µg/m³ between the years 2003 to 2009. The predicted hourly Baseline and Application Case NO_2 concentrations at Fort McKay appear to fall above these historical concentration ranges.

Finally, the assumption that the effects of short-term exposure to acetaldehyde, acrolein, NO_2 and SO_2 in the mixture are additive may be overly conservative, as the effect endpoints and the modes of action differ for some of the irritants (including NO_2). For example, NO_2 can be inhaled deeply into the lungs, acting as a deep-lung irritant, while SO_2 is soluble in water and is readily absorbed through the upper respiratory tract, inducing increases in airway resistance higher up in the respiratory tract (Calabrese 1991). As such, the potential respiratory irritants mixture risks are likely overstated, as the effects of SO_2 and NO_2 exposure may not be truly additive.

Overall, given the minimal change in the RQ values between the Base Case and Application Case, the Project will have a minimal impact on the predicted acute inhalation respiratory irritation risks at the locations evaluated in the HHRA.

Table 4-20 Acute Inhalation Mixture RQs for the LSA MPOI

Mixture	*Baseline*	*Application*	*PDC*
Eye irritants	8.4E-01	8.4E-01	1.1E+00
Nasal irritants	8.4E-01	8.4E-01	1.1E+00
Respiratory irritants	3.4E+00	3.4E+00	3.4E+00

Table 4-21 Acute Inhalation Mixture RQs for the Cabin Group

Mixture	*Baseline*	*Application*	*PDC*
Eye irritants	4.7E-01	4.7E-01	5.3E-01
Nasal irritants	4.7E-01	4.7E-01	5.3E-01
Respiratory irritants	2.5E+00	2.5E+00	2.6E+00

Table 4-22 Acute Inhalation Mixture RQs for the Resident Group

Mixture	*Baseline*	*Application*	*PDC*
Eye irritants	6.7E-01	6.7E-01	7.1E-01
Nasal irritants	6.7E-01	6.7E-01	7.1E-01
Respiratory irritants	1.7E+00	1.7E+00	1.7E+00

Table 4-23 Acute Inhalation Mixture RQs for the Worker Group

Mixture	*Baseline*	*Application*	*PDC*
Eye irritants	1.7E-01	1.7E-01	2.2E-01
Nasal irritants	1.7E-01	1.7E-01	2.2E-01
Respiratory irritants	1.1E+00	1.1E+00	1.1E+00

Table 4-24 Acute Inhalation Respiratory Irritants Mixture - Chemical Contributions (%)

Receptor Group	*COPC*	*Baseline*	*Application*	*PDC*
LSA-MPOI	Acetaldehyde	1	1	1
	Acrolein	18	18	22
	NO_2	26	26	20
	SO_2	56	56	56
Maximum Cabin (R2)	Acetaldehyde	1	1	1
	Acrolein	12	12	14
	NO_2	18	18	19
	SO_2	69	69	66
Maximum Resident (R10)	Acetaldehyde	2	2	2
	Acrolein	28	28	30
	NO_2	46	46	44
	SO_2	24	24	24
Maximum Worker	Acetaldehyde	1	1	1
	Acrolein	12	12	14
	NO_2	37	37	36
	SO_2	50	50	49

4.5.2 Chronic Inhalation Mixture Results

The chronic inhalation assessment mixture results for the various groups of individuals evaluated in the HHRA are presented in Table 4-25, Table 4-26 and Table 4-27. As people are unlikely to be located at locations where the MPOI may occur, the MPOI was not included in the chronic mixtures assessment. All chronic inhalation mixture RQ values were less than 1.0, indicating that the risk of additive effects occurring as a result of the combined exposure to COPCs with common chronic toxicological endpoints is low.

Table 4-25 Chronic Inhalation Non-Cancer Mixture RQs for the Cabin Group

Mixture	*Baseline*	*Application*	*PDC*
Nasal irritants	3.1E-02	3.1E-02	5.1E-02
Respiratory irritants	1.9E-01	1.9E-01	2.0E-01

Table 4-26 Chronic Inhalation Non-Cancer Mixture RQs for the Resident Group

Mixture	*Baseline*	*Application*	*PDC*
Nasal irritants	5.0E-02	5.0E-02	6.7E-02
Respiratory irritants	3.2E-01	3.2E-01	3.2E-01

Table 4-27 Chronic Inhalation Non-Cancer Mixture RQs for the Worker Group

Mixture	*Baseline*	*Application*	*PDC*
Nasal irritants	1.1E-02	1.2E-02	1.7E-02
Respiratory irritants	1.4E-01	1.4E-01	1.6E-01

4.5.3 Chronic Multiple Exposure Pathway Mixture Results

The chronic multiple pathway mixture results for the resident and worker groups are presented in Table 4-28. As no mixtures for carcinogenic endpoints were identified, all results presented in these tables are for non-carcinogenic endpoints only. The RQ values for the renal toxicants mixture for both groups were less than 1.0 in all cases, indicating that the additive risk of renal toxicity is negligible. There are no apparent differences between the Baseline and Application Case risks, indicating that the Project will have a negligible impact on the risks to renal impacts.

Table 4-28 Chronic Multiple Exposure Pathway Mixture RQ Values (Renal Toxicants) for the Resident (Resident and Cabin) and Worker Groups

Receptor Group	*Baseline*	*Application*	*PDC*
Resident and Cabin	1.4E-02	1.4E-02	2.7E-02
Workers	2.8E-03	2.8E-03	5.2E-03

5.0 SUMMARY AND CONCLUSIONS

The chemical emissions from the Project are not expected to result in adverse health effects in the region. For most of the COPCs, the magnitude of the differences in predicted health risks between the Baseline and Application Cases is negligible. The key findings of the HHRA are discussed below.

5.1 Acute Inhalation Assessment

The potential short-term health risks associated with the Project and other emissions sources were evaluated through the comparison of predicted air concentrations (10-minute, 1-hour, 8-hour or 24-hour) against health-based exposure limits. Overall, there were minimal changes between the Baseline and Application Cases, indicating that the Project emissions are not anticipated to have an impact on human health in the area.

5.2 Chronic Inhalation Assessment

Predicted risks associated with continuous, long-term inhalation of the COPCs were evaluated through the comparison of predicted annual average air concentrations with health-based exposure limits. No exceedances of health-based exposure limits were predicted in the chronic inhalation assessment.

All incremental lifetime cancer risks were predicted to be less than 1.0 in 100,000, indicating that the cancer risks associated with the Project are essentially negligible.

5.3 Chronic Multiple Pathway Assessment

The potential long-term health risks associated with exposure to the COPCs via multiple pathways of exposure were evaluated for permanent and seasonal residents in the area. In all instances, potential risks were determined to be negligible. All incremental lifetime cancer risks associated with exposure via multiple pathways of exposure were predicted to be less than 1.0 in 100,000, suggesting that the cancer risks associated with the Project are negligible.

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7.0 LIST OF ABBREVIATIONS

Abbreviation	Definition
µg/kg bw/d	microgram per kilogram of bodyweight per day
µg/m³	microgram per cubic metre
95UCLM	95th upper confidence level on the mean
AAQO	Ambient Air Quality Objective
ACGIH	American Conference of Governmental Industrial Hygienists
AENV	Alberta Environment
AHW	Alberta Health and Wellness
AOSC	Athabasca Oil Sands Corporation
ATSDR	Agency for Toxic Substances and Disease Registry
bbl/d	barrels per day
BCS	Bureau of Chemical Safety
BMD	benchmark dose
CAC	criteria air contaminants
Cal EPA	California Environmental Protection Agency
CARB	California Air Resources Board
CCME	Canadian Council of Ministers of the Environment
CCS	Canadian Cancer Society
cm^2	square centimetre
CO	carbon monoxide
COPCs	chemicals of potential concern
COPD	chronic obstructive pulmonary disease
CS_2	carbon disulphide
D	day
e.g.	Latin – for example
EIA	Environmental Impact Assessment
ERCB	Alberta Energy Resources Convention Board
etc.	Latin – and others
G	gram
g/d	gram per day
$g/m^2/d$	gram per square metre per day
H_2S	hydrogen sulphide
HHRA	human health risk assessment
HSDB	Hazardous Substances Databank
i.e.	Latin – that is
ILCR	incremental lifetime cancer risk
kg	kilogram
km	kilometre
L/d	litre per day
LCR	lifetime cancer risk
LOAEL	lowest-observable-adverse-effects level
LOEL	lowest-observable-effects level
LSA	local study area
m³/d	cubic metre per day
MDL	method detection limit
mg/kg	milligram per kilogram
MPOI	maximum point of impingement
n/a	not applicable
NA	not assessed
NIOSH	National Institute of Occupational Safety and Health
NO_2	nitrogen dioxide
NOAEL	no-observable-adverse-effects level
NOEL	no-observable-effects level

Abbreviation	Definition
NO_x	nitrogen oxides
O_3	ozone
OEHHA	Office of Environmental Health Hazard Assessment
OMOE	Ontario Ministry of the Environment
PAH	polycyclic aromatic hydrocarbon
PDC	planned development case
PM	particulate matter
$PM_{2.5}$	fine particulate matter with a diameter of 2.5 micrometres or less
ppm	parts per million
RfC	reference concentration
RfD	reference dose
RIVM	Netherlands National Institute of Public Health and the Environment
RQ	risk quotient
RSA	regional study area
RsC	risk-specific concentration
RSC	reduced sulphur compounds
RsD	risk-specific dose
SAGD	steam assisted gravity drainage
SF	slope factor
SLWRA	screening-level wildlife risk assessment
SO_2	sulphur dioxide
STP	Southern Pacific Thermal Project
TCEQ	Texas Commission on Environmental Quality
TOR	terms of reference
UR	unit risk
US EPA	United States Environmental Protection Agency
VOC	volatile organic compound
WHO	World Health Organization

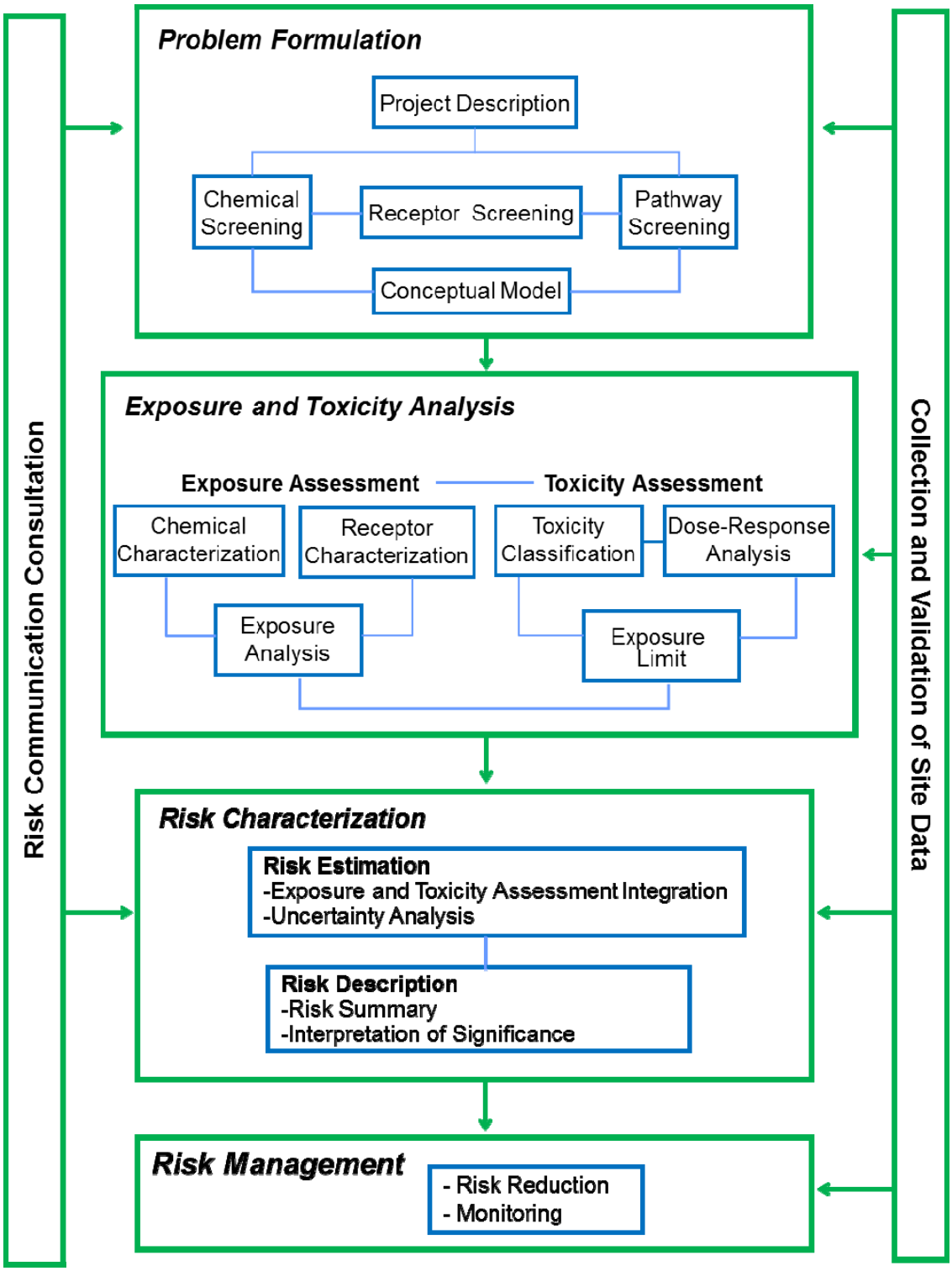
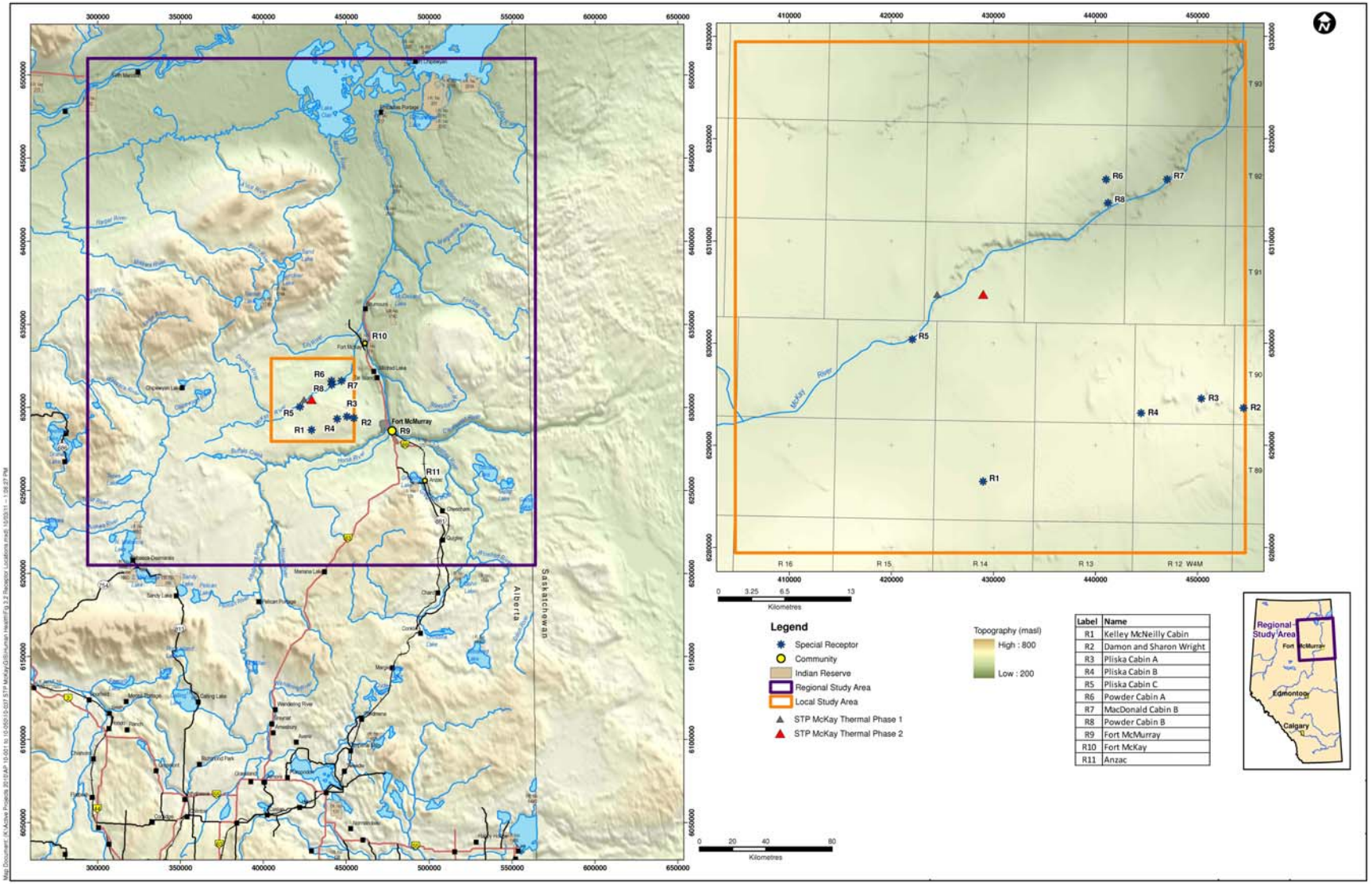


Figure 3.1 Risk Assessment Paradigm

Figure 3.2 Human Health Receptors



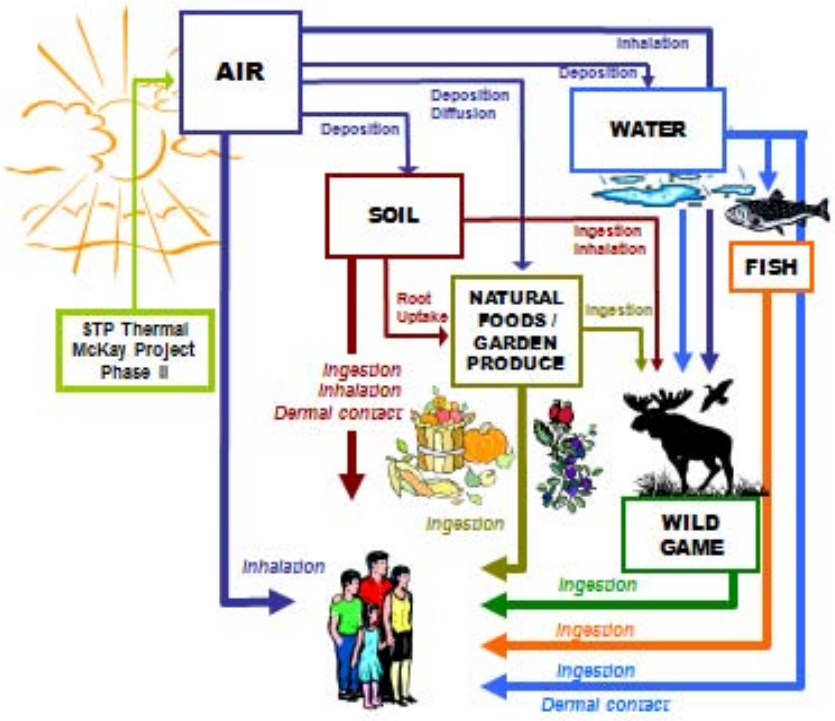


Figure 3.3 Exposure Pathways Considered for Residents

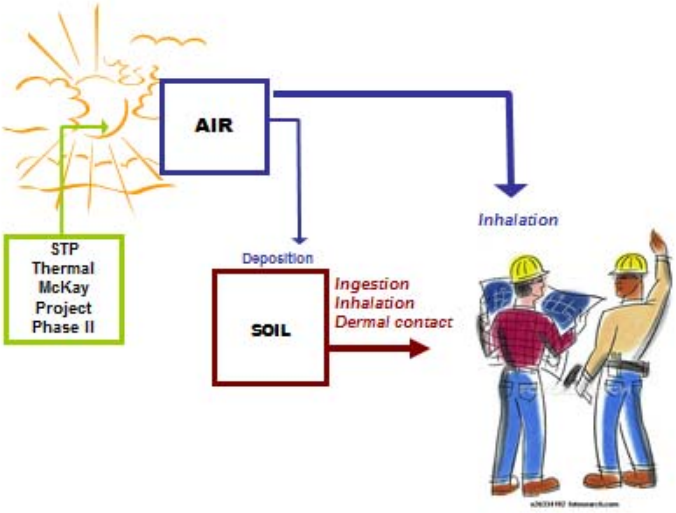


Figure 3.4 Exposure Pathways Considered for Workers

APPENDIX A

Chemicals of Potential Concern (COPCs) Screening

APPENDIX A: COPC SCREENING

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A1.0 CHEMICALS OF POTENTIAL CONCERN SCREENING

In order to determine the chemicals of potential concern (COPCs) for the Southern Pacific Resource Corp. (STP) McKay Thermal Project – Phase 2 (the Project), qualitative and quantitative screening methods were used to narrow the list of chemicals for the human health risk assessment (HHRA). The methods were described in a work plan that was developed between STP and Alberta Health and Wellness (Intrinsik 2011).

The qualitative screening method to determine relevant COPCs for the Project involved:

- identifying COPCs viewed as a concern by regulatory authorities for the oil sands region; and
- identifying COPCs that have been recognized as a potential concern in previous HHRAs.

The qualitative screening method listed above ensures that a complete list of COPCs was obtained in addition to the quantitative screening methods described below.

The quantitative screening method used to determine relevant COPCs for the Project involved:

- relative toxic potency determinations using air emission rates and inhalation exposure limits for the identification of COPCs to be included in the acute and chronic inhalation assessment; and
- physical-chemical screening of parameters for each chemical in the emissions profile for the Project against criteria to determine the volatility of a chemical and to identify chemicals to be included in the multiple exposure pathway assessment.

A1.1 Qualitative COPC Inhalation Screening

Criteria air contaminants (i.e., CAC, defined as CO, NO_2, $PM_{2.5}$ and SO_2) were identified as COPCs for the HHRA based on concern by regulatory authorities for the oil sands region. As well, these COPC have been recognized as a potential concern in previous assessments. Therefore, CAC did not undergo chemical screening but were automatically included in the HHRA as COPCs.

A1.2 Quantitative COPC Inhalation Screening

Toxic potency screening was used to determine which chemicals in the air emissions inventory would most likely pose a potential health hazard via direct exposure (i.e., inhalation). Physical/chemical screening was used to determine which chemicals in the emissions inventory would most likely pose a potential health hazard via secondary pathways (i.e., ingestion).

Table A-1 presents the predicted air emissions inventory from the Project, excluding CAC.

Table A-1 Summary of Total Air Emissions of Chemicals from the Project

Chemical [1]	*Total Emissions*[2] *(t/d)*
Polycyclic aromatic Hydrocarbons (PAHs)	
7,12-Dimethylbenz(a)anthracene	2.81E-04
Acenaphthene	4.48E-04
Acenaphthylene	3.13E-04
Anthracene	5.64E-04
Benzo(a)anthracene	4.89E-04
Benzo(a)pyrene	3.34E-04
Benzo(b)fluoranthene	2.61E-04
Benzo(g,h,i)perylene	3.03E-04
Benzo(k)fluoranthene	2.61E-04
Chrysene	5.43E-04
Dibenzo(a,h)anthracene	4.78E-04
Fluoranthene	1.09E-03
Fluorene	1.61E-03
Indeno(1,2,3-cd)pyrene	4.89E-04
Phenanthrene	8.31E-03
Pyrene	5.21E-04
Petroleum Hydrocarbon Fractions (PHCs)	
C_5-C_8 Aliphatic	7.87E+01
C_9-C_{18} Aliphatic	3.85E-05
C_9-C_{18} Aromatic	1.66E-05
Reduced Sulphur Compounds (RSCs)	
CS_2	2.32E-06
H_2S	1.35E-03
Mercaptans[3]	2.96E-04
Thiophenes[3]	1.53E-06
Volatile Organic Compounds (VOCs)	
1,3-Butadiene	1.60E-03
2-Methylnaphthalene	4.43E-04
3-Methylcholanthrene	3.16E-05
Acetaldehyde	3.95E-01
Acrolein	1.09E-01
Benzene	8.18E-02
Dichlorobenzene	2.11E-02
Ethyl Benzene	1.19E-01
Formaldehyde	3.96E+00
Naphthalene	1.56E-02
n-Hexane	3.16E+01
n-Pentane	4.57E+01
Toluene	5.43E-01
Xylenes	4.89E-01

Notes:

1) CAC (i.e., CO, NO_2, $PM_{2.5}$ and SO_2) excluded since these chemicals are automatically included as COPCs for the HHRA.
2) Emission values presented are the total of emission sources from tank fugitives, plant fugitives, and combustion.
3) Mercaptans and thiophenes were not included in the toxic potency screening as no exposure limits were identified for these reduced sulphur compounds.

t/d = tonnes per day

The toxic potency screening process took into consideration both the potential for exposure to each COPC as well as the potential toxicity of COPCs on an acute and chronic basis. Potential exposure was based on the estimated emission rate for each chemical from the Project. The potential toxicity of each chemical was represented by acute and chronic inhalation exposure limits developed by recognized regulatory agencies such as Health Canada and the U.S. Environmental Protection Agency (US EPA). Further details regarding the basis of exposure limits used in the toxic potency screening are provided in Appendix B. The relative toxic potency of each chemical was calculated by dividing the air emission rate by its acute or chronic exposure limit and determining the relative contribution of each chemical to the total toxic potential (sum of individual toxic potentials). When combined, those chemicals that contributed 99% to the overall toxic potency were included as COPCs to be evaluated in the HHRA.

Table A-2 and Table A-3 presents the results of the acute and chronic toxic potency screening for each of the chemicals emitted from the Project, respectively. Chemicals that make up 99% of the overall toxic potency of emissions from the project are identified by the grey shading.

Table A-2 Toxic Potency Screening for Identification of COPC for the Acute Inhalation Assessment

Chemical Category	*COPC*	*Total Emission Rate (t/d)*	*Acute Exposure Limit*[(1)]	*Toxic Potential*[(4)]	*Relative Toxic Potential*	*Cumulative Toxic Potential*
VOC	Formaldehyde	3.96E+00	5.0E+01	7.9E-02	63.7%	64%
VOC	Acrolein	1.09E-01	2.5E+00	4.4E-02	35.0%	99%
VOC	Acetaldehyde	3.95E-01	4.7E+02	8.4E-04	0.7%	99%
PHC	C_5-C_8 Aliphatics[(2)]	7.87E+01	2.0E+05	3.9E-04	0.3%	100%
VOC	Benzene	8.18E-02	5.8E+02	1.4E-04	0.1%	100%
VOC	1,3-Butadiene	1.60E-03	1.5E+01	1.1E-04	0.1%	100%
VOC	Xylenes	4.89E-01	7.4E+03	6.6E-05	0.1%	100%
VOC	Toluene	5.43E-01	1.5E+04	3.6E-05	0.0%	100%
PHC	C_9-C_{18} Aromatic group[(3)]	2.99E-02	2.0E+03	1.5E-05	0.0%	100%
RSC	H_2S	1.35E-03	9.8E+01	1.4E-05	0.0%	100%
VOC	Naphthalene	1.56E-02	2.0E+03	7.8E-06	0.0%	100%
VOC	Dichlorobenzene	2.11E-02	3.0E+03	7.0E-06	0.0%	100%
VOC	Ethyl Benzene	1.19E-01	2.2E+04	5.5E-06	0.0%	100%
RSC	CS_2	2.32E-06	6.2E+03	3.7E-10	0.0%	100%
VOC	n-Pentane	4.57E+01	n/a	–	–	–
VOC	n-Hexane	3.16E+01	n/a	–	–	–
PHC	C_9-C_{18} Aliphatic	3.85E-05	n/a	–	–	–
PHC	C_9-C_{18} Aromatic	1.66E-05	n/a	–	–	–
VOC	2-Methylnaphthalene	4.43E-04	n/a	–	–	–
RSC	Thiophenes	1.53E-06	n/a	–	–	–
RSC	Mercaptans	2.96E-04	n/a	–	–	–
VOC	3-Methylcholanthrene	3.16E-05	n/a	–	–	–
PAH	7,12-Dimethylbenz(a)anthracene	2.81E-04	n/a	–	–	–
PAH	Acenaphthene	4.48E-04	n/a	–	–	–
PAH	Acenaphthylene	3.13E-04	n/a	–	–	–
PAH	Anthracene	5.64E-04	n/a	–	–	–

Chemical Category	*COPC*	*Total Emission Rate (t/d)*	*Acute Exposure Limit[(1)]*	*Toxic Potential[(4)]*	*Relative Toxic Potential*	*Cumulative Toxic Potential*
PAH	Benzo(a)anthracene	4.89E-04	n/a	–	–	–
PAH	Benzo(a)pyrene	3.34E-04	n/a	–	–	–
PAH	Benzo(b)fluoranthene	2.61E-04	n/a	–	–	–
PAH	Benzo(g,h,i)perylene	3.03E-04	n/a	–	–	–
PAH	Benzo(k)fluoranthene	2.61E-04	n/a	–	–	–
PAH	Chrysene	5.43E-04	n/a	–	–	–
PAH	Dibenzo(a,h)anthracene	4.78E-04	n/a	–	–	–
PAH	Fluoranthene	1.09E-03	n/a	–	–	–
PAH	Fluorene	1.61E-03	n/a	–	–	–
PAH	Indeno(1,2,3-cd)pyrene	4.89E-04	n/a	–	–	–
PAH	Phenanthrene	8.31E-03	n/a	–	–	–
PAH	Pyrene	5.21E-04	n/a	–	–	–
			Sum of Toxic Potential	1.2E-01		

Notes:

1) Refer to Appendix B (Toxicity Profiles) for references for acute exposure limits.
2) C_5-C_8 Aliphatics includes n-hexane and n-pentane
3) On an acute basis, C_9-C_{18} Aromatics group is the sum of emission rates for the following chemicals: acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, C_9-C_{18} aromatics, chrysene, fluoranthene, fluorene, naphthalene, 2-methylnaphthalene, phenanthrene, and pyrene
4) Toxic potential = Total Emission Rate ÷ Acute Exposure Limit

t/d = tonnes per day
n/a = Exposure limit not available
- = value could not be calculated due to lack of exposure limit
Shaded cells represent the chemicals that make up 99% of the toxic potential of the air emissions from the project.

Table A-3 Toxic Potency Screening for Identification of COPC for the Chronic Inhalation Assessment

Chemical Category	*COPCs*	*Total Emission Rate (t/d)*	*Chronic Exposure Limit*[1]	*Toxic Potential*[6]	*Relative Toxic Potential*	*Cumulative Toxic Potential*
PAH	Benzo(a)pyrene[2]	3.34E-04	1.2E-04	2.8E+00	76.9%	77%
VOC	Formaldehyde	3.96E+00	1.1E+01	3.6E-01	10.0%	87%
VOC	Acrolein	1.09E-01	3.5E-01	3.1E-01	8.6%	96%
VOC	Benzene	8.18E-02	1.3E+00	6.3E-02	1.7%	97%
VOC	n-Hexane	3.16E+01	6.7E+02	4.7E-02	1.3%	99%
VOC	Acetaldehyde	3.95E-01	1.7E+01	2.3E-02	0.6%	99%
PAH	7,12-Dimethylbenz(a)anthracene[3]	2.81E-04	3.2E-02	8.8E-03	0.2%	99%
VOC	1,3-Butadiene	1.60E-03	3.0E-01	5.3E-03	0.1%	100%
VOC	Naphthalene	1.56E-02	3.0E+00	5.2E-03	0.1%	100%
PHC	C_5-C_8 Aliphatics[4]	7.87E+01	1.8E+04	4.3E-03	0.1%	100%
PAH	Dibenzo(a,h)anthracene[3]	4.78E-04	3.2E-01	1.5E-03	0.0%	100%
PAH	Benzo(a)pyrene[3]	3.34E-04	3.2E-01	1.0E-03	0.0%	100%
VOC	Xylenes	4.89E-01	6.1E+02	8.0E-04	0.0%	100%
RSC	H_2S	1.35E-03	2.0E+00	6.8E-04	0.0%	100%
VOC	Ethyl Benzene	1.19E-01	2.6E+02	4.6E-04	0.0%	100%
PHC	C_9-C_{18} Aromatic group[5]	1.95E-02	5.0E+01	3.9E-04	0.0%	100%
VOC	Dichlorobenzene	2.11E-02	6.0E+01	3.5E-04	0.0%	100%
PAH	Benzo(a)anthracene[3]	4.89E-04	3.2E+00	1.5E-04	0.0%	100%
PAH	Indeno(1,2,3-cd)pyrene[3]	4.89E-04	3.2E+00	1.5E-04	0.0%	100%
VOC	Toluene	5.43E-01	5.0E+03	1.1E-04	0.0%	100%
PAH	Benzo(b)fluoranthene[3]	2.61E-04	3.2E+00	8.2E-05	0.0%	100%
PAH	Benzo(k)fluoranthene[3]	2.61E-04	3.2E+00	8.2E-05	0.0%	100%
PAH	Phenanthrene[3]	8.31E-03	3.2E+02	2.6E-05	0.0%	100%
PAH	Chrysene[3]	5.43E-04	3.2E+01	1.7E-05	0.0%	100%
PAH	Benzo(g,h,i)perylene[3]	3.03E-04	3.2E+01	9.5E-06	0.0%	100%
PAH	Fluoranthene[3]	1.09E-03	3.2E+02	3.4E-06	0.0%	100%

Chemical Category	*COPCs*	*Total Emission Rate (t/d)*	*Chronic Exposure Limit[(1)]*	*Toxic Potential[(6)]*	*Relative Toxic Potential*	*Cumulative Toxic Potential*
PHC	C_9-C_{18} Aliphatics	3.85E-05	2.0E+02	1.9E-07	0.0%	100%
RSC	CS_2	2.32E-06	1.0E+02	2.3E-08	0.0%	100%
VOC	n-Pentane	4.57E+01	n/a	–	–	–
VOC	2-Methylnaphthalene	1.66E-05	n/a	–	–	–
RSC	Thiophenes	4.43E-04	n/a	–	–	–
RSC	Mercaptans	1.53E-06	n/a	–	–	–
VOC	3-Methylcholanthrene	2.96E-04	n/a	–	–	–
PAH	Acenaphthene	3.16E-05	n/a	–	–	–
PAH	Acenaphthylene	4.48E-04	n/a	–	–	–
PAH	Anthracene	3.13E-04	n/a	–	–	–
PAH	Fluorene	5.64E-04	n/a	–	–	–
PAH	Pyrene	1.61E-03	n/a	–	–	–
			Sum of Toxic Potential	3.6E+00		

Notes:

1) Refer to Appendix B (Toxicity Profiles) for references for chronic exposure limits
2) Benzo(a)pyrene was assessed using two approaches. This approach is based on the exposure limit of 0.00012 µg/m^3 from WHO (2000). See Appendix B, benzo(a)pyrene toxicity profile for further details
3) These chemicals were assessed using the Benzo(a)pyrene PEQ approach, where carcinogenic PAHs are assigned PEFs based on their toxicity relative to benzo(a)pyrene. Exposure limits were adjusted for each chemical based on the benzo(a)pyrene and equivalents exposure limit of 0.32 µg/m^3 (Health Canada 2009). See Appendix B, the benzo(a)pyrene toxicity profile for further details
4) C_5-C_8 aliphatics includes n-hexane and n-pentane
5) On a chronic basis, C_9-C_{18} aromatic group is the sum of emission rates for the following chemicals: acenaphthene, acenaphthylene, anthracene, C_9-C_{18} aromatics, fluorene, naphthalene, 2-methylnaphthalene and pyrene
6) Toxic Potential = Total Emission Rate ÷ Chronic Exposure Limit

t/d = tonnes per day
n/a = Exposure limit not available
- = value could not be calculated due to lack of exposure limit
Shaded cells represent the chemicals that make up 99% of the toxic potential of the air emissions from the project

Results of the acute toxic potency screening (Table A-2) identified three COPCs that make up 99% of the total toxic potential of the air emissions from the Project, as follows:

- Formaldehyde
- Acrolein
- Acetaldehyde

Results of the chronic toxic potency screening (Table A-3) identified seven COPCs that constitute 99% of the total toxic potential of the chemicals emitted into air from the Project. In addition to the chronic toxic potency screening, if one or more of the PAHs for which a potency equivalent factor (PEF) was available and identified in the 99% of the toxic potency screening, than it was assumed that all PAHs with a PEF would be included in the chronic inhalation assessment. Of all the PAHs with a PEF available, benzo(a)pyrene and 7,12-dibenz(a)anthracene was identified in the 99% of the toxic potency screening. Therefore, a total of 16 COPCs were identified for the chronic inhalation assessment, as follows:

- 7,12-Dimethylbenz(a)anthracene
- Acetaldehyde
- Acrolein
- Benzene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Dibenzo(a,h)anthracene
- Formaldehyde
- Fluoranthene
- n-Hexane
- Indeno(1,2,3-cd)pyrene
- Phenanthrene

A1.3 Physical-Chemical Screening of COPC for Multiple Exposure Pathways

The purpose of the physical-chemical screening method was to assess the potential health risks associated with exposure pathways other than inhalation, such as ingestion of country foods that may be linked to Project air emissions, via deposition to the local environment. For this purpose, only relatively non-volatile COPCs were considered, including polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs). The volatility and accumulation

potential of these chemicals required further consideration based on physical and chemical properties that influence their fate and persistence in the environment. This was accomplished via a step-wise process, described below.

Step 1 Comparison of Physical-Chemical Properties with Established Criteria for Volatility. The purpose of this step was to identify COPCs that are non-volatile and thus have the potential to accumulate in media other than air, in accordance with the following criteria from the US EPA (2003):

- molecular weight >200 g/mol;
- Henry's Law Constant <0.00001 atm-m^3/mol (or 1.0E-05 atm-m^3/mol); and
- vapour pressure <0.001 mmHg (or 1.0E-03 mmHg).

Step 2 Comparison of Octanol-Water Partition Coefficents (Kow). For COPCs that were identified as volatile in Step 1, another screening step was completed where the Log K_{ow} values for these volatile substances were evaluated. In the event that the Log K_{ow} for a COPC exceeded 3.5, indicating a potential to bioaccumulate, the COPC was carried forward to Step 3,

Step 3 Fugacity Modelling. For COPCs from Step 2 that had Log K_{ow} values greater than 3.5, fugacity modelling was completed to determine the potential relative apportionment of the chemical within environmental compartments other than air. If a COPC was found to be less than 95% in air, or more than 5% in environmental compartments other than air (e.g., water, soil or sediment), the COPC was included in the multiple exposure pathway assessment since it was assumed there was potential for persistence and accumulation within soils, plants or other biota (Boethling et al. 2009).

Physical-chemical criteria were adopted from Syracuse Research Corp. (SRC 2011), or, if a chemical was not available from SRC 2011, from the EPI Suite program developed by US EPA (2011). Table A-4 summarizes the relevant physical-chemical properties of each of the chemicals emitted from the Project, and identifies those COPCs to be included in the HHRA based on potential human exposure through secondary exposure pathways such as ingestion or dermal contact with soils.

Table A-4 Identification of COPCs for the Multiple Pathway Assessment

Chemical	*CAS #*	*Step 1*			*Step 2*	*Step 3*	*Included in Multiple Pathway Assessment*
		Molecular Weight (g/mol)	*Henry's Law Constant (atm-m^3/mol)*	*Vapour Pressure (mm Hg)*	*Log K_{ow}*	*Fugacity*	
	CRITERIA:	*> 200*	*< 0.00001*	*< 0.001*	*> 3.5*	*< 95% in air*	
Polycyclic Aromatic Hydrocarbons (PAHs)							
7,12-Dimethylbenz(a)anthracene	000057-97-6	**256.35**	**0.00000376**	**0.00000068**	–	–	Yes
Acenaphthene	000083-32-9	154.21	0.000184	0.00215	**3.92**	81%	Yes
Acenaphthylene	000208-96-8	152.2	0.000114	0.00668	**3.94**	87%	Yes
Anthracene	000120-12-7	178.24	0.0000556	**0.00000653**	–	–	Yes
Benzo(a)anthracene	000056-55-3	**228.3**	0.000012	**0.00000021**	–	–	Yes
Benzo(a)pyrene	000050-32-8	**252.32**	**0.000000457**	**0.00000000549**	–	–	Yes
Benzo(b)fluoranthene	000205-99-2	**252.32**	**0.000000657**	**0.0000005**	–	–	Yes
Benzo(g,h,i)perylene	000191-24-2	**276.34**	**0.000000331**	**0.0000000001**	–	–	Yes
Benzo(k)fluoranthene	000203-12-3	**226.28**	**0.00000134**	**0.0000002**	–	–	Yes
Chrysene	000218-01-9	**228.3**	**0.00000523**	**0.00000000623**	–	–	Yes
Dibenzo(a,h)anthracene	000053-70-3	**278.36**	**0.000000141**	**0.000000000955**	–	–	Yes
Fluoranthene	000206-44-0	**202.26**	**0.00000886**	**0.00000922**	–	–	Yes
Fluorene	000086-73-7	166.22	0.0000962	**0.0006**	–	–	Yes
Indeno(1,2,3-cd)pyrene	000193-39-5	**276.34**	**0.000000348**	**0.000000000125**	–	–	Yes
Phenanthrene	000085-01-8	178.24	0.0000423	**0.000121**	–	–	Yes
Pyrene	000129-00-0	**202.26**	0.0000119	**0.0000045**	–	–	Yes
Reduced Sulphur Compounds (RSCs)							
Carbon disulphide (CS_2)	000075-15-0	76.14	0.0144	359	1.94	–	No
Hydrogen sulphide (H_2S)	007783-06-4	34.08	0.00856	15,600	0.23	–	No
Volatile Organic Compounds (VOCs)							
1,3-Butadiene	000106-99-0	54.09	0.0736	2,110	1.99	–	No
2-Methylnaphthalene	000091-57-6	142.2	0.000518	0.055	**3.86**	94%	Yes
3-Methylcholanthrene	000056-49-5	**268.36**	**0.00000524**	**0.000000043**	–	–	Yes
Acetaldehyde	000075-07-0	44.05	0.0000667	902	-0.34	–	No
Acrolein	000107-02-8	56.07	0.000122	274	-0.01	–	No
Benzene	000071-43-2	78.12	0.00555	94.8	2.13	–	No
C_5 to C_8 Aliphatics	No value	100	0.804878049	47.88	**3.81**	100%	No

Chemical	*CAS #*	*Step 1*			*Step 2*	*Step 3*	*Included in Multiple Pathway Assessment*
		Molecular Weight (g/mol)	*Henry's Law Constant (atm-m^3/mol)*	*Vapour Pressure (mm Hg)*	*Log K_{ow}*	*Fugacity*	
	CRITERIA:	*> 200*	*< 0.00001*	*< 0.001*	*> 3.5*	*< 95% in air*	
C_9 to C_{18} Aliphatics	No value	200	12	0.03648	**6.91**	100%	No
C_9 to C_{18} Aromatics	No value	150	0.0013	0.03648	**3.6**	94%	Yes
Dichlorobenzene	025321-22-6	147	0.00355	1.47	3.28	–	No
Ethyl Benzene	000100-41-4	106.17	0.00788	9.6	3.15	–	No
Formaldehyde	000050-00-0	30.03	**0.000000337**	3,890	–	–	Yes
n-Hexane	000110-54-3	86.18	1.8	151	**3.9**	100%	No
Naphthalene	000091-20-3	128.18	0.00044	0.085	3.3	–	No
n-Pentane	000109-66-0	72.15	1.25	514	3.39	–	No
Toluene	000108-88-3	92.14	0.00664	28.4	2.73	–	No
Xylenes	1330-20-7	106.17	0.00663	7.99	3.16	–	No

NOTES:
Bold values indicate that the physical-chemical parameter meets or exceeds the criterion
– = not applicable or indicates that the step was not completed for the chemical, based on exceeding the criteria in the previous step.

The results of the physical-chemical screening revealed that 20 COPCs are eligible for inclusion in the multiple pathway assessment, provided that defensible exposure limits are available. The multiple pathway assessment in the HHRA evaluates a total of 20 COPCs based on this analysis.

The final list of COPCs for the multiple pathway assessment is as follows:

- 2-methylnaphthalene
- 3-methylcholanthrene
- 7,12-dimethylbenz(a)anthracene
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- C_9-C_{18} aromatics
- Chrysene
- Dibenzo(a,h)anthracene
- Fluoranthene
- Fluorene
- Formaldehyde
- Indeno(1,2,3-cd)pyrene
- Phenanthrene
- Pyrene

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APPENDIX B

Chemical Toxicity Profiles

Appendix B: Chemical Toxicity Profiles

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B1.0 INTRODUCTION

This appendix describes the scientific basis for the acute (short-term) and chronic (long-term) exposure limits used to assess potential human health risks associated with the chemicals of potential concern (COPCs) for the Southern Pacific Mckay Thermal Project Phase 2. An overview of the general process used to evaluate and select exposure limits or toxicity reference values for use in the HHRA is provided. As well, this appendix presents a series of individual profiles for the COPCs, wherein the available values are summarized and information regarding the selected exposure limits is provided.

B1.1 Background

The toxicity assessment ultimately requires understanding of the toxic effects that can be caused by each of the COPCs for the Project. Knowledge in this regard is typically obtained through review of the scientific literature describing the responses witnessed in laboratory animals or volunteer human subjects following administration of the chemical at various doses for varying periods of time under controlled conditions, or from observations gathered as part of community health studies (i.e., epidemiological investigations) examining the incidence of disease in relation to chemical exposures.

In general, chemicals may be categorized into two groups based on the nature of their toxic response – threshold chemicals and non-threshold chemicals. Threshold chemicals make up the largest category and consist of virtually all types of toxic responses and chemicals. For threshold chemicals, a minimum or 'threshold' dose must be exceeded for a toxic response to be observed, and the severity or magnitude of the toxic response is generally assumed to increase with increasing dose. Non-threshold chemicals are a select group of substances which can potentially produce cancer through mechanisms that do not involve a threshold response, and a dose-response relationship is not always apparent.

For non-carcinogens, exposure limits are often derived based on the identification of a no-observed-adverse-effect level (NOAEL) – the dose at which no adverse effects are observed. Alternatively, exposure limits may be based upon a lowest-observed-adverse-effect level (LOAEL) or a benchmark dose/concentration (BMD/BMC). A NOAEL, LOAEL or BMD/BMC can then be used to derive an exposure limit or 'safe' level of exposure through the application of 'uncertainty' or safety factors that provide an added level of protection. The exposure limit refers to the dose of the chemical that is without effect on even the most sensitive subjects and is calculated as follows, using a NOAEL as an example:

$$Exposure\ Limit = \frac{NOAEL}{Uncertainty\ Factor(s)}$$

The uncertainty factor can vary from to 3 or √10 to over 1,000 in order to ensure adequate protection of any exposed population. The most common forms of uncertainty factors are listed in Table 1.

The need for these uncertainty factors is dictated largely by the practical constraints that apply to conventional toxicological research (i.e., the study of the harmful effects of chemicals). Most of the available information for some chemicals is limited to studies in laboratory rodents (e.g.,

rats, mice, guinea pigs, rabbits), owing largely to their availability in large numbers, their low cost, and the ease with which they can be housed and handled.

It is common practice to apply an uncertainty factor of 10 to account for possible differences in sensitivity between species (i.e., interspecies differences, such as those that might exist between rodents and humans) and an additional uncertainty factor of 10 to accommodate differences in sensitivity between individuals within the same species (i.e., intraspecies differences). Other uncertainty factors that are often applied include an uncertainty factor of 10 to adjust from subchronic to chronic exposure and a factor of 10 to account for the uncertainty associated with the use of a LOAEL instead of a NOAEL. Where the toxicity database is very limited, an additional uncertainty factor can be applied to account for uncertainties in the database.

In some instances, the uncertainty factors may be less than 10, based on the chemical-specific information reviewed by an agency or organization in the derivation of the value. For example, values of 3 or √10 are used when the available information does not support the use of a factor of 10.

Table B1.1 Examples of Commonly Used Uncertainty Factors

Nature of Uncertainty[1]	*Magnitude of Factor*	*Comments*
Differences in sensitivity between species	3 or √10, 10	Used to accommodate the uncertainty around the use of laboratory animal data to predict potential human responses.
Differences in sensitivity within a species	3 or √10, 10	Used to account for individuals within the human population that may be more sensitive to a chemical than the average person.
Subchronic to chronic exposure duration	3 or √10, 10	Used to account for the uncertainty surrounding the use of data involving shorter exposure periods to predict the responses that might occur over longer periods of exposure. Subchronic data is used when exposures are expected to occur for long periods and defensible chronic toxicity data is not available.
LOAEL to a NOAEL	3 or √10, 10	Used to account for the uncertainty surrounding the use of a LOAEL when a NOAEL is not available for the most sensitive test species.
Database uncertainty	3 or √10, 10	Used to account for a lack of toxicological information for one or more endpoints.

(1) Uncertainty factors are not applied in the derivation of non-threshold carcinogenic exposure limits.

Typically, exposure limits are differentiated on the basis of the duration of exposure in recognition of the variability in toxic responses that may be seen with the same chemical following an acute vs. chronic exposure. For the purposes of this assessment, exposure limits selected to evaluate acute and chronic exposures were based on the following definitions:

- Acute – single or intermittent exposures lasting up to 24-hours; and
- Chronic – repeated, exposures over longer term periods that are conservatively assumed to take place over a lifetime.

Differing terminology may also be assigned to exposure limits depending on the source of exposure (e.g., air, water, food) and the regulatory jurisdiction involved. Often, generic terminology will apply, with the following terms and descriptions used:

- Reference Concentration (RfC) - refers to the safe levels of air-borne threshold chemicals where the primary route of exposure is through inhalation. The RfC is expressed as a concentration of the chemical in air (i.e., micrograms per cubic metre - µg/m³).
- Reference Dose (RfD) - refers to the safe levels of threshold chemicals to which exposure occurs through multiple pathways, both primary and secondary (i.e., oral, dermal). It is most commonly expressed as the daily dose of the chemical per unit body weight of the receptor (i.e., micrograms per kilogram of body weight per day - µg/kg•bw/d).
- Risk-specific Concentration (RsC) – reserved for non-threshold carcinogens, the RsC refers to the concentration via inhalation that corresponds to a 'socially acceptable' incremental increase in the incidence of cancer, typically of one case in a population of 100,000 people. The RsC is expressed as a concentration in air (i.e., µg/m³).
- Risk-specific Dose (RsD) – same as the RsC except that it refers to the dose from multiple pathways that corresponds to a 'socially acceptable' incremental increase in the incidence of cancer (one in 100,000), often expressed as the daily dose of the chemical per unit body weight of the receptor (e.g., µg/kg•bw/d).

B1.2 Identification of the Chemicals of Potential Concern

The COPCs from the air emissions inventory for the Project were identified through:

- Recognition of pre-defined aliphatic and aromatic hydrocarbons as well as carcinogenic PAHs for which exposure limits have been developed by reputable scientific and/or regulatory authorities for the chemical group as a whole;
- Determination of whether or not sufficient toxicological information is available (i.e., the availability of regulatory exposure limits) to assess potential health risks for an individual chemical or chemical group; and
- Selection of chemical surrogates to represent any of the chemicals for which no suitable exposure limits were available. In the event that no limits were available, the potential for grouping a chemical with other similar chemicals was considered.

B1.3 Chemical Group Identification

In recognition of various pre-defined chemical groups for which exposure limits have been developed by reputable scientific or regulatory authorities, these include the various categories of aliphatic and aromatic hydrocarbons (i.e., aliphatic C_5-C_8 group, aliphatic C_9-C_{16} group, aliphatic C_{17}-C_{34} group, aromatic C_9-C_{16} group and aromatic C_{17}-C_{34} group) as well as the carcinogenic polycyclic aromatic hydrocarbons (PAHs), the air emissions inventory for the Project was examined with the aim of identifying those chemicals that could be assigned to one of the pre-defined groups. For example, n-pentane is an aliphatic hydrocarbon containing five carbon atoms. As such, n-pentane was combined with aliphatic C_5-C_8 in the order to assess the

aliphatic C_5-C_8 group as a whole. The aliphatic and aromatic hydrocarbon groups as well as the carcinogenic PAHs group (referred to as benzo(a)pyrene and equivalents) are defined in HHRA. For aliphatic and aromatic hydrocarbons, the selection of chemical groupings was consistent with guidance provided by various organizations (e.g. the CCME).

B1.4 Exposure Limit Selection

A tiered approach was used in the review and selection of available exposure limits for each of the COPCs. If a suitable exposure limit could not be identified from one of the regulatory agencies in the first tier, the search was then expanded to the second tier of agencies.

To ensure that the most defensible and appropriate exposure limit was selected for each chemical in the HHRA, consideration was given only to exposure limits meeting the following criteria:

- Established or recommended by reputable scientific authorities.
- Protective of the health of the general public based on the current scientific understanding of the health effects known to be associated with exposures to the COPC.
- Protective of sensitive individuals through the use of appropriate uncertainty factors.
- Supported by adequate and available documentation.

All supporting documents were critically evaluated to identify the most appropriate and defensible value for use in the HHRA. In the case that the above criteria were supported by more than one standard, guideline or objective, the most scientifically defensible limit was selected and the rationale for the decision is provided in the toxicity profile.

The process and resources used in selecting exposure limits varied slightly between the acute inhalation, chronic inhalation and chronic oral sections, due to the types of information available for these values. For all three categories of exposure limits, a tiered process of limit review and selection was utilized.

Two ‘Tiers’ of sources for exposure limits have been identified. The resources in Tier 1 represent reputable governmental agencies or established organizations, generally have supporting documentation available, and are generally recognized by governmental agencies. In the event that a defensible value with available supporting documentation was not available from Tier 1, the search for exposure limits was extended to include the agencies and organizations listed as Tier 2.

For some chemicals, our approach for Tier 1 can vary slightly due to the nature of the information available. Some notable examples are below.

Exception Criteria Air Contaminants

- For $PM_{2.5}$, in addition to the standard Tier 1 list, the CCME Canada-Wide Standard, the California Air Resources Board and the U.S. EPA air standards for $PM_{2.5}$ are considered.
- For NO_2 and SO_2, as no other U.S. EPA values are available, and recent National Ambient Air Quality Standards from the U.S. EPA are available for these two

substances, consideration is given to the 1-hour Standards for both NO_2 and SO_2 as well as the appropriate statistics.

- Carbon monoxide is considered only on an acute basis, using the standard Tier 1. No limit is selected for the chronic inhalation section due to the toxicological characteristics of CO.

Exception Petroleum Hydrocarbon Fractions

The petroleum hydrocarbon (PHC) fractions are groups of aliphatic PHCs (e.g., alkanes, alkenes, cycloalkanes and alkynes) and aromatic PHCs (e.g., arenes) that consist entirely of hydrogen and carbon and for which chronic inhalation and oral exposure limits have been developed for the chemical group as a whole. As a result, on a chronic basis, the limits for these chemical groups are obtained from an alternate set of Tier 1 agencies, namely:

- Canadian Council for Ministers of the Environment (CCME);
- Total Petroleum Hydrocarbon Working Group (TPHCWG); and,
- Massachusetts Department of Environmental Protection (MA DEP).

Because chronic inhalation and oral exposure limits have been developed for the aliphatic and aromatic PHC groups as a whole, these limits are given preference over a limit developed for a potential surrogate chemical. All chemicals relevant to the aliphatic and aromatic PHC groups, regardless of whether an exposure limit is available for the chemical on an individual basis, should be included in the aliphatic and aromatic PHC groups. The only exceptions include the carcinogenic PAHs (on a chronic basis), as per CCME (2008) recommendations that carcinogenic PAHs not be included in aromatic hydrocarbon groupings.

If a chronic inhalation or oral exposure limit is available for an individual chemical that is lower (i.e., more conservative) than the exposure limit for the aliphatic and aromatic PHC groups, then the chemical may be assessed both as part of the aliphatic and aromatic PHC group and as an individual chemical (e.g., chronic inhalation limit for naphthalene).

As only chronic inhalation and oral exposure limits have been developed for the aliphatic and aromatic PHC groups, the default approach for the acute inhalation exposure limit is to use a surrogate chemical. See below for the methodology to follow when using the surrogate approach.

The aromatic hydrocarbons that are not carcinogenic PAHs (i.e., not part of the benzo(a)pyrene group) should be compared to the chronic aromatic group limits.

The sections below provide additional information regarding the selection of acute inhalation, chronic inhalation and chronic oral exposure limits.

B1.5 Acute Inhalation Exposure Limits

The Tier 1 sources for acute inhalation exposure limits are as follows:

- Alberta Environment (AENV) - Ambient Air Quality Objectives (1-hr, 8-hr, 24-hr);

- Agency for Toxic Substances and Disease Registry (ATSDR) – Minimal Risk Levels (MRLs), Acute inhalation;
- California Office of Environmental Health Hazard Assessment (OEHHA) – Acute Reference Exposure Levels (RELs);
- Ontario Ministry of the Environment (OMOE) – Air Quality Standards and Guidelines (1-hr, 24-hr guidelines);
- Texas Commission for Environmental Quality (TCEQ) – Acute Reference Values (ReV) (although you may see ESLs listed, do not use these as they are not relevant for the purpose of our assessments);
- United States Environmental Protection Agency (U.S. EPA). Integrated Risk Information System (IRIS) – Acute Reference Concentrations;
- World Health Organization (WHO) – Air Quality Guidelines for Europe (WHO 2000, 2005).

In the event that a defensible value with adequate supporting documentation could not be identified from the Tier 1 sources, the search for acute exposure limits was expanded to include the following Tier 2 sources:

- American Conference for Governmental and Industrial Hygienists (ACGIH). Only Short-term Exposure Limits (STELs) and ceiling values should be considered as potential Tier 2 acute values.
- U.S. EPA Acute Exposure Guideline Levels (AEGLs) Level 1 (i.e., AEGL-1 values).

B1.6 Chronic Inhalation Exposure Limits

The search for chronic inhalation exposure limits involved the consideration of both cancer-based and non-cancer based exposure limits, when applicable.

The Tier 1 sources used to identify chronic inhalation exposure limits for the HHRA included:

- AENV – Ambient Air Quality Objectives (annual);
- ATSDR – Minimal Risk Levels (Chronic inhalation);
- Health Canada - Federal Contaminated Sites document and Existing Substances Division Tolerable Concentrations and Tumourigenic Concentrations); or the Health Based Guidance Values for Substances on the Second Priority Substances List;
- OEHHA – Chronic RELs, Chronic inhalation RsC (or unit risk estimates (URE) or slope factors (SF) converted to RsC) from the Cancer Potency Factors document;
- Health Institute of the Netherlands (RIVM) – Chronic Tolerable Concentrations in Air (TCA);
- TCEQ – Chronic ReVs and Chronic Linear ESLs1 and,

[1] In general, Effect Screening Levels or ESL from the TCEQ are not considered for use in the HHRA, as these values represent adjusted air concentrations for the purposes of air quality permitting within the

- U.S. EPA– Chronic RfCs, Chronic RsCs (or URE or SF converted to RsC).
- WHO – Annual Air Quality Guidelines

In the event that a defensible chronic value with adequate supporting documentation was not available from these sources, the search was expanded to include the following Tier 2 sources:

- ATSDR MRLs, intermediate (subchronic) inhalation;
- ACGIH TLV-TWA; and,
- PPRTVs from the U.S. EPA.

B1.7 Chronic Oral Exposure Limit Selection

The selection of chronic oral exposure limits for use in the multiple pathway assessment also considered two Tiers of values. As for the chronic inhalation assessment, consideration was given to both cancer and non-cancer based values, where applicable.

The Tier 1 sources consulted for chronic oral exposure limits included:

- ATSDR - Minimal Risk Levels (Chronic oral);
- Health Canada – Federal Contaminated Sites Document, Existing Substances Division Tolerable Daily Intakes (TDI) and Tumourigenic Concentrations, and TDI or Allowable Daily Intakes (ADI) that serve as the basis for the Canadian Drinking Water Quality Guidelines;
- OEHHA Cancer Potency Factors
- RIVM – oral TDIs;
- U.S. EPA- Chronic Oral RfDs (or SF converted to RsD); and,
- WHO - TDIs or ADIs that are the basis of the World Health Organization drinking water guidelines.

In the event that a defensible value with adequate documentation could not be identified for a COPC, the following Tier 2 sources were consulted:

- ATSDR MRLs, intermediate (subchronic) oral; and,
- Provisional Peer Review Toxicity Values (PPRTVs) from the U.S. EPA.

State of Texas, and often have been apportioned to a particular hazard quotient. In some instances (i.e. benzene, 1,3-butadiene, nickel), the TCEQ has recently derived cancer based ESLs using a linear risk model, for which supporting documentation is available. Review of the supporting documentation for linear cancer ESLs reveals that these values are equivalent to RsCs. As such, only linear, cancer-based ESLs were evaluated for the purposes of the HHRA, where supporting documentation was available. All non-cancer ESLs (acute and chronic) were disregarded on the basis of relevance to the HHRA and/or due to a lack of supporting documentation.

B1.8 Surrogate Exposure Limits

For groups of COPCs for which exposure limits have not been developed or recommended by the various regulatory or reputable scientific agencies either as individuals or as pre-defined chemical groups, surrogate chemicals have been identified based upon the emissions inventory for the Project and the availability of exposure limits for the various constituents of the inventory. Available values were compared and critiqued and typically the most conservative and defensible value for the group was selected. This step relied on the toxicological principle that states that the molecular structure of a chemical has a distinct bearing on its reactivity, biological activity and toxicity. The principle allows for the toxicity of a chemical for which little or no toxicological information exists to be predicted on the basis of information available on another chemical of similar molecular structure. The second chemical is termed a "surrogate". As the selection of limits was not restricted to one COPC, in some instances different surrogates were identified for groups on an acute and chronic basis.

B2.0 ACETALDEHYDE

B2.1 Inhalation Exposure Limits

B2.1.1 Acute Inhalation Exposure Limits

Table B2.1 Acute Inhalation Exposure Limits for Acetaldehyde

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO	90	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	1-hour REL 8-hour REL	470 300	OEHHA 2008a, 2008b
OMOE	24-hour Standard	500	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

– = Not available

The OEHHA (2008a, b) derived two acute RELs (1-hour and 8-hour). The acute 1-hour REL is based on a study by Prieto (2000), the purpose of which was to establish the concentration at which a 20% decrease in forced expiratory volume (FEV_1) occurred in 1 second – an endpoint selected by the authors as being of interest with respect to the acute effects of acetaldehyde inhalation (OEHHA 2008b). Subjects were exposed via mouth inhalation to air concentrations ranging from 150 to 1,200 mg/m³, with a geometric mean of 527 mg/m^3, and a lower 95% confidence interval of about 142 mg/m³. This concentration was selected as the LOAEL for effects on expiratory volume in asthmatics, and this value was used as the basis of the acute REL. Two follow-up studies (Prieto et al. 2002a, b) were conducted and considered in the development of the REL. Prieto et al. (2002a) compared the respiratory response to acetaldehyde with known bronchoconstricting compounds (methacholine and adenosine-5'-monophosphate), and the repeatability of the respiratory response to acetaldehyde. Prieto et al. (2002b) also incorporated a healthy subject group, and subjects with allergic rhinitis or asthma. Subjects with allergic rhinitis and asthma both demonstrated significant differences from the

healthy subject group with respect to the occurrence of FEV_1 decreases of 20%. The geometric mean exposure concentrations associated with significant bronchoconstriction in the rhinitis group and asthmatic group were determined to be 2,166 mg/m³ and 1,136 mg/m³, respectively. A study by Silverman et al. (1946) was cited by OEHHA (2008b) as a supporting study to the acute REL. In this study, twelve people were exposed to acetaldehyde for 15 minutes at concentrations ranging from 25 to above 200 ppm (not specified). Nose and throat irritation were reported at 200 ppm and above, evidence of eye irritation was not apparent at 200 ppm.

The LOAEL of 142 mg/m³ observed in Prieto et al. (2000) was selected by OEHHA (2008b). A cumulative uncertainty factor of 300 was applied to this LOAEL to account for the use of a LOAEL instead of a NOAEL (10), and to account for intraspecies variability (30). The factor of 30 was applied to account for the potential for exacerbation of asthma in children (as the subjects examined were all adults) and the potential for hyper-responsiveness to methacholine (OEHHA 2008b). The result is an REL of 470 µg/m³. Although the exposure duration in the key study was 2 to 4 minutes, the OEHHA (2008b) did not convert the REL using Haber's law. Instead it states that the REL represents a level at which intermittent 1-hour exposures are not expected to result in adverse health effects. As such, the REL of **470 µg/m³** was used in the assessment as a 1-hour exposure limit, based upon respiratory effects. The OEHHA (2008b) states that this REL also is protective against the effects of eye irritation.

The OEHHA (2008b) also provides an 8-hour REL of 300 µg/m³ to be protective of repeated 8-hour exposures to acetaldehyde. This value was based on a 4-week study in Wistar rats exposed to 0, 273, 728, 910, 1,820, 4,004, or 9,100 mg/m³ acetaldehyde for 6 hours/day, 5 days/week. Significant degeneration of the olfactory epithelium was observed at concentrations of 728 mg/m³ and above (the study LOAEL). As such, 273 mg/m³ was identified as the NOAEL. Benchmark dose modelling was completed on the study data, and the BMC_{05} was identified as being 178 mg/m³. The BMC_{05} was further converted to a human equivalent concentration of 242 mg/m³ using pharmacokinetic modelling specific to the study species and acetaldehyde. Adjustments were made to account for continuous exposure (6/24 hours × 5/7 days) resulting in an adjusted BMC_{05} of 86.5 mg/m³. A cumulative uncertainty factor of 300 was applied to account for subchronic exposure (√10), interspecies differences (√10), inter-individual variation (√10), and potential for exacerbation of asthma in children (10). The result is the 8-hour REL of 300 µg/m³. This value was not used in the acute effects assessment, given that it is based on animal rather than human data, and involves repeated dose exposures as opposed to instantaneous effects (which are well documented in support of the OEHHA 1-hour REL).

The AENV (2011) recommends a 1-hour AAQO for acetaldehyde of 90 µg/m³. This objective, however, was adopted from the TCEQ, which developed its short-term ESL based on odour perception. Given that the AENV AAQO is not health-based, it was not used to evaluate the potential short-term health risks associated with acetaldehyde.

The OMOE (2008) has derived a 24-hour standard of 500 µg/m³; however, adequate supporting documentation is not provided. As a result, the study team is unable to comment on the scientific merit of this standard and it was not used in the acute effects assessment.

B2.1.2 Chronic Inhalation Exposure Limits

Table B2.2 Chronic Inhalation Exposure Limits for Acetaldehyde

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	TC_{05} TC	17.2 390	Health Canada 2009, 2004
OEHHA	RsC REL	3.7 140	OEHHA 2009 OEHHA 2008a, 2008b
RIVM	–	–	RIVM 2009, 2001
TCEQ	–	–	TCEQ 2011
US EPA	RfC RsC	9 5	US EPA 2011, 1991a US EPA 2011, 1991b
WHO	–	–	WHO 2000

– = Not available

Health Canada (2004) derived a TC_{05} of 86 mg/m³, which is associated with a 5% increase in nasal tumours in rats. In the key study (Woutersen et al. 1986), male and female Wistar rats were exposed to 0, 750, 1,500, or 3,000 ppm (equivalent to 0, 1,350, 2,700, or 5,400 mg/m³) of acetaldehyde for 6 hours/day, 5 days/week for 28 months. Squamous cell carcinomas and adenocarcinomas were observed in olfactory and respiratory epithelia in the nasal cavities of exposed animals. No lung tumours were observed (Woutersen et al. 1986). The TC_{05} of 86 mg/m³ was derived using a multistage model, with adjustment for intermittent to continuous exposure (6/24 hours × 5/7 days). Based on a risk level of one in 100,000, the TC_{05} equates to a risk specific concentration of 17.2 µg/m³. The adjusted value of **17.2 µg/m³** was used in the chronic inhalation assessment of acetaldehyde.

Health Canada (2004) also presents a non-cancer TC of 390 µg/m³ based on the incidence of olfactory lesions after 4 weeks of exposure. Health Canada applied a benchmark dose model and calculated a BMC_{05} based on tumour incidence data from Appelman et al. (1982, 1986). This value was not selected as the carcinogenic value was more conservative and based on a longer-term study.

The OEHHA (2009) derived a URE of 2.7 E-06 $(\mu g/m^3)^{-1}$ for acetaldehyde (equivalent to an RsC of 3.7 µg/m³) based on the same study used by Health Canada (Woutersen et al. 1986), described above. The OEHHA (2009) adjusted exposure estimates for intermittent exposure. Linearized multistage modelling was conducted, and the 95% upper confidence limit was determined. Exposures were then scaled based on body weight by the OEHHA. The OEHHA (2009) value was not used in the chronic inhalation effects assessment as the tumours observed in the study animals appear to be in tissues that have first contact with inhaled acetaldehyde, making the dose-scaling adjustments based on body weight less relevant.

The US EPA (2011, 1991b) also presents a quantitative estimate of carcinogenic risk from inhalation exposure. Its inhalation unit risk of 2.2E-06 per µg/m³ equates to an RsC of 5 µg/m³ (based on a risk level of one in 100,000). The US EPA inhalation unit risk was not used in the current assessment for the following reasons:

- The US EPA last reviewed its limit in 1991, while the Health Canada value is more recent (published in 2004). The Health Canada and US EPA limits are based on studies conducted by the same researchers.
- The Health Canada limit is based on a 1986 study by Woutersen et al., which is more recent than the work completed by Woutersen and Appelman in 1984, upon which the US EPA limit is based.
- The scientific rationale for the Health Canada limit is considerably more detailed than what the US EPA provides in support of its limit.

In addition to the RsC, the US EPA (2011, 1991a) has derived an RfC of 9 µg/m³ based on the degeneration of olfactory epithelium in rats exposed to 0, 150, or 500 ppm of acetaldehyde for a duration of 4 weeks. This limit was not considered further due to the short exposure duration, the availability of other chronic-based values, and the toxicological endpoint.

The OEHHA (2008a, b) also has derived a chronic REL of 140 µg/m³ based on the incidence of olfactory epithelium degeneration following a 4-week exposure in rats. This limit was not given further consideration on the basis that the non-carcinogenic REL is less conservative than the other available cancer-based limits and the relatively short-term nature of the exposure (4 weeks).

B2.2 Oral Exposure Limits

B2.2.1 Chronic Oral Exposure Limits

Acetaldehyde was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria to be defined as a non-volatile chemical. Thus, a chronic oral exposure limit was not required for acetaldehyde.

B2.3 References

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B3.0 ACROLEIN

B3.1 Inhalation Exposure Limits

B3.1.1 Acute Inhalation Exposure Limits

Table B3.1 Acute Inhalation Exposure Limits for Acrolein

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	1-hour MRL	6.9	ATSDR 2011, 2007
OEHHA	1-hour REL 8-hour REL	2.5 0.7	OEHHA 2008a, b
OMOE	24-hour Standard	0.08	OMOE 2008, 2005
TCEQ	1-hour ReV	11	TCEQ 2011, 2010
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

– = Not available

The OEHHA (2008a, 2008b) has derived a 1-hour acute REL of 2.5 µg/m³ based on the geometric mean of two acute REL values developed from two acute exposure studies employing human subjects – Darley et al. (1960) and Weber-Tschopp et al. (1977). Darley et al. (1960) exposed 36 healthy people to 0, 0.06, 1.3 to 1.6, or 2.0 to 2.3 ppm acrolein for

5 minutes. Acrolein was dissolved in water and administered via face masks equipped with respirators such that only the eyes were exposed to acrolein. Subjects rated the degree of eye irritation every 30 seconds during exposure. A LOAEL of 0.06 ppm (~0.14 mg/m³) was identified. A cumulative uncertainty factor of 60 was applied to account for the use of a LOAEL instead of a NOAEL for a relatively mild adverse effect (6), and intraspecies variability (to protect against the exacerbation of asthma in children - 10). The result is an acute 1-hour REL of 2.3 µg/m³.

In a chamber study by Weber-Tschopp et al. (1977), 54 healthy human volunteers were exposed to increasing concentrations (0 to 0.6 ppm, equivalent to 0 to 1.4 mg/m³) of acrolein for 40 minutes, while 46 healthy human volunteers were continuously exposed to 0.3 ppm (equivalent to 0.68 mg/m³) for 60 minutes. Another group of individuals (n=42) were exposed to various acrolein concentrations (not specified) for 90 seconds. Subjective eye and nasal irritation were reported and eye-blink and respiratory rates were measured during the exposures. For the exposure group with increasing levels of acrolein, significantly higher eye irritation and nasal irritation relative to the control group were reported at 0.07 ppm and 0.26 ppm, respectively. As well, respiratory rates decreased with increasing acrolein concentrations, with changes being significant between 0.09 and 0.30 ppm acrolein. For the continuous exposure group, subjective eye and nasal irritation increased quickly during the initial 20 minutes of exposure and plateaued by 40 minutes. Respiratory rates decreased by 10% and eye blink rates doubled after 10 minutes of exposure. On this basis, the OEHHA (2008b) identified a LOAEL of 0.07 ppm for subjective ocular irritation. A cumulative uncertainty factor of 60 was applied to the LOAEL to account for the use of a LOAEL instead of a NOAEL for a relatively mild adverse effect (6), and intraspecies variability (10 – to protect against the exacerbation of asthma in children). The result is an acute 1-hour REL of 2.7 µg/m³.

The OEHHA (2008b) calculated the geometric mean of the two acute RELs to derive the acute 1-hour REL for acrolein of 2.5 µg/m³. Although no conversion was made for a 5-minute to a 1-hour exposure, the OEHHA (2008b) states that the acute REL is intended to be protective of intermittent 1-hour exposures. The acute REL of **2.5 µg/m³** was selected for use in the acute effects assessment.

The OEHHA (2008b) also developed an 8-hour REL based on a 65-day study in which Fischer 344 rats were exposed to 0.02 to 1.8 ppm for 6 hours/day, 5 days/week over the 65-day period. The 8-hour REL was not used in the acute effects assessment as it is based on subchronic exposure data in animals, as opposed to acute human data used in the 1-hour limit.

The OMOE (2008, 2005) provides a 24-hour standard of 0.08 µg/m³ for acrolein based on a LOAEL of 920 µg/m³ for nasal and upper respiratory lesions in rats (Feron et al. 1978; Kutzman 1981; Kutzman et al. 1985). This standard was not used as the data came from subchronic studies using animals, and alternative values based on acute toxicity and human-derived data are available.

The TCEQ (2011, 2010) has derived an acute 1-hour ReV for acrolein of 11 µg/m³, based on the Weber-Tschopp et al. (1977) study. The TCEQ (2010) states that the 40-minute exposure group experienced the highest degree of irritation, as reported in questionnaires completed by subjects every 5 minutes. Eye irritation was reported at 0.3 ppm, throat irritation at 0.4 ppm, and significantly decreased respiratory rates were recorded at 0.6 ppm. From this 40-minute exposure group, the exposure concentration of 0.3 ppm was identified by the TCEQ as a

LOAEL. No adjustments for continuous exposure were applied. An uncertainty factor of 63 was applied to account for the use of a LOAEL for a mild effect (6.3) and intraspecies differences (10). The TCEQ value was not selected for use in the assessment, primarily because the OEHHA (2008) selected a lower LOAEL value than the TCEQ for the Weber-Tschopp et al. (1977) study. The analysis by the OEHHA appears to be more representative of the findings of the study, as effects were reported below 0.3 ppm. It is possible that the TCEQ value may not be adequately conservative as a result of the LOAEL selected.

The ATSDR (2011, 2007) has derived an acute MRL of 0.003 ppm (0.0069 mg/m³) based on decreased respiratory rate and nose and throat irritation reported in the Weber-Tschopp et al. (1977) study. Forty-six volunteers were exposed to a gradually increasing concentration of acrolein for 40 minutes. Participants subjectively scored irritancy at 5 minute intervals as the concentrations increased from 0 to 0.6 ppm (0 to 1.3 mg/m³). The ATSDR identified a LOAEL for nose irritation of 0.26 ppm (0.60 mg/m³) and then applied an uncertainty factor of 100 to the LOAEL to account for the use of a LOAEL instead of a NOAEL (10) and intraspecies variability (10). Because the OEHHA developed a lower exposure limit based on the same study, ATSDR's MRL of 6.9 µg/m³ was not used in the current assessment.

B3.1.2 Chronic Inhalation Exposure Limits

Table B3.2 Chronic Inhalation Exposure Limits for Acrolein

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	−	−	AENV 2011
ATSDR	−	−	ATSDR 2011
HEALTH CANADA	TC	0.4	Health Canada 2004, Government of Canada 2000
OEHHA	REL	0.35	OEHHA 2008a, b
RIVM	−	−	RIVM 2009, 2001
TCEQ	ReV	0.5	TCEQ 2011, 2010
US EPA	RfC	0.02	US EPA 2011, 2003
WHO	−	−	WHO 2000

− = Not available

The OEHHA (2008a, 2008b) has derived a chronic REL of 0.35 µg/m³ based on the incidence of nasal lesions in a subchronic rat inhalation study by Dorman et al. (2008). Groups of 12 adult male F344 rats were exposed to 0, 0.02, 0.06, 0.2, 0.6 or 1.8 ppm acrolein (approximately 0, 0.05, 0.14, 0.5, 1.4, or 4.1 mg/m³) acrolein *via* inhalation for 6 hours/day, 5 days/week for up to 13 weeks. Some animals were sacrificed after 4, 14, 30 and 65 days of exposure, and respiratory tract histopathology was examined at these intervals. A number of rats were included in a recovery group that was sacrificed 60-days post-exposure. A statistically significant decrease in body weight was observed in all acrolein exposed animals after 13 weeks of exposure, although the body weight effects were less pronounced and slower to develop at the lower dose levels. Mild hyperplasia of respiratory epithelia was observed at concentrations of 0.6 ppm and above after four days or more of exposure. The hyperplasia became more severe at 1.8 ppm, and squamous metaplasia also was observed. The most sensitive site within the nasal cavity was observed to be the lateral wall, although lesions were observed at other sites as well. Immunohistochemical analysis of epithelial cells indicated that immunoreactivity was not observed at 0.2 ppm, but was present at 0.6 ppm and 1.8 ppm. An

exposure-related effect on olfactory epithelium also was observed in animals exposed to 1.8 ppm acrolein for four or more days. After four days, animals in the 1.8 ppm group displayed moderately severe olfactory neuronal degeneration and atrophy, and in some instances, marked olfactory neuron loss was observed. Effects became more severe with increasing exposure duration. Only partial recovery of the olfactory epithelium was observed after 65 days post-exposure. At 1.8 ppm, mild squamous metaplasia also was observed in the larynx and trachea, but no exposure-related effects were observed in the lungs. A NOAEL for nasal epithelial lesions was determined to be 0.2 ppm. Given the subchronic nature of the exposure, and that the toxicological endpoint did not involve trigeminal nerve irritation, this NOAEL was adjusted to account for intermittent exposure (i.e., 6/24 hours x 5/7 days), resulting in a $NOAEL_{ADJ}$ of 0.036 ppm. A human equivalent concentration ($NOAEL_{HEC}$) was calculated by multiplying the duration-adjusted NOAEL by a dosimetric adjustment factor (DAF) of 0.85 derived by the OEHHA (2008b). This DAF represents the ratio of the gas flux across olfactory epithelium in rats relative to humans, based on modeling conducted by Kimbell et al. (2001).

The $NOAEL_{HEC}$ was calculated to be 0.03 ppm (70 µg/m³). A cumulative uncertainty factor of 200 was applied to this $NOAEL_{HEC}$ to account for interspecies variability (a default value of √10 for potential toxicodynamic differences, and a value of 2 for toxicokinetic differences), subchronic to chronic extrapolation (√10), and intraspecies differences (10) to account for the potential for asthma exacerbation in children. The result is a chronic REL of **0.35 µg/m³**. This value was selected for use in the chronic assessment of acrolein

Health Canada (2004) has developed a tolerable concentration of 0.4 µg/m³ based on the lower benchmark concentration of 0.14 mg/m³ associated with a 5% increase in non-neoplastic lesions in the nasal respiratory epithelium of rats (Health Canada 2004; Government of Canada 2000; Cassee et al. 1996). A cumulative uncertainty factor of 100 was incorporated to account for interspecies variation (10) and intraspecies variation (10). The limit was further adjusted by Health Canada to account for continuous exposure (i.e., rats were exposed intermittently for 6 hours/day so the limit was multiplied by 6/24 hours). Given that Health Canada's tolerable concentration is based on acute exposure (3 days) it was not used in the current chronic assessment of acrolein.

The TCEQ (2011, 2010) has derived a chronic ReV of 0.5 µg/m³ based on the same Dorman et al. (2008) study as the OEHHA REL. Information regarding study design is provided above in association with the OEHHA value. The TCEQ identified 0.2 ppm as a NOAEL for nasal epithelial hyperplasia and squamous metaplasia, and a LOAEL of 0.6 ppm for hyperplasia of the nasal cavity, septum and larynx. The NOAEL of 0.2 ppm was selected as the point of departure for the limit. Benchmark dose modelling was considered, but could not be used as a result of the response rates at the various concentrations. An adjustment to account for continuous exposure was conducted (0.2 ppm x 6/24-hours x 5/7-days), resulting in a $NOAEL_{ADJ}$ of 0.035 ppm. To convert this $NOAEL_{ADJ}$ to a $NOAEL_{HEC}$, the TCEQ applied an RGDR value of 0.187, based on a rat ventilation rate of 193 m/min, a rat body weight of 0.273 kg, a rat extrathoracic surface area of 15.0 cm², a human ventilation rate of 13,800 ml/min, and a human extrathoracic surface area of 200 cm². The result of this conversion was a $NOAEL_{HEC}$ of 0.007 ppm. An uncertainty factor of 30 was applied to account for interspecies differences (3), and intraspecies variability (10). The TCEQ value was not used in the assessment, due to the availability of a slightly lower value based on the same study by the OEHHA.

The US EPA (2011, 2003) has derived an inhalation RfC of 0.02 µg/m³ based on nasal lesions observed in a subchronic rat inhalation study conducted by Feron et al. (1978). Six Wistar rats, ten Syrian golden hamsters and two Dutch rabbits were administered 0, 0.4, 1.4, or 4.9 ppm acrolein in a whole-body exposure chamber for five days/week for 13 weeks. Histopathologic changes described as "slightly affected" were observed in the nasal cavity of one of the 12 rats exposed to 0.4 ppm (0.9 mg/m³) (US EPA 2003). Severity increased at the higher levels of exposure in all species, most clearly so in the rat. No nasal lesions were reported in other species at 0.4 ppm (0.9 mg/m³). Based on the concentration-related severity of lesions, the rat was identified as the most sensitive species. The US EPA identified a LOAEL of 0.4 ppm (0.9 mg/m³) and adjusted the LOAEL to continuous exposure (i.e., 6/24 hours x 5/7 days), resulting in a $LOAEL_{ADJ}$ of 0.16 mg/m³. In addition, the US EPA (2003) calculated the $LOAEL_{HEC}$ using the RGDR approach, where the duration-adjusted LOAEL for the rat was then multiplied by the $RGDR_{ET}$ to yield a $LOAEL_{HEC}$ of 0.02 mg/m³. The US EPA (2003) applied an uncertainty factor of 1,000 to the $LOAEL_{HEC}$ to account for extrapolation from rats to humans (3), intraspecies variability (10), adjustment from a subchronic to chronic study (10), and use of a minimal LOAEL (3). An uncertainty factor of 3 was used for interspecies variability because dosimetric adjustments were already made through the use of the RGDR methodology. This value was not selected for use, as the OEHHA (2008) value is based on more recent and robust study data and incorporates dosimetry modelling data instead of the RGDR approach.

The ATSDR (2011) has derived an intermediate inhalation MRL of 0.00004 ppm (0.09 µg/m³) based on the same Feron et al. (1978) study as the US EPA (2003). The end point identified for derivation of the MRL was nasal epithelial metaplasia in rats, based on a LOAEL of 0.4 ppm. As chronic inhalation exposure limits were available from other regulatory agencies, the ATSDR intermediate value was not used in the assessment.

B3.2 Oral Exposure Limits

B3.2.1 Chronic Oral Exposure Limits

Acrolein was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria that determine whether or not a chemical is non-volatile. Thus, a chronic oral exposure limit was not required for acrolein.

B3.3 References

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B4.0 ALIPHATIC C_5-C_8 GROUP

B4.1 Inhalation Exposure Limits

B4.1.1 Acute Inhalation Exposure Limits

Table B4.1 Acute Inhalation Exposure Limits for Aliphatic C_5-C_8 Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	AAQO	21,000 (n-hexane)	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	24-hour Standard	2,500 (n-hexane mixture)	OMOE 2008, 2005
TCEQ	1-hour ReV	200,000 (n-pentane)	TCEQ 2011a, b
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

Acute limits for the aliphatic C_5-C_8 group as a whole were not available from the above agencies, therefore, the search was expanded to include the ACGIH (2011) and the US EPA (2011b). Again no values were available for the aliphatic C_5-C_8 as a whole, thus, the search was further expanded to consider limits for the individual components of the group.

The TCEQ (2011a, 2011b) has derived a 1-hour ReV of 200,000 µg/m^3 for n-pentane. In the key study by Lammers et al. (2011), two acute experiments were conducted. In the first

experiment, male WAG/RijCHBR rats (8 per group) were exposed to 0, 2,000, 6,500, or 20,000 mg/m^3 of n-pentane for 8 hours per day for 3 consecutive days. An assessment of motor activity and neurobehavioural functions was conducted using a standardized functional observational battery of tests. No significant adverse neurological effects were observed in any of the exposure groups.

In the second experiment, male WAG/RijCHBR rats (8 per group) were exposed to the same concentrations of n-pentane for the same amount of time, with tests for cognitive performance being conducted after exposure. Mild, reversible changes in performance speed were observed in the two lowest exposure groups, but not in the high-exposure group. Tests conducted 1-day post-exposure revealed no adverse effects due to n-pentane exposure. The TCEQ (2011b) identified 20,000 mg/mg^3 (19,872 mg/m^3 average measured concentration) as a free-standing NOAEL. The recommended default RGDR of 1 (TCEQ 2006) was applied to account for the ratio of the blood: gas coefficients of rats to humans being less than one, resulting in a POD of 19,872 mg/m^3 (equivalent to the NOAEL). An uncertainty factor of 90 was applied to the POD to account for interspecies differences (3, due to the use of an RGDR), intraspecies differences (10), and database deficiencies (3).

The TCEQ (2011a) notes that supporting documents are available for hexane and pentene isomers. However, further review of these documents indicate that no acute ReVs have been derived due to a lack of sufficient information.

AENV (2011) presents a 1-hour AAQO for hexane of 21,000 µg/m³, and notes that this value is based on a California air quality objective. A search of the California Air Resources Board (CARB 2011) did not reveal any documentation for a 1-hour value for hexane. As a result, this value was not considered further.

The OMOE (2008, 2005) developed a 24-hour standard of 2,500 µg/m³ for an n-hexane mixture. This standard was developed from a LOAEL of 58 ppm (204 mg/m³) for polyneuropathy in humans (Sanagi et al. 1980). Workers were exposed to low concentrations of n-hexane and acetone in a tungsten carbide alloys facility for an average of 6.2 years. This value is based on chronic exposures that are not relevant to acute, peak exposures. As such, this value was not considered suitable as an acute exposure limit.

B4.1.2 Chronic Inhalation Limits

As the regulatory agencies typically searched for exposure limits did not provide any chronic values for the aliphatic and aromatic groups, the search was expanded to agencies such as the CCME, MA DEP, and TPHCWG that have derived chronic exposure limits for the petroleum hydrocarbon groups as a whole.

Table B4.2 Chronic Inhalation Exposure Limits for Aliphatic C_5-C_8 Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
CCME	RfC	18,400	CCME 2008
MA DEP	RfC	200	MA DEP 2003
RIVM	TCA	18,400	RIVM 2001
TPHCWG	RfC	18,400	TPHCWG 1997

The CCME (2008) and RIVM (2001) both provide an RfC of 18,400 µg/m³ for the C_5-C_8 aliphatic group based on the neurotoxic endpoint of commercial hexane. This exposure limit was adopted from the TPHCWG (1997) and was developed from the NOAEL of 10,307 mg/m³ for two (rat and mice) chronic bioassays involving lifetime exposure. The NOAEL was adjusted for continuous exposure (6/24 hours × 5/7 days) to a concentration of 1,840 mg/m³. The TPHCWG (1997) applied an uncertainty factor of 100 to account for interspecies variability (10) and intraspecies variability (10). The TPHCWG (1997) recommends using the RfC derived for commercial hexane over an RfC specific to n-hexane (as is the case of the MA DEP RfC) as it is more representative of the aliphatic fraction. According to the TPHCWG (1997), using n-hexane alone results in an overestimation of the toxicity of the fraction because n-hexane is the most toxic of the group's constituents, it is uniquely toxic and its interaction with other petroleum compounds influences its toxicity. The RfC of **18,400 µg/m³** for commercial hexane was used to evaluate the risks associated with the aliphatic C_5-C_8 group.

The MA DEP (2003) RfC of 200 µg/m³ was derived from toxicity data specific to n-hexane, which is considered overly conservative when characterizing the toxicity of the aliphatic C_5-C_8 group as a whole. As n-hexane has unique neurotoxic characteristics, it is not representative of the toxicity of the aliphatic C_5-C_8 group. As such, the MA DEP value was not selected.

B4.2 Oral Exposure Limits

The aliphatic C_5-C_8 group was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria to be defined as a non-volatile chemical. Thus, a chronic oral exposure limit was not required for the aliphatic C_5-C_8 group.

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B5.0 ALIPHATIC C_9-C_{16} GROUP

B5.1 Inhalation Exposure Limits

B5.1.1 Acute Inhalation Exposure Limits

Table B5.1 Acute Inhalation Exposure Limits for Aliphatic C_9-C_{16} Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

No acute exposure limits were available for the aliphatic C_9-C_{16} group from the agencies listed above. The search was expanded to include STEL and Ceiling values from the ACGIH (2011) and AEGL-1 values from the US EPA 2011(b). As no values were identified, the individual constituents of the aliphatic C_9-C_{16} were evaluated for exposure limits.

The OMOE (2008) presents a 24-hour health-based guideline for 1-decene of 60,000 µg/m^3. However, no supporting documentation is available for this value. As a result, the OMOE guideline was not used to characterize the acute health risks.

No defensible exposure limits were identified for the individual constituents that make up the aliphatic C_9-C_{16} group. As a result, the aliphatic C_9-C_{16} group could not be evaluated in the acute inhalation assessment.

B5.1.2 Chronic Inhalation Exposure Limits

As the regulatory agencies typically searched for exposure limits did not provide any chronic values for the aliphatic and aromatic groups, the search was expanded to agencies such as the CCME, MA DEP, and TPHCWG that have derived chronic exposure limits for the petroleum hydrocarbon groups as a whole.

Table B5.2 Chronic Inhalation Exposure Limits for Aliphatic C9-C16 Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
CCME	RfC	1,000	CCME 2008
MA DEP	RfC	200	MA DEP 2003
RIVM	RfC	1,000	RIVM 2001
TPHCWG	RfC	1,000	TPHCWG 1997

The MA DEP (2003) derived an RfC of 200 µg/m³ based on a subchronic rodent study by Lund et al. (1995). In this study, rats were exposed to 0, 2,620 or 5,253 mg/m³ (0, 400 or 800 ppm) of

de-aromatized white spirit (DAWS) for 6 hours/day, 5 days/week for 6 months. Following a 2- to 6-month exposure-free period, neurophysiological, neurobehavioural and microscopic pathologic examinations were performed. Exposure-related changes in sensory evoked potentials were observed and a decrease in motor activity during dark periods was reported. According to the authors, a 6-month exposure to DAWS can result in long-lasting and possibly irreversible effects in the nervous system of the rat. The LOAEL of 2,620 mg/m³ (400 ppm) was adjusted for continuous exposure (6/24 hours × 5/7 days) to a concentration of 468 mg/m³. MA DEP applied an uncertainty factor of 3,000 to account for interspecies variability (10), intraspecies variability (10), adjusting from a LOAEL to a NOAEL (10) and use of a subchronic study (3). The result is an RfC of **200 µg/m³**, which was used in the chronic effects assessment of the aliphatic C_9-C_{16} group.

The CCME (2008) derived an RfC of 1,000 µg/m³ for the aliphatic C_9-C_{16} group, which was adopted from the TPHCWG (1997). The RfC is based on the hepatic and hematological effects of de-aromatized petroleum streams and JP-8 Jet Fuel, which together cover the entire range of the fraction. Two separate studies were examined by the TPHCWG (1997). In the study used to derive the RfC (Phillips and Egan 1984), Sprague-Dawley rats were exposed to 0, 300 or 900 ppm (0, 1,742 or 5,226 mg/m³) of C_{10}-C_{11} isoparaffinic solvent for 6 hours/day, 5 days/week for 12 weeks, with questionable body weight effects occurring at both exposure levels. Mild renal toxicity was observed in males at both exposure concentrations, with some evidence of the effect being dose- and duration-related. Sporadic incidences of hepatic abnormalities also were observed. None of the observed effects were considered significant. As such, the highest concentration (900 ppm) was identified as a NOAEL. The NOAEL of 900 ppm (5,226 mg/m³) was adjusted for intermittent exposure (6/24 hours × 5 /7 days) to a concentration of 933 mg/m³. An uncertainty factor of 1,000 was applied to the duration-adjusted NOAEL to account for interspecies variability (10), intraspecies variability (10) and use of a subchronic study (10). The result is an RfC of 0.9 mg/m³. A separate experiment was conducted as part of the same study where male and Sprague-Dawley rats were exposed to 0, 300 or 900 ppm of DAWS vapours for 6 hours/day, 5 days/week for 12 weeks. The study NOAEL of 5,485 mg/m³ was adjusted for intermittent exposure (6/24 hours, 5/7 days) to a concentration of 979 mg/m³. An uncertainty factor of 1,000 was applied to the adjusted NOAEL to account for interspecies variability (10), intraspecies variability (10) and use of a subchronic study (10). From this second experiment, an RfC of 1.0 mg/m³ was calculated. In both the solvent and DAWS exposure studies, renal and hepatic abnormalities were observed. Both Phillips and Egan 1984 and the TPHCWG 1997 debate the biological relevance of the renal and hepatic changes, and declare 900 ppm as the NOAEL rather than a LOAEL.

In the second study (Mattie et al. 1991), male and female mice and rats were exposed to JP-8 vapours of 0, 500 or 1,000 mg/m³ continuously for 90 days. This exposure period was followed by a 24-month recovery period. A statistically significant increase in basophilic foci was observed in male rats. In female rats, increased splenic haematopoiesis was observed, although not deemed exposure-related. The highest dose level (1,000 mg/m³) was identified by the TPHWCG as the NOAEL. An uncertainty factor of 1,000 was applied to account for interspecies variability (10), intraspecies variability (10) and use of a subchronic study (10). The result is an RfC of 1.0 mg/m³.

The CCME/TPHCWG RfC of 1,000 µg/m³ was not selected for use in the chronic effects assessment. Both of the key studies reported adverse effects at the highest dose level, sometimes in association with a dose-response relationship, calling into question the NOAEL

upon which the values are based. The RfC is less conservative than the MA DEP value of 200 µg/m³.

The RIVM (2001) adopted the TPHCWG RfC of 1,000 which is discussed above and was rejected in favour of the MA DEP RfC.

B5.2 Oral Exposure Limits

As the aliphatic C_9-C_{16} group did not pass the physical-chemical screening used to identify non-volatile and potentially accumulative substances, a search for oral exposure limits was not completed.

B5.3 References

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B6.0 AROMATIC C_9-C_{16} GROUP

B6.1 Inhalation Exposure Limits

B6.1.1 Acute Inhalation Exposure Limits

Table B6.1 Acute Inhalation Exposure Limits for Aromatic C_9-C_{16} Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

No acute exposure limits were identified from the above listed sources for the aromatic C_9-C_{16} group as a whole. As a result, the search for group limits was expanded to include STELs and Ceiling values from the ACGIH (2011) and AEGL-1 values from the US EPA (2011b). No values were identified from either one of these sources. As such, the search was extended to evaluate individual limits available for the individual constituents of the aromatic C_9-C_{16} group.

The ACGIH (2011) has derived a STEL for naphthalene (described within the toxicological profile for naphthalene). The adjusted STEL for naphthalene of **2,000 µg/m³** was used as a 1-hour exposure limit in the acute effects assessment for the aromatic C_9-C_{16} group, as it represents the most conservative limit for the constituents of the group on an acute basis that is available with supporting rationale.

The US EPA (2007a) has derived a 1-hour AEGL-1 of 250 mg/m^3 for isopropylbenzene. This value is based on what appears to be an anecdotal report from an occupational environment (Dow 1948) that was published but has since been withdrawn, according to the US EPA (2007a) reference list. As a result, this value was not considered in the acute effects assessment as the supporting information could not be verified.

The OMOE (2008) presents a 24-hour value of 220 µg/m³ for trimethylbenzenes; however, as no supporting documentation is available, this value was not considered in the risk assessment.

The US EPA (2007b) has derived an acute AEGL-1 for all isomers of trimethylbenzene of 140 ppm (690,000 µg/m³). Due to a lack of available human data for acute trimethylbenzene exposure, the AEGL-1 was derived from an analysis of several animal studies. Korsak and Rydzynski (1996) conducted a study involving acute (4-hour) exposure to 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene and 1,2,3-trimethylbenzene at concentrations ranging from 250 to 2,000 ppm (individual doses not specified) within a controlled chamber. Concentration-related changes were observed in rotarod performance in the exposed rats (male only). EC_{50} values for each isomer based on disturbances in rotarod function were determined to be: 4,693 mg/m³ (95% CI 3,891 to 5,493 mg/m³) for 1,2,4-trimethylbenzene; 4,738 mg/m³ (95% CI 3,675 to 5,453 mg/m³) for 1,3,5-trimethylbenzene; and 3,779 mg/m³ (95% CI 2,832 to 4,615 mg/m³) for 1,2,3-trimethylbenzene. Changes in pain sensitivity also were observed for the three isomers in the acute study. EC_{50} values for pain sensitivity (demonstrated by the paw lick response) were determined to be the following: 5,682 mg/m³ (95% CI 2,715 to 7,596 mg/m³) for 1,2,4-trimethylbenzene; 5,938 mg/m³ (95% CI of 5,194 to 6,512 mg/m³) for 1,3,5-trimethylbenzene; and 4,155 mg/m³ (3,400 to 4,811 mg/m³ for 1,2,3-trimethylbenzene. Of the two endpoints, rotarod disturbance seems to be the more sensitive effect. Korzack and Rydzynski (1996) note that the 1,2,3-trimethylbenzene isomer appeared to demonstrate more neurotoxic potential than the other two isomers. Also cited as a key study by US EPA (2007b), Korsak et al. (1995) conducted a similar study with only 1,2,4-trimethylbenzene in male rats. Rats were exposed for a duration of 4 hours to 250 to 2,000 ppm (individual dose levels not specified) within a controlled chamber. Altered rotorod activity indicative of neurotoxicity, altered pain response and decreased respiratory rate were observed in association with concentration-dependent responses. EC_{50} values for rotorod performance, pain sensitivity and respiratory depression were determined to be 4,693 mg/m³ (95% CI 3,891 to 5,493 mg/m³), 5,682(95% CI 2,715 to 7,596 mg/m³) and 2,840 mg/m³ (95%,CI 1,500 to 3,900 mg/m³) respectively. Although it is not clear how the US EPA calculated the value, an average of 900 ppm was calculated to be the average EC_{50} for neurological effects from the animal data, and served as the point of departure for the derivation of the AEGL. The Haber's Law approach was used by the US EPA (2007b) to convert the 4-hour concentration to a 1-hour concentration of 1,429 mg/m³. A total uncertainty factor of 10 was applied to account for interspecies differences (3), and intraspecies differences (3), to result in the 1-hour AEGL of 690 mg/m³ (690,000 µg/m³). This value was not selected for use in the assessment, as it is much higher than the adjusted STEL for naphthalene.

B6.1.2 Chronic Inhalation Exposure Limits

As the regulatory agencies typically searched for exposure limits did not provide any chronic values for the aliphatic and aromatic groups, the search was expanded to agencies such as the CCME, MA DEP, and TPHCWG that have derived chronic exposure limits for the groups as a whole.

Table B6.2 Chronic Inhalation Exposure Limits for Aromatic C_9-C_{16} Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
CCME	RfC	200	CCME 2008
MA DEP	RfC	50	MA DEP 2003
RIVM	TCA	200	RIVM 2001
TPHCWG	RfC	200	TPHCWG 1997

The MA DEP (2003) has developed an RfC of 50 µg/m³ based on a study by Clark et al. (1989). The chronic RfC is based on increased liver and kidney weights in male rats exposed to high flash aromatic naphtha (HFAN), which is primarily composed of 9-carbon aromatic compounds. Rats were administered 0, 450, 900 or 1,800 mg/m³ of a mixture of C_9 aromatics for 6 hours/day, 5 days/week for 12 months (Clark et al. 1989). A NOAEL of 900 mg/m³ was identified for liver and kidney effects and converted to continuous exposure (6/24 hours x 5/7 days) resulting in a NOAEL of 160 mg/m³. After applying an uncertainty factor of 1,000 to account for the interspecies variability (10), intraspecies variability (10) and use of a subchronic study (10), the MA DEP (2003) also applied an additional uncertainty factor of 3 to account for database deficiencies, which are detailed within MA DEP (2003). This partial uncertainty factor was applied to account for the lack of toxicity information on non-PAH compounds in the C_9-C_{16} aromatic fraction range (MA DEP 2003). The resulting value of **50 µg/m³** was selected for use in the chronic effects assessment of the aromatic C_9-C_{16} group.

The CCME (2008) has adopted its chronic RfC for C_9-C_{16} aromatics of 200 µg/m³ from the TPHCWG (1997). The TPHCWG limit also was based on the 1989 study by Clark et al. The TPHCWG (1997) applied an uncertainty factor of 1,000 to the duration-adjusted NOAEL of 160 mg/m³ to account for the interspecies variability (10), intraspecies variability (10) and use of a subchronic study (10). The CCME/TPHCWG RfC of 200 µg/m³ was not used in the chronic inhalation effects assessment, as the MA DEP (2003) RfC represents a more conservative limit.

The RIVM (2001) TCA has been adopted from the TPHCWG (1997), and also was rejected in favour of the more conservative value from MA DEP.

B6.2 Oral Exposure Limits

As the regulatory agencies typically searched for exposure limits did not provide any chronic values for the aliphatic and aromatic groups, the search was expanded to agencies such as the CCME, MA DEP, and TPHCWG that have derived chronic exposure limits for the groups as a whole.

Table B6.3 Chronic Oral Exposure Limits for Aromatic C_9-C_{16} Group

Regulatory Agency	*Type*	*Value (µg/kg bw/d)*	*Reference*
CCME	RfD	40	CCME 2008
MA DEP	RfD	30	MA DEP 2003
TPHCWG	RfD	40	TPHCWG 1997
RIVM	RfD	40	RIVM 2001

The TPHCWG (1997) recommends an oral RfD of 40 µg/kg bw/d for the C_9-C_{16} aromatic group based on the RfDs of eight individual compounds (cumene, acenaphthene, biphenyl, fluorene, anthracene, fluoranthene, naphthalene, pyrene) reported by the US EPA. At the time of the TPHCWG (1997) assessment, four of the eight individual compounds (cumene, naphthalene, fluorene and fluoranthene) had RfDs of 0.04 mg/kg bw/d, while the remaining compounds had RfDs ranging from 0.03 mg/kg bw/d to 0.3 mg/kg bw/d. The TPHCWG (1997) examined the RfDs for liver and kidney effects together with toxicity data for naphthalenes/methylnaphthalenes to determine the RfD of 0.04 mg/kg bw/d. Although the US EPA has revised the isopropylbenzene (0.1 mg/kg bw/d) and naphthalene (0.02 mg/kg bw/d, US EPA 1998) RfDs since the TPHCWG's assessment, it is important to note that the RfD of the group reflects the toxicity of the group as a whole and not a single compound within the group. The TPHCWG limit was adopted by both the CCME (2008) and RIVM (2001). This oral RfD of **40 µg/kg bw/d** was used in the chronic oral effects assessment of the C_9-C_{16} aromatic group.

The MA DEP (2003) selected the US EPA RfD for pyrene of 0.03 mg/kg bw/d to represent the entire range of compounds. The US EPA RfD for pyrene is based on kidney effects (renal tubular pathology, decreased kidney weights) observed in a subchronic mouse oral bioassay. As this value is based on only one substance, and the other values are based on mixtures, the MA DEP RfD was not used in the chronic effects assessment.

B6.3 References

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B7.0 AROMATIC C_{17}-C_{34} GROUP

B7.1 Inhalation Exposure Limits

B7.1.1 Acute Inhalation Exposure Limits

Table B7.1 Acute Inhalation Exposure Limits for Aromatic C_{17}-C_{34} Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

Acute exposure limits for the aromatic C_{17}-C_{34} group were not available from any of the regulatory agencies listed above, therefore the search was expanded to include , short-term occupational limit values (i.e., STEL and Ceiling) developed by the ACGIH (2011), as well as AEGLs-1 (2011b) developed by the US EPA. As acute limits were not available from these additional sources, agencies such as the CCME, MA DEP, and TPHCWG were considered. As acute limits could still not be found for the aromatic C_{17}-C_{34} group, it was not evaluated on an acute basis.

B7.1.2 Chronic Inhalation Exposure Limits

The regulatory agencies typically searched for exposure limits did not provide any values for the aromatic C_{17}-C_{34} group, nor did the occupational TLV-TWA values from the ACGIH (2011), intermediate inhalation MRLs from ATSDR (2011), or PPRTVs from the US EPA (2011c). Therefore limits provided by agencies such as the CCME, MA DEP, and TPHCWG were considered.

Table B7.2 Chronic Inhalation Exposure Limits for Aromatic C_{17}-C_{34} Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
CCME	–	–	CCME 2008
MA DEP	–	–	MA DEP 2003
RIVM	–	–	RIVM 2001
TPHCWG	–	–	TPHCWG 1997

– = Not available

However, inhalation toxicity data were not identified for in the C_{17}-C_{34} carbon range. As a result, the aromatic C_{17}-C_{34} group was not evaluated in the chronic inhalation assessment.

B7.2 Oral Exposure Limits

B7.2.1 Chronic Oral Exposure Limits

As the regulatory agencies typically searched for exposure limits did not provide any values for the aliphatic and aromatic groups, limits developed by the CCME, MA DEP, and TPHCWG were considered.

Table B7.3 Chronic Oral Exposure Limits for Aromatic C_{17}-C_{34} Group

Regulatory Agency	*Type*	*Value (µg/kg bw/d)*	*Reference*
CCME	RfD	30	CCME 2008
MA DEP	RfD	30	MA DEP 2003
RIVM	TDI	30	RIVM 2001
TPHCWG	RfD	30	TPHCWG 1997

The TPHCWG (1997) has derived an oral RfD of 30 µg/kg bw/d for the aromatic C_{17}-C_{34} fraction based on the US EPA's oral RfD for pyrene (US EPA 1993). The US EPA RfD for pyrene was derived from a NOAEL of 75 mg/kg bw/d reported in a chronic oral mouse study, in which male and female CD-1 mice (20/sex/group) were gavaged with 0, 75, 125, or 250 mg/kg/day pyrene in corn oil for 13 weeks (US EPA 1989). Kidney effects (changes in renal tubular pathology and reduced kidney weights) in the two highest dose groups determined the NOAEL of 75 mg/kg bw/d. An uncertainty factor of 1,000 was applied to the NOAEL to account for interspecies variability (10), intraspecies variability (10) and use of a subchronic study (10). A modifying factor of 3 was also applied due to the lack of adequate toxicity data. The resulting RfD of **30 µg/kg bw/d** was used in the chronic oral effects assessment of the C_{17}-C_{34} aromatic group.

The CCME (2008) and RIVM (2001) adopted the TPHCWG's value of 30 µg/kg bw/d as a chronic oral exposure limit for the aromatic C_{17}-C_{34} group.

The MA DEP (2003) also recommends an oral RfD of 30 µg/kg bw/d for the aromatic fraction of C_9-C_{32}. Their RfD is based on the US EPA (1993) RfD of 0.03 mg/kg bw/d for pyrene as well (described above).

B7.3 References

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B8.0 BENZENE

B8.1 Inhalation Exposure Limits

B8.1.1 Acute Inhalation Exposure Limits

Table B8.1 Acute Inhalation Exposure Limits for Benzene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO	30	AENV 2011
ATSDR	24-hour MRL	30	ATSDR 2011, 2007
OEHHA	6-hour REL	1,300	OEHHA 2008a, 2008b
OMOE	–	–	OMOE 2008
TCEQ	1-hour ReV	580	TCEQ 2011, 2007
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

− = Not available

The TCEQ (2011, 2007) derived an acute ReV of 580 µg/m³ for benzene. Review of the supporting documentation for this value indicates that TCEQ used the same key study (Rozen et al. 1984) as the ATSDR. As well, the TCEQ identified the same LOAEL value of 10.2 ppm. The difference between the ATSDR and TCEQ values originates from the adjustment of the LOAEL for continuous exposure and the uncertainty factors applied.

The TCEQ (2007) established that the $LOAEL_{ADJ}$ for benzene in the Rozen et al. (1984) study was 18.5 ppm, using Haber's law and a default approach for converting exposures of more than one hour to a 1-hour exposure level from TCEQ (2007). The $LOAEL_{ADJ}$ was converted to a $LOAEL_{HEC}$ using a regional gas dose ratio (RGDR). In the case that the animal blood to gas partition coefficient is greater than the human blood to gas partition coefficient, a default value of 1 is used for the RGDR. Thus, the $LOAEL_{HEC}$ was calculated to be 18.5 ppm. A cumulative uncertainty factor of 100 was applied by the TCEQ (2007) to the $LOAEL_{HEC}$ to account for interspecies differences (3), intraspecies variability (10), and the use of a LOAEL (3). A factor of 3 was applied for extrapolation of animal data to humans since dosimetric adjustments were conducted to address toxicokinetic differences. In addition, studies indicate that benzene is metabolized along similar pathways in animals and humans and data suggests that mice are relatively sensitive in regards to hematotoxic effects of benzene (TCEQ 2007). A factor of 3 was applied for extrapolation from a LOAEL to a NOAEL on the basis that the LOAEL used to derive the acute ReV is lower than other LOAELs observed in animal and human studies, and the LOAEL is similar to NOAELs observed in mouse studies (TCEQ 2007). In addition, benchmark dose modelling of estimated lymphocyte count depression data produces a BMCL of 4 ppm, which supports a factor of 3 as being sufficiently conservative (TCEQ 2007). The TCEQ (2007) also states that lymphocyte count depression is a sensitive sentinel effect that is not a serious nature, and the reported decreased lymphocyte count at 10.2 ppm appears to be within the normal range. The result is an acute ReV of **580 µg/m³,** which was used as a 1-hour limit in the acute effects assessment of benzene.

The ATSDR (2011, 2007) presents an acute MRL of 0.009 ppm (30 µg/m³) based on immunological effects. Male C57BL/6J mice (7 or 8 per concentration) were exposed to 0, 10.2, 31, 100, or 301 ppm (0, 32.6, 99, 320, or 960 mg/m³) benzene in whole-body dynamic inhalation

chambers for 6 hours/day on six consecutive days (ATSDR 2007). The control group was exposed to filtered, conditioned air only. Significant depression of femoral lipopolysaccharide induced B-colony-forming ability was observed at the 10.2 ppm exposure level in the absence of a significant depression of total number of B cells. Peripheral lymphocyte counts were depressed at all exposure levels. The ATSDR (2007) adjusted a LOAEL of 10.2 ppm (32.6 mg/m³) from intermittent to continuous exposure (6/24 hours) to a concentration of 2.55 ppm (8.16 mg/m³). The duration-adjusted LOAEL ($LOAEL_{ADJ}$) was converted to a HEC ($LOAEL_{HEC}$) for a category 3 gas causing respiratory effects. The average ratio of the animal blood: air partition coefficient would be greater than 1; thus, a default value of 1 was used in calculating the HEC (ATSDR 2007). As a result, a $LOAEL_{HEC}$ of 2.55 ppm (8.16 mg/m³) was identified. The ATSDR (2007) applied a cumulative uncertainty factor of 300 to the $LOAEL_{HEC}$ to account for interspecies variability (3), intraspecies variability (10) and use of a LOAEL (10). A factor of 3 was applied for the extrapolation of laboratory animal data to humans since the calculation of a HEC addressed the pharmacokinetic aspects of the interspecies uncertainty factor. This value was not selected, as the time-adjustment process applied by TCEQ (2007) was more defensible given the dose-response and duration-related effects observed for benzene.

Alberta Environment (AENV 2011) also provides a 1-hour AAQO of 30 µg/m³ for benzene; however, the AAQO was adopted from the TCEQ and the specific basis was not provided. As a result, it was not used in the acute effects assessment.

The OEHHA (2008a,b) presents a 6-hour acute REL of 1,300 µg/m³, based on reproductive effects. The key study (Coate et al. 1984) involved the exposure of pregnant female rats (40 per group) to 0, 1, 10, 40 or 100 ppm (0, 3.2, 32, 130 or 324 mg/m³) for 6 hours/day on days 6 to 15 of gestation. Significantly decreased mean fetal weights were observed at the highest (100 ppm) exposure level. No fetotoxic, teratogenic or maternal toxicity was observed in the 40 ppm group. The study NOAEL was identified as 40 ppm for reduced fetal weight. An uncertainty factor of 100 was applied to account for interspecies differences (10) and intraspecies variability (10). The OEHHA (2008b) notes that the NOAEL was not adjusted to a 1-hour exposure due to the uncertainty associated with extrapolating data from repeated exposures to a 1-hour concentration. As a result of this uncertainty, the 6-hour REL of 1,300 µg/m³ may be considered equivalent to a 1-hour REL. This value was not selected, as reproductive effects do not appear to be the most sensitive endpoint in association with acute benzene exposure.

B8.1.2 Chronic Inhalation Exposure Limits

Table B8.2 Chronic Inhalation Exposure Limits for Benzene

Regulatory Agency	*Type (a)*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	9.8	ATSDR 2011, 2007
HEALTH CANADA	RsC	3	Health Canada 2009
OEHHA	RsC REL	0.3 60	OEHHA 2009 OEHHA 2008a, 2000
RIVM	CR	2	RIVM 2001
TCEQ	ReV Linear ESL	280 4.5	TCEQ 2011, 2007

Regulatory Agency	*Type (a)*	*Value (µg/m³)*	*Reference*
US EPA	RfC RsC	30 1.3 to 4.5	US EPA 2011, 2003 US EPA 2011, 2000
WHO	RsC	1.7	WHO 2000

(a) The IARC (1998) has determined that there is *limited evidence* that benzene is carcinogenic in experimental animals and *sufficient evidence* that benzene is carcinogenic to man.

− = Not available

The US EPA (2011, 2000) presents a range of potential carcinogenic risks from inhalation of benzene. The key data sets employed in the US EPA cancer assessment were those by Rinsky et al. (1987, 1981), which were also critically analyzed by Paustenbach et al. (1993), Crump and Allen (1984), Crump (1994, 1992), and US EPA (1998). The Rinsky et al. (1987, 1981) studies examined the incidence of leukemia in exposed white male workers in the rubber hydrochloride department of a pliofilm plant. The more comprehensive follow up study (Rinsky et al. 1987) involved the evaluation of 1,165 workers who were exposed for at least 1 day between 1965 and 1981. Individual assessments of cumulative exposure were calculated by Rinsky et al. for each worker based on air sampling data. Inhalation unit risks of 2.2×10^{-6} to 7.8×10^{-6} per µg/m³ were extrapolated based on a low-dose linear model using maximum likelihood estimates for leukemia in humans (US EPA 2000). The inhalation unit risks equate to an RsC of 1.3 to 4.5 µg/m³ associated with a risk level of one in 100,000 (US EPA 2000). The RsC of **1.3 µg/m³** was selected as the chronic inhalation limit for benzene as it is the more conservative of the values presented within this range.

In addition, the US EPA (2011, 2003) has derived a non-carcinogenic RfC of 30 µg/m³ based on a cross-sectional occupational study where decreased lymphocyte counts were observed in exposed workers. Although a detailed rationale document is provided (US EPA 2003), this limit was not used in the assessment due to the existence of cancer-based limits that are more conservative.

The ATSDR (2011, 2007) provides a chronic inhalation MRL of 0.003 ppm (9.8 µg/m³) based on a study by Lan et al. 2004. The cross-sectional human study by Lan et al. (2004) looked at 250 workers at two shoe manufacturing factories in China. The control group consisted of 140 workers and 250 exposed workers categorized into four groups consisting of 109 subjects with exposures <1 ppm, 110 subjects between 1 to <10 ppm, and 31 subjects with exposures of ≥ 10 ppm. Benzene exposure was monitored by individual vapour monitors, and analysis methods used to measure benzene in subjects were phlebotomy and urine sampling. Lan et al. (2004) measured several blood factors including white blood cells, granulocytes, monocytes, lymphocytes, CD4+- T cells, CD4+/CD8+ ratio, B cells, and platelets. The ATSDR (2007) selected the decrease in B cell count as the critical end point used to derive the MRL as it represented the highest magnitude of effect. Benchmark dose modelling was completed, and a $BMDL_{0.25sd}$ of 0.2 ppm (328 µg/m^3) was calculated. As the MRL derived by ATSDR is a non-cancer endpoint, and the value is not as conservative as the RsC derived by US EPA, the ATSDR value was not used in the assessment.

The OEHHA (2009) derived a unit risk estimate of 2.9E-05 $(\mu g/m^3)^{-1}$ (equivalent to an RsC of 0.34 µg/m³) based on epidemiological studies of Chinese workers. Although it is not very clear, the basis of the OEHHA value seems to be the studies by Yin et al. (1996, 1994). The Chinese cohort studies that served as the basis of the OEHHA derivation were some of the studies

determined by the US EPA to have methodological issues (poor exposure characterization, co-exposure to other agents, data quality) to the point where the study was not adequate for quantitative assessment. The US EPA RsC value, in contrast, is based on a study that has been critically analyzed by several other studies. As such, the OEHHA value was not used in the chronic inhalation assessment of benzene.

An RsC of 3 µg/m³ is reported by Health Canada (2009) based on an inhalation unit risk of 0.0033 per mg/m³. This value was derived from data in the Rinsky et al. (1987) study discussed above in the US EPA summary, and was calculated through the identification of a dose associated with a 5% increase in mortality from acute myelogenous leukemia. However, this RsC was not selected as the US EPA value is slightly more conservative.

The WHO (2000) provides an RsC of 1.7 µg/m³, which is associated with an increased cancer risk of one in 100,000. Using multiplicative risk estimates and a cumulative exposure model, a unit risk for lifetime exposure of 1.4 to 1.5 × 10^{-5} per ppb was derived with the Paustenbach exposure matrix and 2.4 × 10^{-5} per ppb with the Crump and Allen exposure matrix (WHO 2000). These values equate to unit risks that range from 4.4 × 10^{-6} per µg/m³ to 7.5 × 10^{-6} per µg/m³. From these datasets, the WHO (2000) selected a representative unit risk of 6 × 10^{-6} per µg/m³. The WHO (2000) value was not chosen for the chronic inhalation assessment as the US EPA RsC value was slightly more conservative.

The TCEQ (2011, 2007) derived a chronic ReV of 280 µg/m³ based on a non-carcinogenic endpoint (decreased lymphocyte counts in exposed workers). Although a detailed rationale document is provided, this limit was not used in the assessment due to the availability of more conservative cancer-based limits.

The TCEQ (2011, 2007) also provides a linear Effects Screening Level (ESL) value, using cancer potency estimates based on Crump and Allen (1984) to calculate the URF and ESL. Crump and Allen investigated the risk of leukemia from occupational exposure to benzene in Plioform workers, and determined that acute myelogenous and monocytic leukemia (AMML) was the only cancer response clearly related to benzene exposure. A linear multiplicative risk model fit the Plioform cohort data best, and cancer potency estimates for both cumulative and weighted cumulative exposure metrics were used. The 95th % upper confidence limits (UCLs) on the estimates were calculated, and then the occupational concentrations were converted to environmental concentrations. The best fitting linear model for AMML was based on cumulative exposure as the exposure metric, and the air concentration corresponding to an excess cancer risk of 1 in 100,000 was 2.3. ppb (95% UCL = 1.4 ppb, or 4.5 µg/m³). This limit was not used because a more conservative cancer-based limit is available.

The OEHHA (2008a, 2000) also derived a non-cancer based value of 60 µg/m³. Although a detailed rationale document is provided, this limit was not used in the assessment due to the existence of cancer-based limits that are more conservative.

The RIVM (2001) provides a CR_{inhal} of 20 µg/m³ for one in 10,000 excess lifetime cancer risk for inhalation exposure. The equivalent CR_{inhal} for one in 100,000 excess lifetime cancer risk is 2 µg/m³. The RIVM has chosen the lower end limit adopted from the EU Working Group (EU 1999) cancer risk estimate range of 20 µg/m³ to 36 µg/m³. As the RIVM (2001) value is not as conservative as the US EPA RsC value, this limit was not chosen in the assessment.

B8.2 Oral Exposure Limits

Benzene was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria to be defined as a non-volatile chemical. Thus, a chronic oral exposure limit was not required for benzene.

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B9.0 BENZO(A)PYRENE

B9.1 Inhalation Exposure Limits

B9.1.1 Acute Inhalation Exposure Limits

Table B9.1 Acute Inhalation Exposure Limits for Benzo(a)pyrene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	24-hour Guideline	0.0011	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

Benzo(a)pyrene is the only individual carcinogenic polycyclic aromatic hydrocarbon (PAH) with an established acute exposure limit. The OMOE (2008) has developed a 24-hour guideline of 0.0011 µg/m³ based on the carcinogenic potential for benzo(a)pyrene. The limit was derived from an annual exposure limit of 0.00022 µg/m³ for protection against carcinogenic effects using a simple extrapolation factor generally considered to be overly conservative. However, this limit was not used in the acute effects assessment for benzo(a)pyrene or the benzo(a)pyrene group because it did not account for the influence of duration of exposure on the carcinogenic action of a chemical.

As acute inhalation exposure limits for benzo(a)pyrene are not provided by any of the other agencies listed above, the search for limits was extended to include intermediate inhalation MRLs from ATSDR, STEL and Ceiling values from the ACGIH (2011) and AEGL-1 values from

the US EPA (2011b). No values for benzo(a)pyrene were identified, and therefore neither benzo(a)pyrene nor the benzo(a)pyrene group was assessed on an acute basis.

B9.1.2 Chronic Inhalation Exposure Limits

Benzo(a)pyrene and any other carcinogenic PAHs identified as chemicals of potential concern were evaluated in the chronic inhalation assessment using two different approaches.

In the first approach (Approach 1), a mixture of carcinogenic PAHs was evaluated based on its benzo(a)pyrene content. The use of benzo(a)pyrene as an indicator of the potency of the mixture is based on the World Health Organization's (WHO) review of air quality guidelines for PAHs (WHO 2000). Benzo(a)pyrene was chosen as the indicator PAH as its toxicity is best characterized out of all the carcinogenic PAH compounds.

For the second approach (Approach 2), the mixture of carcinogenic PAHs was evaluated by summing each individual PAH's toxic equivalency to benzo(a)pyrene (i.e., the Toxic Equivalency Quotient (TEQ) approach). The toxic equivalency of each PAH was determined using Potency Equivalency Factors (PEFs) that were assigned by Equilibrium and URS (2006), and later adopted by Health Canada (2009a). PAHs that did not have evidence of being directly carcinogenic or genotoxic were not assigned PEF values (e.g., anthracene).[2]

The Toxic Equivalency Factors (TEFs) used in the current assessment of PAHs via the TEQ approach are shown in the following table.

Table B9.2 Relative Potency of Individual PAHs Compared with Benzo(a)pyrene

Compound	*Toxicity Equivalency Factor* [(a)]
7,12-dimethylbenz(a)anthracene	10
Benz(a)anthracene	0.1
Benzo(a)pyrene	1
Benzo(b)fluoranthene	0.1
Benzo(g,h,i)perylene	0.01
Benzo(k)fluoranthene	0.1
Chrysene	0.01
Cyclopenta[c,d]pyrene	0.1
Dibenz(a,h)anthracene	1
Fluoranthene	0.001
Indeno(1,2,3-cd)pyrene	0.1
Phenanthrene	0.001

(a) Health Canada 2009a

The TEQ approach is consistent with the relative potency approach described by the US EPA (2002), in which the carcinogenic potencies of PAHs are scaled to an index compound (benzo(a)pyrene) using TEFs, (which are analogous to PEFs) and then added together to

[2] Non-carcinogenic PAHs were evaluated on their own or as part of the appropriate aromatic hydrocarbon group.

calculate the total cancer risk for the mixture. This approach permits the evaluation of the mixture when limited data are available for most of the mixture components.

The Tier 1 agencies were then searched to identify appropriate limits for use in each approach.

Table B9-3 Chronic Inhalation Exposure Limits for Benzo(a)pyrene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	AAAQO	0.0003	AENV 2011
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	RsC	0.32	Health Canada 2009b
OEHHA	RsC –	0.009 –	OEHHA 2009 OEHHA 2008
RIVM	–	–	RIVM 2001
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	RsC	0.00012	WHO 2000

– = Not available

The WHO (2000) recommends an inhalation unit risk of 0.09 per µg/m³ based on epidemiological data from studies in coke-oven workers. The WHO (2000) identified an upper-bound individual lifetime unit risk estimate associated with continuous exposure to 1 µg/m³ of benzene-soluble compounds of coke-oven emissions in ambient air of 0.00062 $(\mu g/m^3)^{-1}$ based on a linearized multistage model. Benzo(a)pyrene was selected as an indicator of general PAH mixtures from emissions of coke ovens and similar combustion processes in urban air. In the benzene-soluble fraction of coke oven emissions, 0.71% is reported to be benzo(a)pyrene. On this basis, the lifetime risk of lung cancer of 0.09 per µg/m³ was calculated (WHO 2000), which equates to an RsC of 0.00012 µg/m³ that is associated with an acceptable incremental lifetime cancer risk of one in 100,000. The WHO RsC of **0.00012 µg/m³** was selected for use in the first approach of the chronic inhalation assessment of benzo(a)pyrene (Approach 1).

Health Canada (2009b) derived an inhalation unit risk of 3.10E-02 per mg/m³, which equates to an RsC of 0.32 µg/m³. This RsC is associated with an acceptable incremental lifetime cancer risk of development of respiratory tumours of one in 100,000. The RsC was developed based on exposure to benzo(a)pyrene via multi-stage modelling of respiratory tract tumours in Syrian golden hamsters (Thyssen et al. 1981; Government of Canada 1994). In the key study, groups of 24 male Syrian golden hamsters were exposed by inhalation (nose only) to 0, 2.2, 9.5, or 45.6 mg/m³ benzo(a)pyrene for 4.5 hours/day, 7 days/week for the first 10 weeks, and for 3 hours/day for the rest of the exposure period (up to 96 weeks). A decrease in body weight gain in exposed animals was observed during the first 10 weeks of the study; however, with the exception of the high exposure group, the body weights of all surviving exposed animals were similar to those of the controls from the 10th to the 60th week. Mean survival decreased only in the highest exposure group.

The incidences of unspecified tumours of the respiratory tract (nasal cavity, larynx, and trachea) were:

- 0/27 for controls;

- 0/27 for the low-dose group;
- 9/26 (35%) for the mid-dose group; and
- 13/25 (52%) for the high-dose group (Thyssen et al. 1981).

Exposure related neoplasms (unspecified) were present in the pharynx (0, 0, 23, and 56% for control, low-, mid-, and high-dose, respectively), esophagus (0, 0, 0, and 8% for control, low-, mid-, and high-dose, respectively), and forestomach (0, 0, 4, and 4% for control, low-, mid-, and high-dose, respectively). Lung tumours were not observed (Thyssen et al. 1981). The Health Canada RsC of **0.32 µg/m³** was selected for the chronic inhalation assessment of benzo(a)pyrene using the TEQ approach (Approach 2).

The OEHHA (2009) presents an inhalation unit risk estimate of 1.1E-03 per µg/m³ (equivalent to an RsC of 0.009 µg/m³). This value was derived from the Thyssen et al. 1981 study (discussed above as the basis of the Health Canada value). Linearized multistage modelling was used to evaluate the respiratory tumour incidence data. The OEHHA applied a default body weight scaling method o account for differences in body surface area and body weight. According to the US EPA (2005) Cancer Risk Assessment guidance, for inhalation exposures, other approaches such as tract specific scaling are specified. The body weight scaling approach used by the OEHHA is consistent with the US EPA (2005) guidance for oral exposures, but not inhalation. In addition, the Government of Canada (1994) analysis of the tumourigenicity data is more substantial and technical than what is provided for the OEHHA (2009) value. On the basis that the Health Canada (2009b) value represents the most defensible RsC for use in the chronic inhalation assessment based on the quality of the supporting documentation and methodologies used, the OEHHA (2009) value was not selected.

No supporting document for the AENV 2011 value of 0.0003 µg/m³ was available. As a result, the AENV value was not used in the assessment.

B9.2 Oral Exposure Limits

B9.2.1 Chronic Oral Exposure Limits

Table B9-4 Chronic Oral Exposure Limits for Benzo(a)pyrene

Regulatory Agency	*Type*	*Value (µg/kg bw/d)*	*Reference*
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	RsD –	0.0043 –	Health Canada 2009b Health Canada 2011
OEHHA	RsC –	0.001 –	OEHHA 2009 OEHHA 2008
RIVM	CR	0.05	RIVM 2001
US EPA	RsD	0.0014	US EPA 2011a, 1994
WHO	–	–	WHO 2011, 2003

– = Not available

The US EPA (2011a, 1994) provides an oral slope factor of 7.3 per mg/kg bw/d based on the geometric mean of four slope factors obtained by different modelling procedures and multiple datasets from two different studies, including the Neal and Rigdon (1967) study that was used in the Health Canada (1988) assessment. The US EPA (1994) considered each of these datasets

to be acceptable for the derivation of an oral slope factor for benzo(a)pyrene, but less-than-optimal. As a result, the use of a geometric mean of the four slope factors was preferred because it made use of more of the available data. The four slope factors were calculated as follows:

1) The Neal and Rigdon (1967) data was fit to a two-stage dose response model that included a term to permit the modelling of benzo(a)pyrene as its own promoter (modification of Moolgavkar-Venson-Knudson, generalized forms of two-stage model). In this model, the transition rates and the growth rate of preneoplastic cells were both considered to be exposure-dependent. In addition to the Neal and Rigdon (1967) control group, historical control stomach tumour data from a related, but not identical, mouse strain (SWR/J Swill) was used in the modelling (Rabstein et al. 1973). In the historical control data, the forestomach tumour incidence rate was 2/268 and 1/402 for males and females, respectively. The lifetime unit risk for humans was calculated based on the following standard assumptions: mouse food consumption was 13% of its body weight per day, human body weight was assumed to be 70 kg, and the assumed body weight of the mouse 0.034 kg (US EPA 1994). The standard assumption of surface area equivalence between mice and humans was the cube root of 70 kg/0.034 kg. A conditional upper-bound estimate was calculated to be 5.9 per mg/kg bw/d (US EPA 1994).
2) The same dataset as above was used to generate an upper-bound estimate extrapolated linearly from the 10% response point to the background of an empirically fitted dose-response curve (modification of Moolgavkar-Venson-Knudson, generalized forms of two-stage model). An upper-bound risk estimate was calculated to be 9.0 per mg/kg bw/d (US EPA 1994).
3) In order to reflect the partial lifetime exposure pattern over different parts of the animals' lifetimes, a generalized Weibull-type dose-response model was selected to assess the Neal and Rigdon (1967) data alone (i.e., excluding the two additional control groups from Rabstein et al. 1973). An upper-bound was calculated to be 4.5 per mg/kg bw/d (US EPA 1994).
4) A linearized multistage procedure was used to calculate an upper bound estimate for humans from the Brune et al. (1981) rat dataset. Sprague-Dawley (rats/sex/group) were fed 0.15 mg/kg benzo(a)pyrene (reported to be 'highly pure') in the diet of either every 9th day or 5 days/week. These treatments resulted in annual average doses of 6 or 39 mg/kg, respectively. The control group contained 32 rats per sex. Treatment continued until the rats were moribund or dead; survival was similar in all groups. The combined incidence of tumours of the forestomach, esophagus and larynx was 3/64, 3/64 and 10/64 in the control group, the group fed benzo(a)pyrene every 9th day, and the group fed benzo(a)pyrene five times per week, respectively. A trend analysis showed a statistically significant tendency for the proportion of animals with tumours of the forestomach, esophagus or larynx to increase steadily with dose. An oral slope factor of 11.7 per mg/kg bw/d was calculated (US EPA 1994).

Because the US EPA considered (i) different modelling procedures, (ii) multiple datasets from two different studies, and (iii) both sexes of more than one strain of mice and species of out bred rodents, the US EPA RsD of **0.0014 µg/kg bw/d** was selected as the chronic oral limit for assessing the mixture of carcinogenic PAHs using the TEQ approach (Approach 2).

Health Canada (2009b) presents an oral slope factor of 2.3 (mg/kg bw/d)$^{-1}$ (equivalent to an RsD of 0.004 µg/kg bw/d), based on the Canadian guidelines for drinking water (Health Canada 1988). The Canadian drinking water quality guideline for benzo(a)pyrene took into consideration the increased incidence of stomach tumours (squamous cell papillomas and some carcinomas) (Health Canada, 1988; Neal and Rigdon, 1967). In the key study, male and female CFW-Swiss mice were fed concentrations of 0 ppm, 1 ppm, 10 ppm, 20 ppm, 40 ppm, 45 ppm, 50 ppm, 100 ppm or 250 ppm benzo(a)pyrene in the diet (purity was not reported). The control group contained 289 mice (number of mice/sex was not specified). No forestomach tumours were reported in the 0 ppm, 1 ppm, or 10 ppm dose groups. The incidence of forestomach tumours in the 20 ppm, 40 ppm, 45 ppm, 50 ppm, 100 ppm or 250 ppm dose groups were 1/23, 0/37, 1/40, 4/40, 23/40, 19/23 and 66/73, respectively. Incorporating a surface area correction and using the robust linear extrapolation model, the unit lifetime risk associated with the ingestion of 1 µg/L benzo(a)pyrene in drinking water was estimated as 5 × 10-5. Using an adult body weight of 70.7 kg and an adult water ingestion rate of 1.5 L/d (Health Canada 2009a), an oral slope factor of 2.3 per mg/kg bw/d was calculated. The US EPA value was used over this value as it took more studies into consideration than just the Neal and Rigdon data set.

The OEHHA (2009) has derived an oral slope factor of 11.5 (mg/kg bw/d)$^{-1}$ (equivalent to an RsD of 0.001 µg/kg bw/d) based on the Neal and Rigdon (1967) data. However the approaches used are not clear in the supporting document. As a result, this value was not used in the assessment.

The RIVM (2001) presents an oral RsD of 0.5 µg/kg bw/d associated with a one in 10,000 risk level (or 0.05 µg/kg bw/d for a one in 100,000 risk level). This value was derived from an unpublished study, where rats were administered 0, 3, 10 or 30 mg/kg/d of benzo(a)pyrene via oral gavage, 5 days/week for a duration of 2 years. Tumours in the forestomach, liver, kidney, skin, intestine and auditory canal and sarcomas of the esophagus, skin, and mammary glands were observed. However, the incidence relative to controls is not clear. Given that the study cited by the RIVM is in draft and thus not peer reviewed, the RIVM value was not used in the assessment.

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B10.0 1,3-BUTADIENE

B10.1 Inhalation Exposure Limits

B10.1.1 Acute Inhalation Exposure Limits

Table B10.1 Acute Inhalation Exposure Limits for 1,3-Butadiene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	24-hour MRL	220	ATSDR 2011, 2009
OEHHA	–	–	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	1-hour ReV	3,700	TCEQ 2011, 2008
US EPA	24-hour RfC	15	US EPA 2011, 2002
WHO	–	–	WHO 2000

– = Not available

The US EPA (2011, 2002) presents a 24-hour acute RfC of 15 µg/m³ based on decreased fetal body weights in males. Pregnant CD-1 mice were administered 0, 40, 200 and 1,000 ppm 1,3-butadiene via inhalation for 6 hours/day on gestational days (GDs) 6 to 15. Dams were weighed prior to mating and on GDs 0, 6, 11, 16 and 18. They were sacrificed on GD 18. The study examined a number of reproductive and developmental outcomes. The reproductive outcomes included the number of implants, resorptions, and live/dead fetuses, while fetal weights and observation of external, visceral, and/or skeletal abnormalities observed as the developmental outcomes (Hackett et al. 1987). Hackett et al. (1987) reported a statistically significant reduction in male fetal body weights at all exposure concentrations relative to the controls. On GD 20, male fetal body weights were 5, 18 and 23% lower than controls in the 40, 200 and 1,000 ppm groups, respectively. As such, a LOAEL of 40 ppm was identified for fetal effects (decreased body weight in males).

The US EPA (2002) selected this endpoint for further investigation, and conducted several iterations of benchmark dose modelling (generating Effect Concentrations) and various approaches for evaluating and transforming data. Of the approaches used by the US EPA (2002), the most conservative estimate of a POD was the LEC_{05} of 2.9 ppm. An uncertainty factor of 400 was applied to account for interspecies differences (3), intraspecies differences (10), the use of an effect-level (4, similar to a LOAEL-to-NOAEL extrapolation factor), and database limitations (3). The result is an acute RfC of 7 ppb or **15 µg/m³.** This value was selected for use as a 24-hour limit in the acute effects assessment.

The TCEQ (2011, 2008) has derived an acute ReV of 3,700 µg/m³ (1,700 ppb) also based on Hackett et al. (1987). In addition, the TCEQ (2008) presents a re-analysis of the Hackett et al. (1987) data based on indications that the apparent significant decrease in male fetal body weight in the 40 ppm groups was the erroneous result of the statistical analysis used (Christian 1996; Green 2003). The Green (2003) re-analysis using analysis of covariance (ANCOVA) on the average pup weight adjusted for covariates in combination with the Dunnett-Hsu test to compare the mean weight for each of the exposed groups to the mean weight for the control group indicates that the lowest exposure concentration of 40 ppm (88 mg/m³) should be considered the study NOAEL for decreased male fetal body weights (TCEQ 2008), and not an effect level as reported by Hackett et al. (1987). Green's conclusions were corroborated by Sielken et al. following review of the Hackett et al. (1987) study and the Green (2003) re-analysis (TCEQ 2008). The analysis by Green (2003) was not available at the time of the US EPA analysis and derivation of the acute RfC. The US EPA appears to have selected fetal body weights as the toxicological endpoint of interest (without completing benchmark dose modelling etc. for any other endpoints) based on the original statistics presented in Hackett et al. (1987).

Benchmark dose modelling was completed by the TCEQ based on Hackett et al. (1987) data for reduction in extragestational weight gain and fetal weight gain (TCEQ 2008). BMCL and Critical Effect Size (CES – similar to the BMC in concept, but is intended for continuous data) values were calculated for both decreased male fetal body weights and maternal extragestational weight gain. The $BMCL_{1\ SD}$ for the most sensitive endpoint, reduction in extragestational weight gain, was calculated as 51.3 ppm (in comparison to the $BMCL_{05}$ of 55 ppm for decreased fetal body weights). Given that the $BMCL_{1\ SD}$ was derived from a developmental endpoint (the TCEQ notes that the maternal effects observed are correlated with fetal effects in the literature, thus are considered to be developmental in nature), the exposure duration was not adjusted to 1 hour due to potential sensitive windows of exposure (TCEQ 2008). The TCEQ (2008) applied dosimetry adjustments from animal-to-human exposure to the POD, calculating a $BMCL_{1SD}$ of

51.3 ppm for extragestational weight gain. The TCEQ (2008) applied an uncertainty factor of 30 to the $(BMCL_{1\ SD})_{HEC}$ to account for interspecies variability (3) and intraspecies variability (10). This results in a 6-hour acute ReV value of 3,700 µg/m³ (1.71 ppm). Although it is recognized that the TCEQ (2008) assessment is more recent and takes additional information into account, the acute TCEQ ReV was not selected for use in the acute effects assessment. The approaches used by the two agencies (US EPA and TCEQ) are different enough that there is uncertainty as to which agency-derived value is the most protective of human health. Given this uncertainty, the more conservative US EPA value was selected for use in the acute effects assessment.

A draft acute MRL of 0.1 ppm (220 µg/m³) has been developed by the ATSDR (2011, 2009) that is based on the Hackett et al. (1987) study as well. The ATSDR assumed the LOAEL of 40 ppm (88 mg/m³) for 5% decrease in fetal weight gain relative to controls, as reported by Hackett et al. (1987). A $LOAEL_{HEC}$ was calculated using a default RGDR of 1, given that the $(H_{b/g})_A/(H_{b/g})_H$ is greater than 1. The $LOAEL_{HEC}$ was adjusted for intermittent exposure (6/24 hours) resulting a duration-adjusted LOAEL of 10 ppm (22 mg/m³). The ATSDR applied an uncertainty factor of 90 to the $LOAEL_{ADJ}$ to account for use of a minimal LOAEL (3), extrapolation from animals to humans using a dosimetric conversion (3), and human variability (10). The result is an acute MRL of 220 µg/m³ for 1,3-butadiene. The ATSDR also calculated a BMD and associated BMDL for reduction in male fetal body weight. The ATSDR concluded, however, that the resulting BMD and BMDL were higher than the LOAEL of 40 ppm and thus the LOAEL was the more conservative POD for deriving the acute MRL. Given that the US EPA acute RfC is based on the use of different modelling techniques, statistical interpretations and analysis, and data transformations, the acute MRL was not used in the acute effects assessment.

B10.1.2 Chronic Inhalation Exposure Limits

Table B10.2 Chronic Inhalation Exposure Limits for 1,3-Butadiene

Regulatory Agency	*Type[(a)]*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011, 2009
HEALTH CANADA	RsC	1.7	Health Canada 2009, 2004
OEHHA	RsC REL	0.06 20	OEHHA 2009 OEHHA 2008, 2000
RIVM	CR	0.3	RIVM 2009
TCEQ	ReV ESL - cancer	33 20	TCEQ 2011, 2008
US EPA	RfC RsC	2 0.3	US EPA 2011, 2002
WHO	–	–	WHO 2000

(a) The IARC (1999) has determined that 1,3-butadiene is probably carcinogenic to humans (Group 2A) based on limited evidence in humans and sufficient evidence in experimental animals

− = Not available

Both Health Canada and the US EPA classify 1,3-butadiene as a human carcinogen via inhalation based on an observed increase in leukemia in epidemiological studies and investigations in experimental animals (Government of Canada 2000; US EPA 2002).

The US EPA (2011, 2002) bases its inhalation unit risk of 3×10^{-5} per µg/m³ on the Health Canada (1998) analysis of the leukemia incidence rates in styrene-butadiene rubber workers (n = 15,000) from eight different facilities. The key study evaluated by Health Canada (1998) was a cohort study by Delzell et al. (1996). 1,3-butadiene exposures to individual workers were estimated to derive cumulative exposure estimates for each worker. The follow-up period with workers was about 49 years. Both Delzell et al. (1996) and Health Canada (1998) conducted dose-response modeling for leukemia incidence, and the Health Canada (1998) modeling served as the basis for the US EPA assessment. Adjustments to the data were made for benzene and styrene exposure, to focus the statistics on 1,3-butadiene. The occupational exposures from Delzell et al. (1996) were adjusted for continuous exposure (240/365 days × 10/20 m³/day), and potential risks up to age 85 were predicted for the workers. Age-specific mortality rates for all races and genders were used to distinguish leukemia deaths from all-cause mortality rates. The US EPA also applied a linear rate model and leukemia incidence rate date from 1994 to 1998 to estimate leukemia rates. From the incidence rate data, a 95% lower confidence limit of the exposure concentration associated with a 1% increased risk (LEC_{01}) was calculated to be 0.25 ppm. The US EPA then conducted low-dose linear extrapolation (assuming that zero exposure is associated with zero risk), resulting in a predicted unit risk estimate of 0.04 per ppm 1,3-butadiene. An adjustment factor of 2 was applied by the US EPA to account for the potential for tumours to occur at other sites in humans, and also to account for potential differences in sex-sensitivity to 1,3-butadiene carcinogenicity. The resulting value equates to an RsC of **0.3 µg/m³**. This value was selected for use in the chronic effects assessment, as it represents the most relevant value to human health out of those evaluated.

An RsC of 1.7 µg/m³ was developed by Health Canada (2004) from a tumorigenic concentration (TC_{01}) of 1.7 mg/m³ based on the incidence of leukemia in 15,649 workers in the same epidemiological study (Delzell et al. 1996) considered by the US EPA in their derivation of the unit risk estimate. As the Health Canada value uses the same data set as the US EPA, but is less conservative than the US EPA RsC, the Health Canada RsC was not selected for use in the chronic effects assessment.

RIVM (2009) adopted the US EPA (2002) RsC value described above as the human chronic inhalation value.

The OEHHA (2009) derived a unit risk estimate of 0.00017 per µg/m³ for 1,3-butadiene based on the incidence of lung alveolar and bronchoalveolar tumours in female mice. This unit risk estimate equates to an RsC of 0.06 µg/m³. Given that the US EPA and Health Canada consider there to be sufficient human data available for the development of a human-based RsC, the OEHHA animal-based RsC was not used in the chronic effects assessment. The US EPA (2011, 2002) has also derived an RfC of 2 µg/m³ based on ovarian atrophy in a 2-year mouse inhalation study. This value was derived from a study in female B6C3F1 mice exposed to 0, 6.25, 20, 62.5, or 200 ppm 1,3-butadiene for up to 103 weeks. This value, along with the OEHHA REL and TCEQ ReV (discussed below), was not used in the chronic effects assessment, as these limits are based on a non-carcinogenic endpoint (ovarian atrophy in female mice) when the weight of evidence suggests that the carcinogenic effects associated with 1,3-butadiene exposure are of more concern. This is exemplified by the more conservative US EPA RsC. The NTP (1984) and Melnick et al. (1990) data sets serve as the basis of the OEHHA (2000) non-carcinogenic assessment. In NTP (1984), male and female mice were exposed to 0, 652 or 1,250 ppm of 1,3-butadiene for 6 hours/day, 5 days/week for a duration of

60 weeks (males) or 61 weeks (females). Mortality resulted from malignant neoplasms of the heart, lung, mammary gland, ovaries, forestomach and liver, as well as hematopoeitic lymphoma. The majority of these tumours were observed in control and exposed animals. Differences in incidence rates were found to be significantly higher in exposed animals than in controls for tumours of the heart, lymphoma, lung, mammary, ovary and forestomach. In the Melnick et al. (1990) study, male and female mice were exposed to 0, 6.25, 20, 62.5, 200 and 625 ppm 1,3-butadiene for 40 or 65 weeks. Significantly increased incidences of cardiac hemangiosarcomas, hematopoietic lymphomas, squamous cell neoplasms in the forestomach, alveolar-bronchiolar neoplasms and mammary gland adenocarcinomas. Similar to the NTP study, the majority of these tumours were observed in control and exposed animals at varying rates. Statistical significance comparisons between control and exposure groups were not provided by the OEHHA (2000). The OEHHA (2000) selected the incidence of lung alveolar and bronchoalveolar tumours in female mice as the critical effect. However, in both of these mouse studies, control animals also presented these tumours. Both mouse studies involved the administration of relatively high concentrations of 1,3-butadiene, particularly given that human exposures are typically at the ppb level (US EPA 2011).

The TCEQ (2011, 2008) has developed a chronic ReV of 33 µg/m³ for 1,3-butadiene based on reproductive toxicity observed in a study by NTP (1993). In a 2-year bioassay, groups of 70 female $B6C3F_1$ mice were exposed via inhalation to 0, 6.25, 20, 62.5, 200 or 625 ppm 1,3-butadiene for 6 hours/day, 5 days/week for up to 103 weeks. At 9 and 15 months, ovarian atrophy was evaluated in 10 mice per group. The increase in the incidence of ovarian atrophy was statistically significant in all exposure groups following lifetime exposures (NTP 1993). As a result, the lowest exposure level of 6.25 ppm was identified as a LOAEL for ovarian atrophy (NTP 1993). The $BMCL_{05}$ was used as the POD since the benchmark response level of 5% is typically preferred for more severe effects such as ovarian atrophy and it is considered a conservative NOAEL surrogate. Benchmark concentration dose modelling was conducted on data already adjusted from discontinuous to continuous exposure to arrive at the ReV of 33 µg/m³.

The TCEQ (2011) also provides a linear Effects Screening Level (ESL) of 20 µg/m³ based on a cancer endpoint. A thorough review of Denzell's findings by the Health Review Committee (HEI 2006) confirmed the exposure response relation between increasing cumulative exposures to butadiene and the linear increase in the relative rate of leukemia mortality. Sathiakumar et al. (2007) conducted an exposure estimate validation study using updated butadiene exposure estimates, then dose-response modeling was conducted based on the updated studies (Cheng et al. 2007; Sielken et al. 2007).

The ATSDR values were not selected as the US EPA value of 0.3 µg/m³, is lower than either TCEQ value.

B10.2 Oral Exposure Limits

B10.2.1 Chronic Oral Exposure Limits

1,3-butadiene was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria to be defined as a non-volatile chemical. Thus, a chronic oral exposure limit was not required for 1,3-butadiene.

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B11.0 CARBON DISULPHIDE GROUP

B11.1 Inhalation Exposure Limits

B11.1.1 Acute Inhalation Exposure Limits

Table B11.1 Acute Inhalation Exposure Limits for Carbon Disulphide Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO	30	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	6-hour REL	6,200	OEHHA 2008
OMOE	24-hour Guideline	330	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011
WHO	24-hour	100	WHO 2000

− = Not available

The OEHHA (2008) acute REL of 6,200 µg/m³ for carbon disulphide is based on reproductive, developmental effects in rats. The key study consisted of pregnant rats with 40 in the control group and 17 to 22 in each exposure group being exposed via inhalation to concentrations of 0, 100, 200, 400 and 800 ppm for six hours per day on gestational days 6 to 20 (OEHHA 2008). Significant reductions in fetal weight were reported at 400 ppm, and the study NOAEL was identified as 200 ppm (620 mg/m³). Given that the endpoint is developmental, no adjustments for intermittent exposure were made. The OEHHA (2008) applied a cumulative safety factor of 100 to the NOAEL to account for interspecies variability (10), and intraspecies variability (10). The 6-hour REL of **6,200 µg/m³** was used in the acute effects assessment as a 1-hour exposure limit.

Both the AENV (2011) 1-hour AAQO and the OMOE (2008) 24-hour Guideline for carbon disulphide are based on odour and thus were not employed in the short-term assessment of the carbon disulphide group.

The WHO (2000) developed a 24-hour guideline for carbon disulphide of 100 µg/m³ based on the lowest concentration at which adverse effects were observed in occupational exposure. However, the lowest observed concentration of 10 mg/m³ is based on a 10- to 15-year duration of exposure, and therefore is not appropriate for the derivation of an acute exposure limit. Thus, this guideline was not used in the short-term assessment of the carbon disulphide group.

B11.1.2 Chronic Inhalation Exposure Limits

Table B11.2 Chronic Inhalation Exposure Limits for Carbon Disulphide Group

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	930	ATSDR 2011, 1996
HEALTH CANADA	TRV	100	Health Canada 2004
OEHHA	REL	800	OEHHA 2008, 2002
RIVM	–	–	RIVM 2001
TCEQ	–	–	TCEQ 2011
US EPA	RfC	700	US EPA 2011
WHO	–	–	WHO 2000

− = Not available

Health Canada (2004) derived a chronic inhalation TRV of 100 µg/m³ based on the tolerable concentration (TC_{05}) for carbon disulphide (Government of Canada 2000). The key study, Johnson et al. (1983) was an epidemiological study that consisted of 165 exposed and 245 unexposed male workers in a U.S. viscose rayon plant. The TC_{05} was derived from the lower benchmark concentration of 20 mg/m³, associated with a 5% adverse response for peroneal motor nerve conduction velocity in the occupationally exposed workers (Government of Canada 2000). The TC_{05} was adjusted by Health Canada for intermittent exposure of 8 hours/day and 5 days/week (i.e., 8/24 hours × 5/7 days). A safety factor of 50 was applied by Health Canada in the derivation of the human exposure limit to account for intraspecies variability (10) and for potential effects on neurobehavioral development (5). The resulting value of **100 µg/m³** was used as the chronic inhalation exposure limit for the carbon disulphide group.

The US EPA (2011) derived a chronic RfC of 700 µg/m³ based on peripheral nervous system effects in exposed workers. Male viscose rayon workers were compared to an unexposed control group. Exposure concentrations were determined from monitoring data collected in the facility over a period of several years. Decreased peroneal and sural motor nerve conduction velocities were observed in exposed workers. A BMC_{10} of 55.1 mg/m³ was calculated from the available data by the US EPA. This value was converted to a BMC_{10} HEC of 19 mg/m³ by adjusting for intermittent occupational exposure (10/20 m³/day × 5/7 hours/week). An uncertainty factor of 30 was applied by the US EPA to account for intraspecies variability (3) and database limitations (10). This value was not selected for use in the chronic effects assessment, as it is less conservative than the Health Canada limit.

The OEHHA (2008, 2002) derived a chronic REL of 800 µg/m³ based on the same study as Health Canada and the US EPA. A BMC_{05} of 6.9 ppm was derived based on the observed changes in motor nerve conduction velocities. This concentration was adjusted for continuous exposure (10/20 m³/day × 5/7 days/week) to a concentration of 2.54 ppm, and an uncertainty factor of 10 was applied for intraspecies differences. The OEHHA differs from the US EPA in the benchmark dose modeling approach as well as in the application of uncertainty factors. This value was not selected for use in the chronic effects assessment as it is less conservative than the Health Canada limit.

In addition, the ATSDR (2011, 1996) derived a chronic MRL of 0.3 ppm (930 µg/m³) also based on the study used by the US EPA and OEHHA. Benchmark dose modelling was not conducted, and the study LOAEL (7.6 ppm) was used instead. Given the availability of more conservative values, the ATSDR MRL was not selected for use in the assessment.

B11.2 Oral Exposure Limits

The carbon disulphide group was not incorporated in the multiple pathway exposure assessment because it did not meet the physical-chemical criteria used to define non-volatile chemicals. Thus, a chronic oral exposure limit was not required for the carbon disulphide group.

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B12.0 CARBON MONOXIDE

B12.1 Inhalation Exposure Limits

B12.1.1 Acute Inhalation Exposure Limits

Table B12.1 Acute Inhalation Exposure Limits for Carbon Monoxide

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO 8-hour AAQO	15,000 6,000	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	1-hour REL	23,000	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	1-hour NAAQS 8-hour NAAQS	40,000 10,000	US EPA 2011, 2010
WHO	15-minute	100,000	WHO 2000

	30-minute 1-hour Guideline 8-hour Guideline	60,000 30,000 10,000	

− = Not available

The US EPA has developed two National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO): a 1-hour standard of 40,000 µg/m³ and an 8-hour standard of 10,000 µg/m³. The US EPA (2011) issued a proposed rule recommending that these standards be maintained. These values are based on blood carboxyhemoglobin (COHb) concentrations ranging from 2.1 to 2.9%, representing the levels of concern identified by the US EPA from several controlled human studies.

Concentrations associated with this range of COHb represent about a 2.5% increase above baseline values. Overall, there is a lack of information regarding adverse effects and COHb concentrations below 2%. In the derivation of the 8-hour standard, the US EPA concluded that ambient CO concentrations equivalent to the 8-hour standard of 10,000 µg/m³ would be unlikely to increase COHb concentrations above 2.1% in non-smokers. It was further concluded that ambient air exposure (excluding indoor sources) of 10,000 µg/m³ is associated with a relatively low degree of potential risk to sensitive, non-smoking individuals. While specifics regarding the key studies that these two standards are based on are not clear, it is apparent that the US EPA has recently reviewed a substantial amount of information as part of the Integrated Science Assessment (US EPA 2010 that accompanies this Rule). An equation (Coburn Forster Kane) was used by the US EPA to take into account CO uptake and kinetics in the derivation and review of the standards. The US EPA 1-hour and 8-hour NAAQS of **40,000 µg/m³** and **10,000 µg/m³** were selected for use in the assessment, as these values are associated with the most recent and thorough review of CO toxicity. Due to the unique toxicological mechanism of CO, it was not included in the mixtures assessment.

Alberta Environment (AENV 2011) provides a 1-hour AAQO of 15,000 µg/m³ and an 8-hour AAQO of 6,000 µg/m³ for CO. These AAQOs were adopted from the Canadian Environmental Protection Act and Federal Provincial Advisory Committee (CEPA/FPAC) Working Group on Air Quality Objectives and Guidelines, which recommends maximum desirable, acceptable and tolerable objectives for CO. The Alberta objectives are based on the maximum desirable levels (i.e., the lowest objective). These objectives were developed to protect the subpopulation sensitive to cardio-respiratory effects (CEPA/FPAC 1994). Given that the US EPA 1-hour and 8-hour values are more thoroughly documented than the AENV AAQOs for CO and have been reviewed more recently, the AENV AAQOs for CO were not used in the assessment.

The OEHHA (2008) has derived a 1-hour REL of 23,000 µg/m³. This value is based on the observed aggravation of pre-existing angina and other cardiovascular conditions. Increased COHb concentrations in blood have been associated with CO toxicity. A COHb concentration as low as 2% has been associated with an aggravation of angina symptoms. The OEHHA (2008) cites a NOAEL based on COHb concentrations ranging from 1.1% to 1.3%, corresponding to a CO concentration of about 20 ppm (i.e., 23,000 µg/m³). However, no information regarding the design features (duration of exposure, concentrations, number of subjects, etc.) were provided for the key study. As a result of the limited information provided in the supporting document, this value was not used in the assessment.

The World Health Organization (WHO 2000) has derived 1-hour and 8-hour ambient air quality guidelines of 30,000 and 10,000 µg/m³, respectively. Values for 15-minute and 30-minute averaging times also were provided in WHO (2000).. The WHO values were derived to prevent blood COHb concentrations from exceeding 2.5%. The WHO (2000) notes that during pregnancy, endogenous maternal blood COHb increases and can range from 0.7 to 2.5%. Also, it is noted that blood concentrations between 2 and 10% have been associated with low fetal birth weights. The threshold of 2.5% appears to have been derived based on this information. The WHO (2000) states that the Coburn Forster Kane equation was applied to account for all potential routes of CO uptake in the derivation of the guidelines, although further details are not provided. It is not evident that any uncertainty factors were applied in the derivation of the guidelines, however, sensitive individuals (pregnant women and foetuses) have been accounted for. Given that the US EPA presents the most recent and comprehensive documentation in support of the 1-hour and 8-hour standards, the WHO values were not used in the assessment.

B12.1.2 Chronic Inhalation Exposure Limits

Table B12.2 Chronic Inhalation Exposure Limits for Carbon Monoxide

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	–	–	Health Canada 2009, 2004
OEHHA	–	–	OEHHA 2009 OEHHA 2008
RIVM	–	–	RIVM 2009, 2001
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

– = Not available

No regulatory exposure limits were available for chronic exposure to CO, and it was not assessed on a chronic basis. The critical effect of carbon monoxide exposure is the formation of COHb in blood. Given that COHb concentrations reach a steady-state after 6 to 8 hours of exposure, CO exposure for longer periods of time (i.e., chronic exposure), is not expected to cause accumulation of COHb in the blood (WHO 2000). The recent US EPA (2010) Integrated Science Assessment for CO concluded that there is no association between long term exposure to CO and mortality.

B12.2 Oral Exposure Limits

Carbon monoxide is a gaseous criteria air contaminant. As such, it was not evaluated in the multiple pathway assessment.

B12.3 References

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B13.0 DICHLOROBENZENE

1,4-dichlorobenzene was used as the surrogate for dichlorobenzene as it represents the most toxic isomer.

B13.1 Inhalation Exposure Limits

B13.1.1 Acute Inhalation Exposure Limits

Table B13.1 Acute Inhalation Exposure Limits for 1,4-Dichlorobenzene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	8-hour MRL	12,000	ATSDR 2011, 2006
OEHHA	–	–	OEHHA 2008
OMOE	24-hour Standard	95	OMOE 2008
TCEQ	1-hour ReV	3,000	TCEQ 2011, 2009
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

– = Not available

The TCEQ (2011, 2009) has derived an acute reference value (ReV) of 0.50 ppm (3,000 µg/m³) based on eye and nasal irritation in exposed workers. The TCEQ (2009) used an occupational study conducted by Hollingsworth et al. (1956) as the key study in the derivation of the acute ReV. Fifty-eight male workers involved in the handling of 1,4-dichlorobenzene were generally exposed for 8 hours/day, 5 days/week, continually or intermittently for periods of 8 months to 25 years (mean of 4.75 years). The TCEQ (2009) selected the NOAEL of 15 ppm (90 mg/m³) as the point-of-departure for derivation of the acute ReV. The TCEQ (2009) did not extrapolate the NOAEL from an 8-hour workday to a 1-hour exposure because acute irritant effects of 1,4-dichlorobenzene appear to be primarily concentration dependent rather than duration-dependent. An uncertainty factor (10) was applied to the NOAEL to account for intraspecies variability and a factor of 3 was applied to account for limitations in the acute toxicological database for 1,4-dichlorobenzene (TCEQ 2009). Given that the TCEQ acute ReV is more conservative than the ATSDR value (described below) through the incorporation of an additional uncertainty factor of 3 for database uncertainty, the acute ReV of **3,000 µg/m³** was used as a 1-hour exposure limit in the acute effects assessment of dichlorobenzene.

The ATSDR (2011, 2006) has developed an acute inhalation MRL for 1,4-dichlorobenzene of 2 ppm (12,000 µg/m³) based on the same study NOAEL of 15 ppm (90 mg/m³) for eye and nose irritation in occupationally exposed workers used by the TCEQ to derive its acute ReV. An uncertainty factor of 10 was applied to the NOAEL to account for intraspecies variability (ATSDR 2006). As a more conservative, defensible value exists from the TCEQ, the ATSDR value was not considered in the acute inhalation assessment.

The OMOE (2008) provides a 24-hour standard for 1,4-dichlorobenzene protective of health; however, the scientific basis is not provided. As a result, the study team is unable to comment on the scientific merit of this standard and did not use it in the acute effects assessment.

B13.1.2 Chronic Inhalation Exposure Limits

Table B13.2 Chronic Inhalation Exposure Limits for 1,4-Dichlorobenzene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	60	ATSDR 2011, 2006
HEALTH CANADA	TC	95	Health Canada 2009, Government of Canada 1993
OEHHA	RsC REL	0.9 800	OEHHA 2009 OEHHA 2008, 2000
RIVM	TCA	670	RIVM 2001
TCEQ	ReV	110	TCEQ 2011, 2009
US EPA	RfC	800	US EPA 2011, 1996
WHO	–	–	WHO 2000

– = Not available

The ATSDR (2011, 2006) has developed a chronic MRL of 0.01 ppm (60 µg/m³) for the increased incidence of nasal lesions in female rats based upon Aiso et al. (2005). Male and female F344/DuCrj rats and male and female Crj:BDF1 mice were exposed to 0, 20, 75 or 300 ppm 1,4-dichlorobenzene via inhalation for 6 hours/day, 5 days/week for a duration of 104 weeks. Absolute and relative liver and kidney weights were increased in the 300 ppm group in both sexes, in both species. Histopathological changes in the nasal epithelia were observed in female rats at 75 ppm and 300 ppm, and in male rats at 300 ppm. Lesions included increased incidences of eosinophilic changes in the olfactory and respiratory epithelium. Renal lesions were observed only in male rats at the highest dose level. In mice, nasal lesions in respiratory and olfactory epithelium were observed in males at 75 ppm but not at 300 ppm, and in females only at 300 ppm. Centrilobular hepatocellular hypertrophy was significantly increased in male mice exposed to 300 ppm. Lesions of the olfactory epithelium in female rats were determined by the ATSDR to be the most sensitive effect, and benchmark dose modelling was completed on this data set. A $BMCL_{10}$ of 9.51 ppm was determined from the dose-response modelling, and was adjusted for intermittent exposure (6/24 hours × 5/7 days) to a $BMCL_{10\ (ADJ)}$ of 1.7 ppm. A human equivalent concentration was determined using the US EPA (1994) approach for deriving a regional gas dose ratio (RGDR):

$$RGDR = \frac{VE\ (rat) / SA\ (rat)}{VE\ (human) / SA\ (human)}$$

$$RGDR = \frac{0.24 / 15}{20 / 200}$$

$$RGDR = 0.16$$

Where:

VE (rat) = calculated ventilation rate for a rat, 0.24 L/min

SA (rat) = extrathoracic region surface area of rat, 15 cm^2

VE (human) = calculated ventilation rate for a human, 20 L/min

SA (human) = extrathoracic region surface area of 200 cm^2

Multiplying the $BMCL_{10\ (ADJ)}$ of 1.7 ppm by the RGDR of 0.16 results in a $BMCL_{10\ (HEC)}$ of 0.27 ppm, to which a cumulative uncertainty factor of 30 was applied to account for interspecies differences (3), and intraspecies variability (10). The resulting chronic MRL of 0.01 ppm (**60 µg/m³**) was chosen as the exposure limit for dichlorobenzenes in the chronic assessment.

Health Canada (2009) has developed a tolerable concentration of 95 µg/m³ for 1,4-dichlorobenzene. The tolerable concentration is based on a study by Loeser and Litchfield (1983) cited by the Government of Canada (1993). Loeser and Litchfield studied chronic inhalation effects in rats and mice exposed to 1,4-dichlorobenzene for a duration of 76 weeks and followed by 36 weeks without exposure. The rats and mice were dosed at 75 ppm (450 mg/m³) and 500 ppm (3,000 mg/m³) for 5 hours/day, 5 days/week and critical effects observed were increases in liver and kidney weights, urinary protein, and coproporphyrin in the 500 ppm dose group of rats. A NOAEL was identified at 75 ppm (450 mg/m³). Health Canada (2009) adjusted the NOAEL for continuous exposure and the difference in inhalation and body weights between rats and humans (using the child receptor age 5 to 11 years). A cumulative uncertainty factor of 500 was applied to account for interspecies variation (10), intraspecies variation (10), and for less than lifetime exposure (5). This value was not selected as the ATSDR value is more conservative, and is based upon a more robust approach.

The RIVM (2001) presents a tolerable concentration of 670 µg/m³ for 1,4-dichlorobenzene, based on a NOAEL of 450 mg/m³. Following correction for exposure duration (5/24 hours, 5/7 days), this NOAEL was adjusted to 67 mg/m³. A cumulative uncertainty factor of 100 was applied (presumably for interspecies and intraspecies differences). As limited information regarding this value was provided in the supporting documentation, it was not used in the assessment.

OEHHA (2008, 2000) has derived a chronic REL of 800 µg/m³ based on nasal and eye irritation, and increased liver and kidney weights in rats (CPA 1986). Male and female Sprague-Dawley rats were exposed via inhalation to 0, 50, 150 or 450 ppm 1,4-dichlorobenzene for 6 hours/day, 7 days/week for a duration of 10 weeks and were mated for 3 weeks. It was not clear if the animals were exposed during mating. The F_1 generation were exposed to the same concentrations of 1,4-dichlorobenzene as the F_0 generation, and also were mated. No developmental abnormalities were observed. At 450 ppm, significant decreases in live births, pup weights and survival were observed. At 150 ppm, nasal and eye irritation, and increased liver and kidney weights were observed in the animals following the 10-week exposure period. The study NOAEL was identified as being 50 ppm. This NOAEL was adjusted to account for intermittent exposure (6/24 hours/day), resulting in a $NOAEL_{ADJ}$ of 13 ppm. The RGDR between rats and humans for these endpoints was determined by the OEHHA to be 1, thus the HEC is the same as the $NOAEL_{ADJ}$ of 13 ppm. A cumulative uncertainty factor of 100 was applied to account for the use of a subchronic study (3), interspecies differences (3), and intraspecies variability (10).

In addition, the OEHHA (2009) has derived a unit risk estimate of 1.1E-05 $(\mu g/m^3)^{-1}$ for 1,4-dichlorobenzene. However, this value is based on a chronic oral bioassay and was not selected for use in the assessment due to uncertainty associated with route-to-route extrapolation. Although the IARC (1999) has classified 1,4-dichlorobenzene as Group 2B Possibly Carcinogenic to Humans based upon an increased incidence of renal tumours in rats following oral exposure. However, it is also stated the mechanism of carcinogenicity is specific to male

rats. Thus, on an inhalation basis, the use of this oral-based value does not appear to be defensible.

The US EPA (2011, 1996) has derived an RfC of 800 µg/m³ using the same study as the OEHHA (CPA 1986) (described above). A $NOAEL_{HEC}$ of 75 mg/m³ was derived from the study NOAEL of 301 mg/m^3 (50 ppm), and a cumulative uncertainty factor of 90 was applied to account for interspecies (3) and intraspecies differences (10), and the extrapolation of a subchronic study (3).

The TCEQ (2011, 2009) has established a chronic ReV of 110 µg/m³ based upon the incidence of nasal lesions in rats, and considers the same toxicological studies as the OEHHA, US EPA and ATSDR chronic limits. The study NOAEL was interpreted by the TCEQ as being 66 ppm in rats. In addition, benchmark dose modelling was conducted on the incidence rates of nasal lesions in female rats from the Aiso et al. (2005) study (relied upon by the ATSDR 2006, described above), and increased liver weights in male rats from the CPA (1986) study (relied upon by the US EPA and OEHHA in the derivation of their limits, which are discussed above). Following adjustments for continuous exposure (6/24 hours/day, 5/7 days/week) the $BMCL_{10}$ value for the Aiso et al. (2005) study was calculated to be 2.7 ppm and for the CPA (1986) study, 32.77 ppm. As the ReV derived from the Aiso et al. (2005) study was selected by the TCEQ, the discussion of the calculation of the HEC and the application of uncertainty factors below is limited to the Aiso et al. (2005) $BMCL_{10}$. A HEC was calculated by multiplying the $BMCL_{10}$ by a RGDR of 0.2, calculated following the approach of the US EPA (1994). A cumulative uncertainty factor of 30 was applied to the HEC of 0.535 ppm to account for interspecies differences in pharmacokinetics (3), and intraspecies variability (10). The result is the ReV of 110 µg/m³. Although the ReV is based on the same key study as the ATSDR MRL, it is not used in the chronic effects assessment as the ATSDR MRL is slightly more conservative.

B13.2 Oral Exposure Limits

B13.2.1 Chronic Oral Exposure Limits

Dichlorobenzene was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria that are used to determine whether a chemical is volatile or non-volatile. Thus, a chronic oral exposure limit was not required for dichlorobenzene.

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B14.0 ETHYLBENZENE

B14.1 Inhalation Exposure Limits

B14.1.1 Acute Inhalation Exposure Limits

Table B14.1 Acute Inhalation Exposure Limits for Ethylbenzene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO	2,000	AENV 2011
ATSDR	acute MRL	21,700	ATSDR 2011, 2010
OEHHA	–	–	OEHHA 2008
OMOE	24-hour Standard	1,000	OMOE 2008
TCEQ	acute ReV	86,000	TCEQ 2011
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

– = Not available

The ATSDR (2011, 2010) provides an acute inhalation MRL of 5 ppm (21,700 µg/m³) based on neurological effects in rats. Wag/Rij rats were exposed to 0, 300, 400, or 550 ppm (0, 1,302, 1,736, or 2,387 mg/m³) ethylbenzene (99% pure) for 8 hours/day for 5 days (Cappaert et al. 2000). Three to six weeks following cessation of exposure, Measurement of Distortion Product Otoacoustic Emissions (DPOAE), Compound Action Potential (CAP), and hair cell counts were conducted. Although Cappaert et al. (2000) only provided the results of the study graphically the ATSDR was able to obtain the individual animal data directly from Cappaert et al., allowing for use of the BMD model approach. Benchmark dose modelling was completed using the CAP auditory threshold data, where the largest effects were observed in response to 8, 12 and 16 kHz stimuli. The BMD model estimated $BMDL_{1SD}$ values of 102.3, 89.47, and 81.10 µmol/L at 8, 12 and 16 kHz, respectively. The lowest $BMDL_{1SD}$ of 81.10 µmol/L was used as the POD for the acute inhalation MRL. A HEC of 154.26 ppm (669.49 mg/m³) was calculated using the human PBPK model, a human body weight of 70 kg, and the assumption of 14-day continuous exposure. A cumulative uncertainty factor of 30 was applied to the $BMDL_{HEC}$ to account for

extrapolation from animals to humans with dosimetric adjustment (3) and for human variability (10). The result is an acute inhalation MRL of **21,700 µg/m³** which was used as a 1-hour exposure limit in the acute effects assessment of ethylbenzene.

The TCEQ (2011) provides an acute ReV of 86,000 µg/m³ based on the same key study as the ATSDR (i.e., Cappaert et al., 2000). However, the TCEQ did not obtain the individual animal data directly from Cappaert et al. and thus used the NOAEL/LOAEL approach over the BMD model approach to determine the POD for the development of the acute ReV. A NOAEL of 300 ppm (1,302 mg/m³) and a LOAEL of 400 ppm (1,736 mg/m³) were identified for significant deterioration in CAP auditory thresholds and significant outer hair cell (OHC) losses. The 8-hour NOAEL was adjusted to a 1-hour NOAEL using modified Haber's law.

$$C_{ADJ}^{n} \times T_{ADJ} = C^{n} \times T$$

$$C^{3} \times 1 \text{ hour} = (1{,}302 \text{ mg/m}^3)^{3} \times 8 \text{ hours}$$

Where:

C_{ADJ} = duration-adjusted concentration

T_{ADJ} = desired time of exposure (1 hour)

C = concentration of exposure (1,302 mg/m³)

T = time of exposure (8 hours)

n = chemical-specific modification factor designed to account for the toxicity of a chemical being concentration and duration dependent (3).

The HEC was calculated from the $NOAEL_{ADJ}$ of 600 ppm (2,604 mg/m³) using the recommended equation for category 3 gases. The TCEQ notes, however, that ethylbenzene is classified as a category 2 gas since it is relatively soluble in water and produces both local and systemic effects, but category 2 gases are still under review by the US EPA.

$$RGDR = (H_{b/g})_A / (H_{b/g})_H$$

Where:

RGDR = regional gas dosimetry ratio

$H_{b/g}$ = ratio of blood:gas partition coefficient

A = animal

H = human

The TCEQ (2011) assumed an $H_{b/g}$ for rats of 42.7 and a mean $H_{b/g}$ for humans of 28.0. When the $(H_{b/g})_A/(H_{b/g})_H$ is greater than 1, a default value of 1 is used for the RGDR. The RGDR was then multiplied by the $NOAEL_{ADJ}$, resulting in a $NOAEL_{HEC}$ of 600 ppm (2,604 mg/m³). The TCEQ (2011) applied a cumulative uncertainty factor of 30 to the $NOAEL_{HEC}$ to account for interspecies variability with dosimetric adjustment (3) and intraspecies variability (10). The result is an acute ReV of 86,000 µg/m³ for ethylbenzene. The TCEQ acute ReV was not used in the acute effects assessment for ethylbenzene because: (a) the TCEQ did not provide sufficient evidence to justify the use of this less conservative (i.e., higher) limit over the ATSDR acute MRL of 21,700 µg/m³ that is based on the same key study; and, (b) the ATSDR obtained the

individual animal data, and applied the BMD and PBPK models in the development of its acute MRL.

The OMOE (2008) has established a health-based 24-hour standard of 1,000 µg/m³ for ethylbenzene. However, no scientific basis or supporting document is provided for this standard. As a result, this limit was not used in the acute effects assessment of ethylbenzene.

Alberta Environment (AENV 2011) presents an AAQO of 2,000 µg/m³ for a 1-hour average exposure. This limit was adopted from the TCEQ based on odour perception, but no specific basis was provided. As well, the TCEQ (2011) recently revised its acute odour-based acute ESL to a value of 740 µg/m³. Given that this objective is not health-based and does not reflect TCEQ's most current odour-based acute ESL, the AENV AAQO was not used in the acute effects assessment of ethylbenzene.

B14.1.2 Chronic Inhalation Exposure Limits

Table B14.2 Chronic Inhalation Exposure Limits for Ethylbenzene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	260	ATSDR 2011, 2010
HEALTH CANADA	TC	1,000	Health Canada 2009
OEHHA	RsC REL	4 2,000	OEHHA 2009 OEHHA 2008, 2000
RIVM	TCA	770	RIVM 2001
TCEQ	ReV	1,900	TCEQ 2011, 2010
US EPA	RfC	1,000	US EPA 2011, 1991
WHO	–	–	WHO 2000

− = Not available

The ATSDR (2010), OEHHA (2008, 2000) and TCEQ (2011) have each developed their respective limits using the same key study – NTP (1999). In NTP (1999), male and female F344/N rats and $B6C3F_1$ mice were exposed to 0, 75, 250 or 750 ppm ethylbenzene via inhalation 6 hours/day, 5 days/week for 103 to 104 weeks. Increased severity of nephropathy was statistically significant for the 750 ppm male exposure group and for all female exposure groups (i.e., 75, 250 and 750 ppm). However, the TCEQ (2011) notes that, for the 75 ppm female group, the severity of nephropathy was minimal to mild, that clinical findings and survival were unaffected by treatment, and the severity of nephropathy was similar to the control group. On this basis, the TCEQ (2011) and OEHHA (2000) selected 75 ppm as the NOAEL for increased severity of nephropathy. When adjusted for intermittent exposure (6/24 hours x 5/7 days), the $NOAEL_{ADJ}$ was calculated to be about 13 ppm (58 mg/m³). The TCEQ (2011) and OEHHA (2000) concluded that the RGDR should be equal to 1; thus, the $NOAEL_{HEC}$ was assumed to be 13 ppm. A cumulative uncertainty factor of 30 was applied by both the TCEQ (2011) and OEHHA (2000) to account for interspecies differences (3) and intraspecies variability (10). The result is a TCEQ ReV of 1,900 µg/m³ and an OEHHA REL of 2,000 µg/m³.

The ATSDR (2011, 2010) selected 75 ppm as the LOAEL for increased severity of nephropathy. The human PBPK model was used to estimate the internal dose metrics and predict the HEC of

17.45 ppm (75.73 mg/m³). The ATSDR (2010) applied a cumulative uncertainty factor of 300 to account for use of a LOAEL (10), extrapolation from animals to humans with dosimetric adjustment differences (3), and human variability (10). The resulting MRL of **260 µg/m³** was used in the chronic inhalation effects assessment of ethylbenzene as it is based on the more conservative (i.e., lower) effect level of 75 ppm for increased severity of nephropathy instead of an no effect level of 75 ppm, and incorporates dosimetry modelling data instead of the RGDR approach to partially account for the uncertainty associated with extrapolation from rats to humans.

The OEHHA (2009) also provides a unit risk estimate of 2.5E-06 $(\mu g/m^3)^{-1}$ (equivalent to an RsC of 4 µg/m³). This value is based on the incidence of renal tumours in exposed rats. However, in the US EPA (2011, 1991) carcinogenicity assessment of ethylbenzene, it is stated that the metabolic pathways for ethylbenzene are different between rodents and humans, and that the mutagenic metabolites observed in rodents have not been observed in humans. The US EPA (2011) did not derive a chronic inhalation quantitative estimate for carcinogenic risk due to the lack of data available. As such, the carcinogenic RsC value from the OEHHA (2009) was not used in the chronic effects assessment, due to the existence of more biologically relevant values.

The US EPA (2011, 1991) assessment of ethylbenzene reports an RfC of 1,000 µg/m³ based on a NOAEL of 100 ppm (434 mg/m³) for developmental toxicity in rats and rabbits. Wistar rats and New Zealand white rabbits were exposed to concentrations of 0, 100 or 1,000 ppm (0, 434 or 4,342 mg/m³) for 6 to 7 hours/day, 7 days/week during days 1 to 19 and 1 to 24 of gestation, respectively. According to the US EPA (1991), a NOAEL based on developmental effects should not be adjusted for intermittent exposure. A $NOAEL_{HEC}$ was calculated assuming a default value of 1.0 since *b:a* lambda values are unknown for the experimental animal species (a) and humans (h) (US EPA 1991). A cumulative uncertainty factor of 300 was applied to the study $NOAEL_{HEC}$ to account for interspecies variability (3), intra-species variability (10), and the absence of multigenerational reproductive and chronic studies (10). An uncertainty factor of 3 for interspecies variability was considered appropriate by the US EPA (1991) since the HEC adjustment addresses the pharmacokinetic component of the extrapolation factor, leaving only the pharmacodynamic area of uncertainty. This study only involved two dose levels (100 and 1,000 ppm). Adverse effects were observed at 1,000 ppm, but due to the lack of dose levels between 100 and 1,000 ppm, the threshold of these effects is unknown. The TCEQ (2011) and OEHHA (2000) discuss the US EPA RfC and its basis relative to the scientific weight of evidence for subchronic and chronic ethylbenzene exposure. The US EPA evaluation incorporated an uncertainty factor of 10 for the lack of multigenerational reproductive and chronic studies; however, both of these study types have since become available. For these reasons, the US EPA RfC was not used in the chronic inhalation assessment of ethylbenzene.

The Health Canada (2009) inhalation TC of 1,000 µg/m³ was adopted from the US EPA (1991). Thus, based on the same rationale for the exclusion of the US EPA RfC, the Health Canada TC was not used in the chronic inhalation assessment of ethylbenzene.

The RIVM (2001) provides a TCA of 770 µg/m³ based on kidney and liver effects in rats and mice. The TCA value was derived from a NOAEL of 430 mg/m³ (100 ppm) identified in the 1992 subchronic NTP (1996) study. The RIVM (2001) adjusted the NOAEL for intermittent exposure (6/24 hours × 5/7 days) and applied an uncertainty factor of 100 to the duration-adjusted NOAEL of 77 mg/m³ to account for interspecies variability (10) and intraspecies variability (10).

An uncertainty factor was not applied to the NOAEL by the RIVM (2001) for use of a subchronic study because a higher NOAEL of 1,075 mg/m³ was reported in a chronic NTP study. This TCA from RIVM was not used in the chronic inhalation effects assessment because it is based on subchronic instead of chronic exposure data.

B14.2 Oral Exposure Limits

Ethylbenzene was not incorporated in the multiple pathway exposure assessment because it did not meet the physical-chemical criteria used to define non-volatile chemicals. Thus, a chronic oral exposure limit was not required for ethylbenzene.

B14.3 References

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B15.0 FORMALDEHYDE

B15.1 Inhalation Exposure Limits

B15.1.1 Acute Inhalation Exposure Limits

Table B15.1 Acute Inhalation Exposure Limits for Formaldehyde

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO	65	AENV 2011
ATSDR	2-hour MRL	50	ATSDR 2011, 1999
OEHHA	1-hour REL 8-hour REL	55 9	OEHHA 2008a, b
OMOE	24-hour Standard	65	OMOE 2008
TCEQ	1-hour ReV	50	TCEQ 2011, 2008
US EPA	–	–	US EPA 2011
WHO	30-minute AQG	100	WHO 2000

− = Not available

The ATSDR (2011, 1999) has developed an acute inhalation MRL of 50 µg/m³ (0.04 ppm) for formaldehyde based on a LOAEL of 0.4 ppm for nasal and eye irritation. Occupationally exposed patients with skin hypersensitivity to formaldehyde and unexposed (control) patients, all of whom were non-smokers, were separated into two groups. Group 1 included seven male and three female volunteers with skin hypersensitivity to formaldehyde and Group 2 included 11 healthy males with no history of allergic diseases. Nasal washings were performed in both groups immediately before and after a 2-hour exposure to 0 ppm (placebo) or 0.4 ppm (0.5 mg/m³) formaldehyde and again 4 and 18 hours after the exposure period. In both groups, the placebo did not result in any effects on nasal wash cellular contents or symptom score. Exposure to 0.4 ppm formaldehyde showed statistically significant increased average symptom scores compared with average placebo scores, in both groups. As well, eosinophil counts and albumin levels were elevated in both groups. After 18 hours, symptom scores, eosinophil counts and albumin levels were no longer elevated. A cumulative uncertainty factor of 10 was incorporated by the ATSDR (1999) to account for intraspecies variability (3) and to account for the use of a minimal LOAEL (3). An uncertainty factor of 3 was considered adequately protective of human variability as the symptoms of irritation were observed in a potentially sensitive group of subjects. This 2-hour MRL of **50 µg/m³** was conservatively used as the 1-hour exposure limit in the acute effects assessment for formaldehyde as it represents the most conservative value that is supported by adequate documentation.

The TCEQ (2011, 2008) also developed an exposure limit of 50 µg/m³ for formaldehyde based on eye and nose irritation in human volunteers. The TCEQ (2008) derived the acute ReV based on the same study used by the ATSDR (Pazdrak et al. 1993) in addition to another study by Krakowiak et al. (1998), which also identified a LOAEL of 0.4 ppm. Similar to the ATSDR, the TCEQ (2008) applied a cumulative uncertainty factor of 10 to account for use of a minimal LOAEL (3) and for intraspecies variability (3). A factor of 3 for intraspecies variability was considered sufficient given that the studies included potentially sensitive subpopulations (TCEQ 2008). The resulting ReV of 50 µg/m³ is the same as the ATSDR MRL.

AENV (2011) has adopted the TCEQ ESL value of 65 µg/m³ for formaldehyde. As the TCEQ does not provide any supporting documentation for this value and more conservative (i.e., lower), scientifically defensible limits are available, this AAQO was not considered further.

The OEHHA (2008a,b) derived 1-hour and 8-hour RELs for formaldehyde. The acute 1-hour REL is based on a study involving 19 healthy non-smokers. People were exposed to 0.5 to 3 ppm formaldehyde for a single 3-hour period. A NOAEL of 0.5 ppm and a LOAEL of 1 ppm were determined from the study results for mild-moderate eye irritation. Benchmark dose modelling was conducted, and the $BMCL_{05}$ was determined to be about 0.44 ppm (530 µg/m³). The OEHHA (2008b) applied an uncertainty factor of 10 to this value to account for intraspecies differences, resulting in the 1-hour REL of 55 µg/m³. This value was not used as the ATSDR value is slightly lower and is well supported by scientific rationale. The 8-hour REL derived by the OEHHA was based on long-term occupational studies with exposures ranging from 1 to 36 years. As the value is not based on acute exposures, it was not considered further.

The OMOE (2008) provides an acute exposure limit value of 65 µg/m³ as a 24-hour standard based on a health effect. As the OMOE does not provide supporting documentation for the derivation of this acute limit, it was not considered further.

WHO (2000) has established a guideline of 100 µg/m³ based on literature reporting that the lowest concentration associated with nose and throat irritation in humans after short-term exposure is 0.1 mg/m³. WHO recommends this air quality guideline is used as a 30-minute limit to prevent sensory irritation in the general population. This value was not selected as the ATSDR value has a more robust supporting document.

B15.1.2 Chronic Inhalation Exposure Limits

Table B15.2 Chronic Inhalation Exposure Limits for Formaldehyde

Regulatory Agency	*Type*[(a)]	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	10	ATSDR 2011, 1999
HEALTH CANADA	RsC	1.9	Health Canada 2004
OEHHA	RsC REL	2 9	OEHHA 2009 OEHHA 2008a, b
RIVM	–	–	RIVM 2009, 2001
TCEQ	ReV RsC	11 18	TCEQ 2011, 2008
US EPA	RsC	0.8	US EPA 2011, 1991
WHO	–	–	WHO 2000

– = Not available

(a) The IARC (2006) has determined that formaldehyde *is carcinogenic to humans (Group 1)* based on *sufficient evidence* in humans and experimental animals.

The TCEQ (2011, 2008) has derived a non-carcinogenic chronic ReV of 11 µg/m³ based on the incidence of eye, nasal and respiratory irritation in exposed workers. In an occupational study by Wilhelmsson and Holmstrom (1992), workers were exposed to a mean formaldehyde concentration of 0.21 ppm (0.26 mg/m³) for an average duration of 10 years. Exposed workers were compared with a control group of non-occupationally exposed workers who on average, were exposed to 0.07 ppm (0.09 mg/m³). Both groups of workers included atopic individuals with Type I hypersensitivity that were responsive to formaldehyde in cutaneous tests. Eye irritation and immune-mediated discomfort and irritation of the nasal passages and respiratory tract were observed in the exposed group but not in the reference group. The study LOAEL was identified as 0.26 mg/m³ and the NOAEL as 0.09 mg/m³. Three other human studies were examined as supporting evidence for the Wilhelmsson and Holmstrom (1992) study, with similar LOAEL and NOAEL values reported. The TCEQ adjusted the NOAEL Of 0.09 mg/m³ for continuous exposure (10/20 m³/day × 5/7 days) to a $NOAEL_{HEC}$ of 0.032 mg/m³. An uncertainty factor of 3 was applied to account for intraspecies variability, given that the study included some sensitive individuals.

The TCEQ (2011, 2008) also derived a cancer-based exposure limit for formaldehyde of 18 µg/m³ derived from a comprehensive analysis of three rodent tumourigenicity data sets by Schlosser et al. (2003). One of the three data sets was the Kerns et al. (1983) study on which the US EPA RsC is based. The pooled data modelled included 482 rats exposed to 0.7, 2.0, 6.0, 10.0 or 15.0 ppm and 122 controls. $BMCL_{01}$ values were calculated for the various modelling approaches and endpoints (tumours, cell proliferation). Schlosser et al. (2003) conducted benchmark dose analysis of the data, and also applied computational flux modelling to account for differences in nasal dosimetry and a pharmacokinetic model to predict DNA

cross-link formation. The dose-response relationship in the data for tumour incidence and cell proliferation were both highly non-linear. The TCEQ selected the 95% $BMCL_{01}$ of 0.44 ppm based on cell proliferation as the point of departure for the derivation of a cancer-based ReV, as it represented the most conservative value derived from biologically-based modelling approaches. An uncertainty factor of 30 was applied to the $BMCL_{01}$ to account for intraspecies variability (10), and interspecies differences (3), due to the use of a pharmacokinetic-based biological model in the derivation of the $BMCL_{01}$.

Based on the weight of evidence, eye, nasal and respiratory irritation in humans are more sensitive endpoints than cell proliferation and carcinogenicity in rats. Therefore, the TCEQ non-carcinogenic ReV of **11 µg/m³** was selected for the chronic effects assessment of formaldehyde as it is the more conservative value.

The ATSDR (2011, 1999) derived a chronic MRL of 10 µg/m³. This value is based on histological changes in nasal mucosa in occupationally exposed workers (n = 70) in a formaldehyde and formaldehyde resins producing chemical plant; furniture factory workers (n = 100) who were exposed to particle boards and glue components; and a control group of non-exposed office workers (n = 36) (Holmstrom et al. 1989). Average employment duration time for the two groups were 10.4 years (range 1 to 36 years) for the chemical workers, and 9.0 years (range 1 to 30 years) for furniture workers. Air concentration estimates of workers' breathing zones were determined to be 0.04 to 0.4 ppm formaldehyde (median 0.24 ± 0.13 ppm) for the chemical workers, and from 0.16 to 0.4 ppm (median 0.20 ± 0.04 ppm) for the furniture workers. Nasal mucosal specimens were taken from the workers from the middle turbinate. A significant difference in the mean histological scores for the chemical workers but not for the furniture workers was observed relative to controls. Histological abnormalities observed in samples from exposed workers included: epithelial dysplasia, cilia loss, goblet cell hyperplasia, cuboidal and squamous cell metaplasia. In addition, exposed workers reported mild eye irritation in the 0.04 to 0.4 ppm (mean 0.24 ppm) range of exposures. The study LOAEL was determined by the ATSDR to be 0.24 ppm. Although the workers were only exposed 8/24 hours/day, 5/7 days a week, adjustments for continuous exposure were not made by the ATSDR based on the rationale that the effects of formaldehyde exposure are more related to concentration than to duration. A total uncertainty factor of 30 was applied for use of a LOAEL (3), and for intraspecies variation (10). This value is similar to the TCEQ value (described above) in both magnitude and toxicological basis. The TCEQ value was selected on the basis of the benchmark dose and inhalation modelling methods used as part of the derivation, as more consideration is given to dosimetry and the dose response-relationship in the supporting documentation than the ATSDR value.

The OEHHA (2008a, b) chronic REL of 9 µg/m³ is based on the same study as the TCEQ chronic ReV (Wilhelmsson and Holmstrom 1992). The same NOAEL (0.09 mg/m³) was identified by the OEHHA as the TCEQ. However, no adjustment was made for continuous exposure, although the rationale for not doing this is not clear. An uncertainty factor of 10 was applied to the NOAEL to account for intraspecies variability, resulting in the REL of 9 µg/m³. The TCEQ value was selected on the basis of the benchmark dose and inhalation modelling conducted as part of the derivation, as more consideration is given to dosimetry and the dose response-relationship in the supporting documentation than the OEHHA value.

The US EPA (2011, 1991) has derived an inhalation RsC of 0.8 µg/m³ based on an inhalation study by Kerns et al. (1983) that examined the incidence of squamous cell carcinomas in rats

exposed to formaldehyde. In the Kerns et al. (1983) study, Fischer 344 rats and B6C3F$_1$ mice were exposed to 0, 2, 5.6 or 14.3 ppm (equivalent to 0, 2.5, 7 or 17.6 mg/m³) for 6 hours/day, 5 days/week for a duration of 24 months. Five animals were sacrificed in each exposure group at 6 and 12 months, while 20 were sacrificed in each exposure group at 18 months (Kerns et al. 1983). Squamous cell carcinomas and polyploidy adenomas were seen in the nasal cavities male and female rats exposed to 14.3 ppm, and in male animals (polyploidy adenoma only) at 5.6 ppm. In the 5.6 ppm group, only one rat of each sex presented nasal carcinomas. In exposed mice, squamous cell carcinomas were seen in two males at 14.3 ppm. No significant lesions were observed. Using the linearized multistage procedure with additional risk the US EPA (1991) developed an inhalation unit risk of 1.3 × 10-5 (µg/m³)$^{-1}$, which equates to an RsC of 0.8 µg/m³ (associated with a one in 100,000 excess cancer risk). This value was not used in the chronic effects assessment, as the TCEQ takes into account mechanistic data and the overall scientific weight of evidence. The Kerns study also focused on higher exposure concentrations of formaldehyde, with tumours being most prevalent at the higher doses.

The OEHHA (2009) presents an inhalation unit risk estimate of 6.0E-06 (µg/m³)$^{-1}$ (equivalent to an RsC of 2 µg/m³). This value was derived based on the Kerns et al. (1983) study and the US EPA RsC described above.

Health Canada (2004) presents a tumorigenic concentration (TC_{05}) for formaldehyde of 9.5 mg/m³ (Government of Canada 2001). This TC_{05} represents the total intake associated with a 5% increase in incidence of nasal squamous tumours in rats exposed to formaldehyde for up to 24 months (Monticello et al. 1996). The TC_{05} corresponds to an RsC of 1.9 µg/m³ that is associated with an increased cancer risk of one in 100,000. This value was not used in the chronic inhalation assessment, as the TCEQ specifically accounts for mechanistic data and considers the overall weight of evidence in the derivation of its chronic limit for formaldehyde.

B15.2 Oral Exposure Limits

B15.2.1 Chronic Oral Exposure Limits

Table B15.3 Chronic Oral Exposure Limits for Formaldehyde

Regulatory Agency	*Type*	*Value (µg/kg bw/d)*	*Reference*
ATSDR	MRL	200	ATSDR 2011
HEALTH CANADA	– TDI	– 150	Health Canada 2009, Health Canada 2011, 2003
OEHHA	RsC REL	– –	OEHHA 2009 OEHHA 2008a, b
RIVM	–	–	RIVM 2009, 2001
US EPA	RfD	200	US EPA 2011, 1990
WHO	TDI	55	WHO 2011, 2005

– = Not available

ATSDR (2011, 1999) and the US EPA (2011, 1990) both derived chronic oral exposure limits of 200 µg/kg-day for formaldehyde based on the same study by Til et al. (1989). Male and female Wistar rats were administered formaldehyde in drinking water at mean doses of 0, 1.1, 15 or 82 mg/kg/day (males) and 0, 1.8, 21 or 109 mg/kg/day (females) for a duration of 104 weeks (2 years). About 10 rats/sex/dose were sacrificed and evaluated after 12 to 18 months of

exposure, and the remaining rats were evaluated at 24 months. Statistically significant urinary symptoms were observed in high dose animals, including decreased urine production, increased mean urine pH, and the presence of occult blood in urine. Increased urinary pH was also observed in males at 1.1 and 15 mg/kg/day, and the presence of occult blood was observed for all males exposed to 1.1 and 15 mg/kg and in females at 21 mg/kg (in addition to the high-dose animals of both sexes). Significant decreases in plasma alkaline phosphatase activity and total plasma protein were observed at 15 and 82 mg/kg in males and 21 and 109 mg/kg and females. Decreased total plasma protein and increased plasma urea was observed in males at 82 mg/kg. Increased cholesterol was reported in males exposed to 15 mg/kg and 82 mg/kg, and plasma potassium was elevated in high dose females. However, all of these clinical chemical observations were made during the study but were not apparent at the end of the 104-week exposure period. Reduced body weights were observed in males at week 1, and in females from week 24 through the rest of the exposure period. Absolute heart, liver, testes and kidney weights were all significantly decreased in males at 82 mg/kg. Increased relative kidney weights were significantly increased at 109 mg/kg after 53 weeks. Increased relative brain weights were observed in males at 82 mg/kg and females at 109 mg/kg after the first 53 weeks.

In male and female high-dose rats, significant histopathological changes in the gastrointestinal tract were observed after 52 weeks of exposure, including irregular mucosal thickenings in the fore stomach or glandular stomach, increased papillary epithelial hyperplasia, hyperkeratosis, focal ulceration, irregular cellular formations, and mucosal evidence of gastric inflammation. Necrotic changes in the kidneys of high-dose males and females also were observed, namely renal papillary necrosis, and scattered necrosis throughout other nephronic structures. Statistical significance for the observed chronic nephropathy was only observed in low dose males and females, but not the higher doses. Til et al. (1989) identified a NOAEL of 15 mg/kg in males and 21 mg/kg in females. The lower NOAEL of 15 mg/kg/day was selected by both the ATSDR and US EPA based on reduced body weights, and histopathological changes of the gastrointestinal tract and kidneys. Both agencies applied an uncertainty factor of 100 to account for interspecies differences (10) and intraspecies variability (10).

The Health Canada Drinking Water Quality Bureau (Health Canada 2011, 2003) derived an oral TDI of 150 µg/kg/day, also based on the Til et al. (1989) study (described above for the ATSDR and US EPA values). A NOAEL of 15 mg/kg/day was identified for pathological chances in the stomach and renal papillary necrosis in male rats. An uncertainty factor of 100 was applied to the NOAEL account for interspecies differences (10) and intraspecies variability (10). The Health Canada TDI is essentially the same as the ATSDR value – numerical rounding appears to be the only difference. As this value represents the more conservative of the two values (ATSDR/US EPA and Health Canada), the Health Canada TDI of **150 µg/kg/day** was selected for use in the chronic oral assessment.

The WHO (2011, 2005) presents a TDI of 55 µg/kg/day, also based on the data from Til et al. (1989). WHO (2005) cites a TDI derived by the WHO International Programme on Chemical Safety of 2.6 mg/mL formaldehyde. This value was based on a NOAEL of 260 mg/L for histopathological changes in the oral and gastric mucosa in rats, cited as being from the Til et al. (1989) study. The WHO IPCS applied an uncertainty factor of 100 to this concentration for inter- and intraspecies differences, resulting in a TDI of 2.6 mg/L. Assuming a drinking water ingestion rate of 1.5 L/day and a body weight of 70.7 kg, this value is equivalent to a TDI of 55 µg/kg/day. Based on the review of the Til et al. (1989) study and the WHO IPCS (2002)

document, and the clear presentation within Til et al. (1989) of a NOAEL of 15 mg/kg for histological changes, it is not clear how WHO IPCS identified the NOAEL concentration of 260 mg/L (which, using a standard body weight of 70.7 and a drinking water consumption rate of 1.5 L/day, is equivalent to about 5.5 mg/day). Due to this uncertainty, and the level of detail presented within the Til et al. (1989) study, the WHO TDI was not used in the assessment.

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B16.0 HEXANE

B16.1 Inhalation Exposure Limits

B16.1.1 Acute Inhalation Exposure Limits

Table B16.1 Acute Inhalation Exposure Limits for Hexane

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO 24-hour AAQO	21,000 7,000	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	24-hour standard	7,500	OMOE 2008, 2005
TCEQ	–	–	TCEQ 2011
US EPA			US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

The OMOE (2008, 2005) provides a 24-hour standard of 7,500 µg/m³ for n-hexane and n-hexane isomers. This standard was developed from a LOAEL of 58 ppm (204 mg/m³) for polyneuropathy in humans (Sanagi et al. 1980). Workers were exposed to a low concentration of n-hexane and acetone in a tungsten carbide alloys facility for an average of 6.2 years. Significant decreases in mean motor nerve conduction velocities and slowed residual latency of motor conduction of lower extremities were observed. This value was not given further consideration, as it is based on chronic exposure, which is not relevant to the acute effects assessment.

The AENV (2011) adopted the chronic California OEHHA value of 7,000 µg/m³ for n-hexane as a 24-hour AAQO, then derived a 1-hour AAQO of 21,000 µg/m³ from this 24-hour objective. The California OEHHA based its chronic REL of 7,000 µg/m³ on a NOAEL of 100 ppm for nervous system effects in mice (AENV 2011). However, as this value is based on chronic exposure data, it was not used in the acute assessment.

Acute guidelines for hexane have not been established by any other regulatory agencies listed above. Therefore, the search was expanded to include short-term occupational limit values (i.e., STEL and Ceiling) developed by the ACGIH (2011), as well as AEGLs-1, (2011b) developed by the US EPA. However, acute exposure limits for hexane were not available from these sources. Due to the lack of defensible, acute-based exposure limits, hexane was not evaluated on an acute basis.

B16.1.2 Chronic Inhalation Exposure Limits

Table B16.2 Chronic Inhalation Exposure Limits for Hexane

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	2,100	ATSDR 2011, 1999
HEALTH CANADA	TC	700	Health Canada 2009
OEHHA	REL	7,000	OEHHA 2008, 2000
OMOE	–	–	OMOE 2008
RIVM	–	–	RIVM 2001
TCEQ	ReV	670	TCEQ 2011, 2007
US EPA	RfC	700	US EPA 2011a, 2005
WHO	–	–	WHO 2000

− = Not available

The TCEQ (2011, 2007) has derived a chronic ReV of 670 µg/m³ based on human occupational data. In the key study by Chang et al. (1993), a group of workers in a printing factory were evaluated for potential neurological effects. Workers were exposed to hexane concentrations ranging from 80 to 210 ppm, with an average exposure concentration of 132 ppm. Workers were exposed for 12 hours/day, 6 days/week for a mean duration of 2.6 years. Approximately 40% of the workers evaluated demonstrated subclinical neuropathy. In addition, reduced sensory and action potentials, motor nerve conduction velocity and increased distal latency were reported for exposed workers. The average concentration of 132 ppm was identified as a LOAEL by the TCEQ. This LOAEL was adjusted by the TCEQ to account for continuous exposure (10/20 m³/day × 6/7 days), resulting in a $LOAEL_{HEC}$ of 57 ppm. An uncertainty factor

of 300 was applied to account for the use of a LOAEL (10), intraspecies variability (10) and database uncertainties (3). The resulting ReV of **670 µg/m³** was selected for use in the chronic assessment of hexane.

The US EPA (2011a, 2005) developed a chronic RfC of 700 µg/m³ for neurotoxicity. This RfC is based on a benchmark concentration level (BMCL) of 430 mg/m³ for peripheral neuropathy (decreased mean conduction velocity at 12 weeks) in a rat subchronic inhalation study (Huang et al. 1989). Male Wistar rats were exposed to 0, 500, 1,200, or 3,000 ppm (equivalent to 0, 1,762, 4,230 or 10,574 mg/m³) of n-hexane for 12 hours/day, 7 days/week for a duration of 16 weeks. Statistically significant decreases in weight gain, and mean conduction velocity accompanied by neural demyelination and remyelination were observed in the middle and high dose groups. A study NOAEL of 50 ppm (1,762 mg/m³) was identified by the US EPA (2005). The incidence of decreased mean conduction velocity was selected as the endpoint of interest, and benchmark dose modeling was conducted. From the modeling, a BMC of 550 mg/m³ and a BMCL of 430 mg/m³ were identified. The BMCL was adjusted from intermittent to continuous exposure (12/24 hours) to a concentration of 215 mg/m³. The blood:gas (air) partition coefficient ($H_{b/g}$) value for n-hexane in humans is 0.8, whereas a value of 2.29 has been reported in rats (US EPA 2005). The $BMCL_{HEC}$ is equal to 215 mg/m³. The US EPA (2005) applied an uncertainty factor of 300 to the $BMCL_{HEC}$ to account for interspecies variability (3), intraspecies variability (10), extrapolation to chronic exposure from data in a less-than lifetime study (3) and database deficiencies (3, due to the limited reproductive and developmental information available for n-hexane).

Health Canada also provides an acute TC (provisional) of 700 µg/m³, which was adopted from the US EPA and is based on the study by Huang et al. (1989) described above. As the Huang et al. (1989) study is based on rodent data, the limit of 700 µg/m³ was not selected for use in the assessment as a human-based value is available.

The ATSDR (2011, 1999) derived a chronic MRL of 2,100 µg/m³ (0.6 ppm) based on the incidence of neurological effects in exposed workers. A group of 14 exposed workers were compared with age-matched unexposed workers. The 8-hour time-weighted average exposure concentration of n-hexane was determined to be about 58 ppm (204,000 µg/m³). Workers also were co-exposed to acetone. Exposure durations were found to range from 1 to 12 years, with the average duration being about 6.2 years. A significant trend in decreased muscle strength was observed in exposed workers. Significantly decreased nerve conduction velocities and increased residual latency of motor nerve conduction were observed in exposed workers. The LOAEL was determined to be 58 ppm. No adjustment for continuous exposure was made, as the ATSDR states that steady-state concentrations of n-hexane in blood are reached after 100 minutes of exposure. An uncertainty factor of 100 was applied to the LOAEL to account for the use of a LOAEL instead of a NOAEL (10), and intraspecies variability (10). This value was not selected, as the influence that acetone co-exposure may have had on the exposed workers is not clear.

The OEHHA (2008, 2000) established a chronic REL of 7,000 µg/m³ based on peripheral neuropathy in mice. In the key study, male SM-A mice were exposed to 0, 100, 250, 500, 1,000 or 2,000 ppm commercial hexane (approximately 67.5% n-hexane) continuously, 6 days/week for a duration of 1 year. A significant, dose-related increase in muscle neurophysiology and dose-related abnormalities in posture and muscle atrophy were observed at concentrations 250 ppm and above. The study NOAEL was identified as 100 ppm for commercial hexane, and

68 ppm for n-hexane (based on the mixture containing about 67.5% n-hexane, and the exposure frequency of 6 days/week). An uncertainty factor of 30 was applied to this value to account for interspecies differences (3), and intraspecies variability (10). This value was not used in the chronic assessment, as human-based values are available.

B16.2 Oral Exposure Limits

n-Hexane was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria to be defined as a non-volatile chemical. Thus, a chronic oral exposure limit was not required for n-hexane.

B16.3 References

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B17.0 HYDROGEN SULPHIDE

B17.1 Inhalation Exposure Limits

B17.1.1 Acute Inhalation Exposure Limits

Table B17.1 Acute Inhalation Exposure Limits for Hydrogen Sulphide

Regulatory Agency	*Averaging Time*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO 24-hour AAQO	14 4	AENV 2011
ATSDR	1-hour MRL	98	ATSDR 2011, 2006
OEHHA	1-hour REL	42	OEHHA 2008a, b
OMOE	24-hour standard	7	OMOE 2008
TCEQ	–	–	TCEQ 2011

US EPA	–	–	US EPA 2011
WHO	24-hour AQG	150	WHO 2000

− = Not available

The ATSDR (2011, 2006) derived an acute inhalation MRL for hydrogen sulphide of 0.07 ppm (98 µg/m³). This MRL is based on a LOAEL of 2 ppm for changes in airway resistance and specific airway conductance in excess of 30% in two of the 10 individuals examined. The test subjects all had bronchial asthma requiring medication for 1 to 13 years, but none of the subjects had severe asthma. The subjects were exposed for a half-hour and their respiratory function in response to a histamine challenge was assessed prior to and following exposure. Although the two subjects showed changes in airway resistance and specific airway conductance after exposure to 2 ppm hydrogen sulphide, no statistically significant alterations in lung function were observed at this concentration. The ATSDR (2006) applied a combined uncertainty factor of 30 to account for intraspecies variability (3), use of a minimal LOAEL (3) and the lack of studies in children (3). The acute MRL of **98 µg/m³** was used as a 1-hour exposure limit in the acute assessment of hydrogen sulphide.

Alberta Environment (AENV 2011) provides 1-hour and 24-hour AAQOs for hydrogen sulphide of 14 µg/m³ and 4 µg/m³, respectively. These guidelines are odour-based rather than health-based and thus were not used in the acute assessment for hydrogen sulphide.

The OMOE (2008) provides a 24-hour standard of 7 µg/m³ for hydrogen sulphide based on the US EPA chronic RfC of 2 µg/m³. As the OMOE value is based on chronic data, it was not used in the assessment.

The OEHHA (2008a, 2008b) derived an acute REL of 42 µg/m³ based on physiological responses to odour, including headache and nausea. Sixteen individuals were exposed to increasing concentrations of hydrogen sulphide until their odour threshold was reached. The LOAEL was based on the range of odour thresholds of 0.012 to 0.069 ppm that was identified among the individuals. The geometric mean of the odour thresholds (0.03 ppm) was used to develop the acute REL (OEHHA 2008b). An uncertainty factor of 1 was applied to the geometric mean, resulting in an acute REL of 0.03 ppm (42 µg/m³) (OEHHA 2008b). It is possible that the symptoms were not the result of direct systemic toxicity, but rather physiological responses triggered by the foul smell of the gas. As a result, the OEHHA acute REL for hydrogen sulphide was not used in the acute assessment.

The WHO (2000) has developed a 24-hour guideline based on eye irritation. However, details regarding the study on which this value is based are not provided. As a result, this value was not used in the assessment.

B17.1.2 Chronic Inhalation Exposure Limits

Table B17.2 Chronic Inhalation Exposure Limits for Hydrogen Sulphide

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011

HEALTH CANADA	–	–	Health Canada 2009, 2004
OEHHA	REL –	10 –	OEHHA 2008a, 2000 OEHHA 2009
RIVM	–	–	RIVM 2009, 2001
TCEQ	–	–	TCEQ 2011
US EPA	RfC	2	US EPA 2011, 2003
WHO	–	–	WHO 2000

− = Not available

The US EPA (2011, 2003) developed an RfC of 2 µg/m³ based on the incidence of nasal lesions of the olfactory mucosa reported in a rat inhalation study by Brenneman et al. (2000). Male CD rats were exposed to 0, 10, 30, or 80 ppm (0, 13.9, 42, or 111 mg/m³) of hydrogen sulphide for 6 hours/day, 7 days/week for a duration of 10 weeks. A NOAEL of 10 ppm (13.9 mg/m³) was identified for olfactory loss in males. The US EPA (2003) adjusted the NOAEL for intermittent exposure (6/24-hours) to a concentration of 3.48 mg/m³. The $NOAEL_{ADJ}$ was converted to a HEC using the RGDR methodology.

$$RGDR_{ET} = \frac{(V_E/SA_{ET})_A}{(V_E/SA_{ET})_H}$$

$$RGDR_{ET} = \frac{(0.019 \text{ L/min} / 15 \text{ cm}^2)}{(13.8 \text{ L/min} / 200 \text{ cm}^2)}$$

Where:

$RGDR_{ET}$ = regional gas dosimetry ratio in the extrathoracic region

V_E = minute volume in rats $(VE)_A$ or humans $(VE)_H$

SA_{ET} = extrathoracic surface area in rats $(SA_{ET})_A$ or humans $(SA_{ET})_H$

The $NOAEL_{ADJ}$ was then multiplied by the $RGDR_{ET}$ of 0.18 to yield a $NOAEL_{HEC}$ of 0.64 mg/m³, as follows:

$$NOAEL_{HEC} = NOAEL_{ADJ} \times RGDR_{ET}$$
$$NOAEL_{HEC} = 3.84 \text{ mg/m}^3 \times 0.18$$

The US EPA (2003) applied an uncertainty factor of 300 to the $NOAEL_{HEC}$ to account for interspecies variability (3), intraspecies variability (10) and subchronic exposure duration (10). An uncertainty factor of 3 was used instead of the default value of 10 for extrapolation from rats to humans because the calculation of an HEC addresses one of the two areas of uncertainty encompassed in an interspecies uncertainty factor (US EPA 2003). The HEC adjustment addresses the pharmacokinetic component of the extrapolation factor, leaving the pharmacodynamic area of uncertainty. The US EPA RfC of **2 µg/m³** was selected as the chronic inhalation limit for hydrogen sulphide.

The OEHHA (2008a, 2000) also derived a chronic exposure limit for hydrogen sulphide. The chronic REL of 10 µg/m³ is based on a NOAEL of 30.5 ppm (42.5 mg/m³). In the key study,

mice were exposed to 0, 10, 30 or 80 ppm (0, 14, 43, or 112 mg/m³) of hydrogen sulphide via inhalation for 6 hours/day, 5 days/week for a duration of 90 days. Weight loss and inflammation of the nasal mucosa were observed in mice exposed to 80 ppm. The study NOAEL was identified as 30 ppm (43 mg/m³). This REL was not used in the chronic effects assessment as the US EPA value is more conservative, and based on more recent data.

B17.2 Oral Exposure Limits

B17.2.1 Chronic Oral Exposure Limits

Hydrogen sulphide was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria to be defined as a non-volatile chemical. Thus, a chronic oral exposure limit was not required for hydrogen sulphide.

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B18.0 3-METHYLCHOLANTHRENE

B18.1 Inhalation Exposure Limits

B18.1.1 Acute Inhalation Exposure Limits

Table B18.1 Acute Inhalation Exposure Limits for 3-Methylcholanthrene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

− = Not available

Acute limits for 3-methylcholanthrene were not available from the above agencies, therefore, the search was expanded to include STELs and Ceiling values from the ACGIH (2011) and AEGL-1 values from the US EPA (2011b). Again no values were available, therefore 3-methylcholanthrene was not assessed individually on an acute basis.

B18.1.2 Chronic Inhalation Exposure Limits

Table B18.2 Chronic Inhalation Exposure Limits for 3-Methylcholanthrene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	−	−	AENV 2011
ATSDR	−	−	ATSDR 2011
HEALTH CANADA	−	−	Health Canada 2009, 2004
OEHHA	−	−	OEHHA 2009 OEHHA 2008
RIVM	−	−	RIVM 2009, 2001
TCEQ	−	−	TCEQ 2011
US EPA	−	−	US EPA 2011a
WHO	−	−	WHO 2000

− = Not available

No published exposure limits with supporting documentation were available for chronic exposure to 3-methylcholanthrene from the agencies listed above. The search was expanded to include occupational TLV-TWA values from ACGIH (2011), intermediate inhalation MRLs from ATSDR (2011) and PPRTVs from US EPA (2011c), however, a chronic exposure limit for 3-methylcholanthrene was not identified from these agencies. Therefore 3-methylcholanthrene was not assessed individually in the chronic inhalation assessment, but was assessed as part of the C_{19}-C_{34} aromatic group.

B18.2 Oral Exposure Limits

B18.2.1 Chronic Oral Exposure Limits

Table B18.3 Chronic Oral Exposure Limits for 3-Methylcholanthrene

Regulatory Agency	*Type*	*Value (µg/kg bw/d)*	*Reference*
ATSDR	−	−	ATSDR 2011
HEALTH CANADA	− −	− −	Health Canada 2009, 2004 Health Canada 2011
OEHHA	−	−	OEHHA 2009 OEHHA 2008
RIVM	−	−	RIVM 2009, 2001
US EPA	−	−	US EPA 2011a
WHO	−	−	WHO 2011

− = Not available

None of the above agencies provide oral limits 3-methylcholanthrene. Therefore, 3-methylcholanthrene was assessed individually in the chronic inhalation assessment, using the

C_{19}-C_{34} aromatic limit as a surrogate. Please refer to the toxicity profile for C_{19}-C_{34} aromatic for details.

B18.3 References

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B19.0 2-METHYLNAPHTHALENE

B19.1 Inhalation Exposure Limits

B19.1.1 Acute Inhalation Exposure Limits

Table B19.1 Acute Inhalation Exposure Limits for 2-Methylnaphthalene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

Acute limits for 2-methylnaphthalene were not available from the above agencies, therefore, the search was expanded to include STELs and Ceiling values from the ACGIH (2011) and AEGL-1 values from the US EPA (2011b). Again no values were available, and therefore 2-methylnaphthalene was not assessed individually on an acute basis. 2-methylnaphthalene was included as part of the aromatic C_9-C_{18} aromatics group in the acute assessment.

B19.1.2 Chronic Inhalation Exposure Limits

Table B19.2 Chronic Inhalation Exposure Limits for 2-Methylnaphthalene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	–	–	Health Canada 2009, 2004
OEHHA	–	–	OEHHA 2009 OEHHA 2008
RIVM	–	–	RIVM 2009, 2001
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

No published exposure limits with supporting documentation were available for chronic exposure to 2-methylnaphthalene from the agencies listed above. The search was expanded to include occupational TLV-TWA values from ACGIH (2011), intermediate inhalation MRLs from ATSDR (2011) and PPRTVs from US EPA (2011c), however, a chronic exposure limit was not identified from these agencies. Therefore 2-methylnaphthalene was not assessed individually in the chronic inhalation assessment, but again was included as a constituent of the C_9-C_{16} aromatics group.

B19.2 Oral Exposure Limits

B19.2.1 Chronic Oral Exposure Limits

Table B19.3 Chronic Oral Exposure Limits for 2-Methylnaphthalene

Regulatory Agency	*Type*	*Value (µg/kg bw/d)*	*Reference*
ATSDR	MRL	40	ATSDR 2011
HEALTH CANADA	– –	– –	Health Canada 2009, 2004 Health Canada 2011
OEHHA	–	–	OEHHA 2009 OEHHA 2008
RIVM	–	–	RIVM 2009, 2001
US EPA	RfD	4	US EPA 2011
WHO	–	–	WHO 2011

– = Not available

Both the ATSDR and US EPA have derived oral exposure limits for 2-methylnaphthalene, each based on a study by Murata et al. (1997). In the study, B6C3F1 mice (50/sex/group) were administered 2-methylnaphthalene at doses of 0, 54, or 114 mg/kg (males) and 0, 50.3, and 107.6 mg/kg (females) in the diet for 81-weeks. Food consumption and body weight were measured weekly for the first 16 weeks and every other week thereafter, while mice were monitored daily for signs of clinical toxicity. Upon sacrifice, organ weights were measured (brain, heart, kidney, liver, individual lobes of the lung, pancreas, salivary glands, spleen, and testis), and blood was collected for leukocyte classification and comprehensive biochemical analyses.

Quantitative differences between groups were statistically analyzed using Fisher's exact test and analysis of variance (ANOVA) with a multiple comparison post-test by Dunnett ($p <= 0.05\%$ was used as the threshold for statistical significance).

Histopathology found exposure related effects in the lung, with increased incidences of pulmonary alveolar proteinosis. Survival and food consumption were not affected, and although mean final body weights for the male and female high-dose groups were reported to be reduced by 7.5 and 4.5%, respectively, the decrease was not considered to be biologically significant Murata et al.,1997.

The US EPA derived its RfD by benchmark dose analysis of the incidence data for pulmonary alveolar proteinosis for males and females combined at the control and low dose groups, as the sexes were not statistically significantly different from each other.

A benchmark response level of 5% extra risk of the critical effect, pulmonary alveolar proteinosis, was selected for this assessment as children may be more susceptible and children affected with the disorder often experience more severe symptoms than adults. The lower 95% confidence limit on the BMD05 (i.e., BMDL05) was 3.5 mg/kg-day. A total uncertainty factor of 1000 was applied to the BMDL05 to account for interspecies differences (10), intraspecies variability (10) and database deficiencies (10), resulting in an RfD of 0.0035 (rounded to 0.004) mg/kg-day. This RfD of **4 µg/kg-day** was selected for use in the assessment as it more conservative than both the ATSDR MRL and the oral exposure limit for the C_9-C_{18} aromatics group, of which 2-methylnaphthalene is a constituent.

The ATSDR also used benchmark dose modeling to derive its MRL, however the BMD_{05} of 4.3 mg/kg-day was selected rather the $BMDL_{05}$. An uncertainty factor of 100 was applied to account for intra- and interspecies variability, resulting in an MRL of 0.04 mg/kg-day. The MRL of 40 µg/kg-day was not selected as the US EPA value is more conservative and based on the same study and endpoints. T

B19.3 References

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B20.0 NAPHTHALENE

B20.1 Inhalation Exposure Limits

B20.1.1 Acute Inhalation Exposure Limits

Table B20.1 Acute Inhalation Exposure Limits for Naphthalene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	24-hour Guideline	22.5	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

− = Not available

The OMOE (2008) has developed a guideline for naphthalene of 22.5 µg/m³ based on a 24-hour averaging period. Although the 24-hour value is based on health considerations, the specific basis of its derivation remains unknown as no supporting documentation is available. Therefore this value was not considered for the acute inhalation assessment.

As acute exposure limits were not available from the other agencies listed in the table above, the search was expanded to include AEGL-1 values from the US EPA (2011b) and STELs or ceiling values from ACGIH (2011). However, an acute inhalation exposure limit was only identified from ACGIH.

The ACGIH (2011) recommends a STEL of 15 ppm (79 mg/m³) based on eye irritation as a result of occupational exposure to naphthalene. The STEL equates to a 15-minute air concentration that should not be exceeded at any time during a workday. The 15-minute STEL can be adjusted to an equivalent 1-hour concentration using a modified Haber's Law.

$$C_{ADJ}^{n} \times T_{ADJ} = C^{n} \times T$$

$$C^{1} \times 60 \text{ minutes} = (79 \text{ mg/m}^3)^{1} \times 15 \text{ minutes}$$

Where:

C_{ADJ} = duration-adjusted concentration

T_{ADJ} = desired time of exposure (60-minutes)

C = concentration of exposure (79 mg/m³)

T = time of exposure (15-minutes)

n = chemical-specific modification factor designed to account for the toxicity of a chemical being concentration and/or duration dependent. The OEHHA recommends using a default n value of 1 in the adjustment for less than 1-hour exposure.

Based on the above conversion factor, the STEL was adjusted to a concentration of 20 mg/m³. A cumulative uncertainty factor of 10 was applied to the duration adjusted STEL to account for intraspecies variability (10). The adjusted STEL of **2,000 µg/m³** was used as a 1-hour exposure limit in the acute effects assessment for naphthalene.

B20.1.2 Chronic Inhalation Exposure Limits

Table B20.2 Chronic Inhalation Exposure Limits for Naphthalene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	3.7	ATSDR 2011, 2005
HEALTH CANADA	TC	3	Health Canada 2009
OEHHA	REL RsC	9 0.3	OEHHA 2008, 2000 OEHHA 2009
RIVM	–	–	RIVM 2009, 2001
TCEQ	–	–	TCEQ 2011
US EPA	RfC	3	US EPA 2011a, 1998
WHO	–	–	WHO 2000

− = Not available

The US EPA (2011a, 1998) has derived a chronic inhalation RfC of 3 µg/m³ for naphthalene. This RfC was estimated from a chronic inhalation mouse study that reported a duration-adjusted $LOAEL_{HEC}$ of 9.3 mg/m³ based on hyperplasia and metaplasia in respiratory and olfactory epithelium in the nasal cavity of treated mice (NTP 1992). Male and female $B6C3F_1$ mice were exposed to 0, 10, or 30 ppm for 6 hours/day, 5 days/week for a duration of 104 weeks. No significant increase in tumour incidence was observed in males, but the incidence of pulmonary alveolar/bronchiolar adenomas was increased in females exposed to 30 ppm relative to controls. Non-neoplastic lesions were observed in the nasal passages and lungs of both male and female mice, namely lesions indicative of an inflammatory response. Both males and females in the 10 and 30 ppm groups had exposure-related increases in alveolar histiocyte and lymphocyte infiltration, alveolar hyperplasia, interstitial fibrosis, and in more advanced lesions – granulomatous inflammation. Bronchial submucousal glands were also observed to be distended when the above lesions were present. Mild lesions in the nasal passages of exposed mice were also observed. The US EPA (1998) applied an uncertainty factor of 3,000 to the $LOAEL_{HEC}$ of 9.3 mg/m³ to account for interspecies variability (10), sensitive human individuals in the population (10), extrapolation from a NOAEL to a LOAEL (10), and for database uncertainties (3). Database uncertainties included the lack of a two generation reproductive toxicity study and chronic inhalation data for other animal species. The US EPA RfC of **3 µg/m³** was selected as the chronic inhalation limit for naphthalene.

Health Canada also provides a TC of 3 µg/m³, as it adopted this value from the US EPA (described above).

The OEHHA (2008, 2000) has derived a chronic REL of 9 µg/m³ (0.002 ppm) that also is based on the same NTP (1992) bioassay used by the US EPA. The OEHHA (2000) determined that the study LOAEL was 10 ppm, but note that almost all animals (>96%) exposed to this concentration exhibited some type of an adverse effect, which limits the reliance of this study with respect to being the basis of a health-protective value. The LOAEL of 10 ppm was

adjusted for continuous exposure to 1.8 ppm (6/24-hours, 5/7-days). To account for uncertainties, a cumulative UF of 1,000 was applied to the adjusted LOAEL. This factor took into account: the use of a LOAEL (10), interspecies differences (10), and intraspecies variability (10). The US EPA value was selected over the OEHHA value, primarily as it is the more conservative value. This is of importance in light of the high incidence of adverse effects at the lowest dose level in the NTP (1992).

The ATSDR (2011, 2005) chronic MRL of 3.7 µg/m³ (0.0007 ppm) is also based on the NTP study used in the derivation of the US EPA and OEHHA values. As well the ATSDR considers a more recent study in rats (NTP 2000) in which male and female F344 rats were exposed to 0, 10, 30 or 60 ppm for 6 hours/day, 5 days/week for a duration of 105 weeks. A LOAEL of 10 ppm was identified for the incidence of non-cancerous lesions in olfactory epithelium in rats (NTP 2000) and mice (NTP 1992). This LOAEL was adjusted for continuous exposure (6/24 hours × 5/7 days) to 1.8 ppm (or 9,400 µg/m³). This value was further adjusted to a $LOAEL_{HEC}$ of 0.2 ppm (1,000 µg/m³) by multiplying the $LOAEL_{ADJ}$ by an RGDR of 0.132 (calculated by the ATSDR). The $LOAEL_{HEC}$ was divided by an uncertainty factor of 300 to account for the use of a LOAEL (10), interspecies differences (3, due to the calculation of a HEC), and intraspecies variability (10). The resulting MRL of 3.7 was not selected for use as the US EPA value is more conservative.

In addition, the OEHHA (2009) presents a cancer unit risk value of 3.4E-05 $(µg/m³)^{-1}$ (equivalent to an RsC of 0.3 µg/m³). This value is based on the two bioassays by the NTP (1992, 2000) described above. In the NTP (2000) study, increased incidences of respiratory epithelial adenoma and olfactory epithelial blastoma were observed in both male and female rats. A positive dose-response relationship was observed in male rats only for the respiratory epithelial adenomas, and the incidences of these tumours were statistically significant at all exposure concentrations. The incidences of these tumours were not statistically significant or were of marginal significance in females. The olfactory epithelial neuroblastomas were significantly increased in all exposure levels in females, and in the 30 and 60 ppm groups for males. The exposure concentrations were adjusted for continuous exposure (6/24 hours × 5/7 days) and converted to mg/m³. Dose scaling based on body weight and breathing rates was conducted. In addition, pharmacokinetic modeling was conducted for both rats and mice and all modeling runs confirmed that the dose-response relationship was linear. A linearized multistage model and a benchmark dose model were both applied to the data set, and similar ranges of unit risk values were calculated. The OEHHA (2009) notes that no naphthalene related tumours have been observed in humans. Given that the US EPA and other agencies have not derived cancer-based values, it suggests that the weight of evidence at the current time in support of human carcinogenicity in association with naphthalene exposure is limited. As such, this value was not selected for use in the assessment.

B20.2 Oral Exposure Limits

Table B20.3 Chronic Oral Exposure Limits for Naphthalene

Regulatory Agency	*Type*	*Value (µg/kg bw/d)*	*Reference*
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	TDI –	20 –	Health Canada 2009 Health Canada 2011
OEHHA	–	–	OEHHA 2009

			OEHHA 2008
RIVM	TDI	40	RIVM 2001
US EPA	RfD	20	US EPA 2011a, 1998
WHO	–	–	WHO 2011

– = Not available

The US EPA (2011a, 1998) has derived an oral RfD based on a subchronic study in rats with the observed critical effect of decreased body weight in male rats. Ten each of male and female Fischer 344 rats were dosed with 0, 25, 50, 100, 200, or 400 mg/kg of naphthalene in corn oil by gavage for a duration of 5 days/week for 13 weeks. The NOAEL was identified at 100 mg/kg-day and was adjusted for continuous exposure (100 mg/kg x 5/7 days = 71 mg/kg bw/d). A LOAEL was identified at 200 mg/kg-day (adjusted for continuous exposure to 142 mg/kg-day), based on greater than 10% of mean terminal body weight decrease in male rats. A cumulative uncertainty factor of 3000 was applied to the adjusted NOAEL of 71 mg/kg bw/d to account for intraspecies variability (10), interspecies variability (10), for using a subschronic study (10), and for database deficiencies (3). The result is an oral TDI of **20 µg/kg bw/d** for naphthalene which was used in the oral assessment.

Health Canada (2009) adopted the oral TDI of 20 µg/kg bw/d for naphthalene from the US EPA (2011a, 1998).

The RIVM (2001) recommends an oral TDI of 40 µg/kg bw/d for naphthalene. The TDI for naphthalene is based on the overall TDI of 40 µg/kg bw/d that RIVM (2001) recommends for non-carcinogenic aromatic compounds with equivalent carbon numbers >9 to 16. Given that this TDI is not based on naphthalene alone, it was not used in the chronic effects assessment of naphthalene.

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B21.0 NITROGEN DIOXIDE (NO_2)

B21.1 Inhalation Exposure Limits

B21.1.1 Acute Inhalation Exposure Limits

Table B21.1 Acute Inhalation Exposure Limits for NO_2

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO	300	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	1-hour REL	470	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	1-hour Standard	188	US EPA 2011, 2010
WHO	1-hour Standard	200	WHO 2005

– = Not available

Although no RfC was available from US EPA IRIS (2011), a 1-hour National Air Standard has been derived by the US EPA (2010). This value is based on a 3-year average 98th percentile of the annual distribution of daily maximum 1-hour concentrations. Although it is derived from NO_2 exposure data, it is intended to apply to all NO_x compounds. Experimental evidence from human and animal studies indicates that respiratory effects attributable to NO_2 can occur after brief exposures (e.g., less than 1 hour, up to 3 hours). The US EPA's 2008 Integrated Science Assessment concluded that 1-hour exposures of 100 ppb may result in small, significant increases in airway responsiveness. This is based in part on the observations from human clinical studies where airway inflammation and increased airway responsiveness were observed in asthmatics at concentrations less than 2 ppm. In contrast, airway inflammation has been observed at much higher concentrations (100 to 200 ppm/minute, or 1 ppm for 2 to 3 hours) in healthy individuals. The 1-hour standard of **100 ppb (188 µg/m³)** is intended to be protective of sensitive individuals in the population, including asthmatics and individuals with pre-existing respiratory conditions. As this value represents the most recent regulatory review of the health effects of NO_2 and provides the most detailed supporting documentation for its basis, it was selected for use in the assessment.

Alberta Environment has a 1-hour AAQO for NO_2 of 159 ppb (300 µg/m³) based on respiratory effects (AENV 2011). The previous 24-hour AAQO of 200 µg/m³ has been withdrawn by Alberta Environment. However, limited information is provided regarding the rationale of deriving 300 µg/m³ as the 1-hour objective. The Alberta Environment (2007) Assessment Report for NO_2 provides a general overview of the potential health effects associated with NO_2, however, it does not provide information regarding the derivation of the 1-hour value. Although it is noted

that healthy individuals may experience adverse effects at NO_2 concentrations greater than 2 ppm, it is also noted that sensitive individuals may respond at lower concentrations. It is not clear what effect threshold or uncertainty factors were selected by Alberta Environment in the derivation of the new 1-hour AAQO of 300 µg/m³. This value was not selected for use in the assessment, due to a lack of available information.

The OEHHA (2008) has derived a 1-hour REL of 470 µg/m³ based upon respiratory effects. The key study upon which this is based is not well described within OEHHA (2008) and the supporting document cited (CARB 1992) is not readily available. As a result, the basis and derivation of this value could not be independently evaluated, and this value was not used in the assessment as a result.

The WHO (2005) has derived a 1-hour guideline of 200 µg/m³ for NO_2. This value is based upon the increased incidence of adverse respiratory effects in animal and epidemiological studies (which are not clearly identified in WHO 2005) at concentrations above 200 µg/m³. As the US EPA (2010) value is more clearly described in detailed supporting documentation, it was used in the acute effects assessment instead of the WHO value.

B21.1.2 Chronic Inhalation Exposure Limits

Table B21.2 Chronic Inhalation Exposure Limits for NO_2

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	Annual Standard	45	AENV 2011
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	–	–	Health Canada 2009, 2004
OEHHA	–	–	OEHHA 2009 OEHHA 2008
RIVM	–	–	RIVM 2009, 2001
TCEQ	–	–	TCEQ 2011
US EPA	Annual Standard	100	US EPA 2011, 2010
WHO	Annual Standard	40	WHO 2005

– = Not available

The US EPA IRIS (2011) does not have an RfC value available due to the existence of a National Ambient Air Quality Standard (NAAQS). The US EPA (2010) has maintained the AAQS of 53 ppb (100 µg/m³) derived by the US EPA in 1971 (US EPA 2010), which was subsequently upheld in scientific and regulatory reviews between 1971 and 2010. Although the 1971 document is not readily available, the scientific reviews conducted in 1993 and 2010 by the US EPA suggest that the annual standard is associated with the potential for human health effects. A scientific review of the annual air standard conducted in 1993 suggests that the standard of 100 µ/m³ was upheld, based upon the results of a meta-analysis of epidemiological studies conducted in children ages 5 to 12. Within this review, an increase in 0.015 ppm or 28 µg/m³ of NO_2 over an averaging period of 2 weeks was associated with a 20% increase in respiratory symptoms. The NO_2 sources included both indoor and outdoor sources, and average concentrations in the studies were noted to range from 0.008 to 0.065 ppm (US EPA 1993). In 1996, the annual standard was maintained by the US EPA on the basis that, in combination with the short-term standard, the annual standard was protective of both the potential short-term and long-term human health effects of NO_2 exposure (US EPA 1996). The most recent edition of the

Final Rule (US EPA 2010) indicates that the annual standard was upheld due to the uncertainty associated with the potential long-term effects of NO_2. As the basis of the annual NO_2 standard of **100 µg/m³** is intended to be protective of human health, and has recently been re-evaluated and upheld by the US EPA in 2010, this value was selected for use in the chronic inhalation assessment.

Alberta Environment has an annual AAQO of 24 ppb (45 µg/m³) which is based on vegetation effects (AENV 2011). The Alberta Environment (AENV 2007) Assessment Report provides a general overview of the potential chronic human health and vegetation health effects, but does not provide detailed information regarding exposure concentrations above which adverse effects would be anticipated in humans. As this annual objective was not based on human health effects, this value was not considered for use in the assessment.

The WHO (2005) guideline value of 40 µg/m³ (0.023 ppm) represents an annual value recommended by the WHO International Program on Chemical Safety (IPCS). WHO IPCS (1997) indicates that the 40 µg/m³ is based on consideration of background concentrations and the observation that adverse health impacts may occur when concentrations in addition to background are above 28 µg/m³. As this value is not well substantiated in the available supporting documentation, the US EPA value was used in the chronic assessment.

B21.2 Oral Exposure Limits

B21.2.1 Chronic Oral Exposure Limits

Nitrogen dioxide is a gaseous criteria air contaminant which acts on the point of contact once it is inhaled, (i.e., the respiratory system). As such, it was not evaluated in the multiple pathway assessment.

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B22.0 PARTICULATE MATTER ($PM_{2.5}$)

B22.1 Inhalation Exposure Limits

B22.1.1 Acute Inhalation Exposure Limits

Table B22.1 Acute Inhalation Exposure Limits for $PM_{2.5}$

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQG 24-hour AAQO	80 30	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	24-hour Standard	35	US EPA 2006
WHO	24-hour (99th percentile) Guideline	25	WHO 2005

– = Not available

A Canada-Wide Standard (CWS) of 30 µg/m³ $PM_{2.5}$ averaged over 24 hours was developed by the CCME under the Canadian Environmental Protection Act (CEPA) (CCME 2000). Under this CWS, the government has committed to reducing levels of $PM_{2.5}$ significantly by 2010. Achievement of this standard is based on the 24-hour 98th percentile of the ambient measurement annually, measured over three consecutive years. The CWS is considered to be an important step towards the long-term goal of reducing the health risks of $PM_{2.5}$. It represents a balance between achieving the best health and environmental protection possible and the feasibility and costs of reducing pollutant emissions that contribute to $PM_{2.5}$ in ambient air. This value is also within the range of both the US EPA and WHO values. The CCME's CWS of **30 µg/m³** was used in the acute assessment of $PM_{2.5}$.

AENV (2011) cites the CWS for its 1-hour AAQG and 24-hour AAQO for fine particulate matter, based on the 2nd highest 24-hour value. The 1-hour value is intended for use in monitoring and reporting of the Ambient Air Quality Index. A description of the CWS is provided above. The CWS was selected over the AENV value, as the value of 30 µg/m³ is the primary source, and the CCME provides more substantive supporting documentation than AENV.

The US EPA (2006) presents a 24-hour ambient air quality standard of 35 µg/m³ for $PM_{2.5}$ for protection against adverse health effects with respect to peak daily concentrations. This value is based on the 98th percentile of 24-hour concentrations over a 3-year period. As the CCME value is slightly more conservative, the US EPA value was not selected.

The WHO (2005) derived a 24-hour value of 25 µg/m³ based on the 99th percentile of 3 years of daily averages. In the supporting documentation for this value, WHO (2005) notes that the use

of the 24-hour value is useful in protecting against excess mortality or morbidity on an episodic basis. This value was not used in favour of the CCME derived CWS for $PM_{2.5}$.

B22.1.2 Chronic Inhalation Exposure Limits

Table B22.2 Chronic Inhalation Exposure Limits for $PM_{2.5}$

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	–	–	Health Canada 2009, 2004
OEHHA	Annual Standard	– – 12	OEHHA 2009 OEHHA 2008 CARB 2005, 2002
RIVM	–	–	RIVM 2009, 2001
TCEQ	–	–	TCEQ 2011
US EPA	Annual Standard	15	US EPA 2006
WHO	Annual Guideline	10	WHO 2005

– = Not available

The California Air Resources Board (CARB) identified an air quality annual average standard for $PM_{2.5}$ of **12 µg/m³** (CARB 2005, 2002). This recommended arithmetic mean value was "based on a growing body of epidemiological and toxicological studies showing significant toxicity (resulting in mortality and morbidity) related to exposure to fine particles". Similar to the CEPA/FPAC reference level, the value was derived based on the average 24-hour concentrations in cities where statistically significant increases in health responses were detected. The CARB Staff report recommendation was adopted by the State of California as an ambient air quality standard in June of 2002. This value was selected, as it falls within the range of annual criteria recommended by the WHO and US EPA.

In 1997, the US EPA first set National Ambient Air Quality Standards (NAAQS) for fine particles. Two primary $PM_{2.5}$ standards were set: an annual standard of 15 µg/m³ to protect against health effects caused by exposures ranging from days to years and a 24-hour standard of 65 µg/m³ to provide additional protection on days with high peak $PM_{2.5}$ concentrations. In September 2006, the US EPA (2006) issued a new suite of standards to better protect public health from particle pollution. The revised NAAQS for $PM_{2.5}$ reduced the 24-hour standard from 65 to 35 µg/m³ and retained the annual standard of 15 µg/m³ (US EPA 2006). The 24-hour standard is based on the 98th percentile annual measurement, averaged over three years, while the annual standard is met when the 3-year average of the annual average $PM_{2.5}$ concentration is less than or equal to 15 µg/m³.

The WHO (2005) recommends an annual average of 10 µg/m³, and suggests the annual average should take precedence over the daily guideline because at low levels there is less concern for episodic excursions. The annual average guideline is based on long-term exposure studies using the American Cancer Society (ACS) data (Pope et al. 2002) and Harvard Six-Cities data (Dockery et al. 1993). The studies reported a robust association between PM exposure and mortality. Historical mean $PM_{2.5}$ concentrations across cities in these two studies were 18 and 20 µg/m³, respectively, but average concentrations in individual cities were as low as 11 µg/m³ over the period of study. An annual mean guideline concentration of 10 µg/m³ was

therefore noted to be below the mean for most likely effects (WHO 2005). However, both the WHO (2005) and the US EPA (2005) note that statistical uncertainties in the risk estimates become apparent at concentrations of about 13 µg/m³, below which confidence bounds significantly widen, indicating the possibility of an effects threshold. In their staff paper, the US EPA (2005) noted that an annual standard of 12 µg/m³ would be precautionary, but a standard set below the range of 12 to 15 µg/m³ would be highly precautionary, "giving little weight to the remaining uncertainties in the broader body of evidence, including other long-term exposure studies that provide far more inconsistent results". The CARB (2005, 2002) value of **12 µg/m³** was selected for use in the assessment, as it falls between the US EPA and WHO values.

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B23.0 PYRENE

B23.1 Inhalation Exposure Limits

B23.1.1 Acute Inhalation Exposure Limits

Table B23.1 Acute Inhalation Exposure Limits for Pyrene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
OEHHA	–	–	OEHHA 2008
OMOE	–	–	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a

WHO	–	–	WHO 2000

– = Not available

Acute inhalation exposure limits for pyrene are not available from the agencies listed above. The search for limits was expanded to include short-term occupational limit values (i.e., STEL and Ceiling) developed by the ACGIH (2011), and AEGLs-1 (2011b) developed by the US EPA (2011b). Acute exposure limits for pyrene were not available from these sources either, therefore pyrene was not assessed individually on an acute basis. Pyrene was included in the acute inhalation assessment as a component of the C_9-C_{18} aromatic group.

B23.1.2 Chronic Inhalation Exposure Limits

Table B23.2 Chronic Inhalation Exposure Limits for Pyrene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	–	–	Health Canada 2009, 2004
OEHHA	– –	– –	OEHHA 2008 OEHHA 2009
RIVM	–	–	RIVM 2001
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011a
WHO	–	–	WHO 2000

– = Not available

None of the agencies listed above provide chronic inhalation exposure limits for pyrene. Expanding the search to include occupational TLV-TWA values from the ACGIH (2011), intermediate inhalation MRLs from ATSDR (2011), and PPRTVs from the US EPA (2011c) did not yield any chronic limits for pyrene either. As a result, pyrene was not evaluated individually in the chronic inhalation assessment, but was assessed as part of the C_9-C_{18} aromatic group.

B23.2 Oral Exposure Limits

B23.2.1 Chronic Oral Exposure Limits

Table B23.3 Chronic Oral Exposure Limits for Pyrene

Regulatory Agency	*Type*	*Value (µg/kg bw/d)*	*Reference*
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	TDI –	30 –	Health Canada 2009 Health Canada 2011
OEHHA	– –	– –	OEHHA 2008 OEHHA 2009
RIVM	CR	500	RIVM 2001
US EPA	RfD	30	US EPA 2011a, 1993
WHO	–	–	WHO 2011

– = Not available

The US EPA (2011a,1993) presents a chronic RfD of 30 µg/kg/day for pyrene based on kidney effects in mice. Male and female CD-1 mice (20 per sex per dose) were exposed to 0, 75, 125, or 250 mg/kg/day pyrene in corn oil via oral gavage for 13 weeks. Mild kidney lesions were observed in all dose groups in both sexes, primarily renal tubular degeneration sometimes appearing with interstitial lymphocytic infiltrates or fibrosis. Relative and absolute kidney weights were reduced in the 125 and 250 mg/kg/day dose groups. The lowest dose group (75 mg/kg/day) was determined to be the NOAEL, while the 125 mg/kg/day was identified to be the LOAEL. An uncertainty factor of 3,000 was applied to the NOAEL to account for interspecies differences (10), intraspecies variability (10), the use of a subchronic study (10), and lack of data in another species and reproductive/developmental studies (3). The resulting oral RfD of **30 µg/kg bw/d** was used in this assessment.

The Health Canada (2009) TDI of 30 µg/kg/day was adopted from the US EPA (described above).

RIVM (2001) presents a CR_{oral} of 500 µg/kg/day for pyrene, which is associated with a lifetime excess cancer risk of one in 10,000. Converted to a risk level of one in 100,000, this value is 50 µg/kg/day. As limited information regarding this value was provided in the supporting documentation, it was not used in the assessment.

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B24.0 SULPHUR DIOXIDE (SO_2)

B24.1 Inhalation Exposure Limits

B24.1.1 Acute Inhalation Exposure Limits

Table B24.1 Acute Inhalation Exposure Limits for Sulphur Dioxide

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO	450	AENV 2011

	24-hour AAQO	125	
ATSDR	1-hour MRL	26	ATSDR 2011, 1998
OEHHA	1-hour	660	OEHHA 2008a, 2008b
OMOE	1-hour 24-hour	680 275	OMOE 2008
TCEQ	–	–	TCEQ 2011
US EPA	1-hour NAAQS	196	US EPA 2010
WHO	24-hour AQG 10-minute AQG	20 500	WHO 2006 WHO 2000

– = Not available

The US EPA (2010) has derived a 1-hour NAAQS of 75 ppb (**196 µg/m^3**) for SO_2 that is intended to protect against short-term effects such as: decrements in lung function, respiratory symptoms, and respiratory morbidity as reflected by emergency department visits and hospital admissions. The value is intended for comparison with a 3-year average of the 99th percentile of the daily maximum 1-hour average concentrations of SO_2. This 1-hour NAAQS was used in the acute effects assessment for SO_2.

Alberta Environment (AENV 2011) has a 1-hour and a 24-hour AAQO for SO_2. The 1-hour value of 450 µg/m^3 was adopted from Health Canada's NAAQO, which represents air quality goals designed for the protection of the general public and the environment (Health Canada 2006). The 1-hour AAQO is health-based and based on controlled studies in sensitive populations (i.e., asthmatics), however, detailed supporting documentation is lacking. Due to the existence of the more robust US EPA value, the AENV 1-hour value was not used in the assessment. In addition, sulphur dioxide was not assessed on a 24-hour basis using the 24-hour average adopted from the European Union. Although AENV indicates the value is based on human health, supporting documentation is not available for review.

The ATSDR (2011, 1998,) has derived a 1-hour acute MRL of 26 µg/m^3 based on respiratory irritation in two studies that involved asthmatics. In the first study, seven people were exposed to 0.1, 0.25 or 0.5 ppm of SO_2 (262, 655, or 1,310 µg/m^3) via a mouthpiece, during exercise. The duration of exposure was not described by the ATSDR (1998). Significant effects on respiratory capacity were observed at 0.25 ppm and above, with very slight effects observed at 0.1 ppm. In the second study, two experiments were conducted. In the first experiment, six individuals were exposed to 1 ppm (2,620 µg/m^3) of SO_2 via a mouthpiece for 5-minutes during exercise. In the second experiment, individuals were exposed to SO_2 concentrations of 1 ppm (2,620 µg/m^3) and asked to voluntarily hyperventilate for an unknown duration of time. In both experiments, all individuals experienced decreased respiratory function and wheezing. The ATSDR (1998) identified 0.1 ppm (262 µg/m$^{3)}$ as a minimal LOAEL for acute SO_2 exposure. An uncertainty factor of 9 was applied to this LOAEL to account for intraspecies differences (3) and the use of a LOAEL (3), resulting in a value of 0.01 ppm or 26 µg/m^3. This value was not selected for use in the assessment for a number of reasons. Firstly, the studies upon which it is based involved the direct inhalation of SO_2 via a mouthpiece, as opposed to breathing within an exposure chamber (which would be more relevant to ambient air exposures). In addition, some elements of the study design were not clear, for example no control subjects were discussed, and the duration of exposure to each concentration was not well described. The results also seemed to be a mixture of exercising, resting and hyperventilating subjects, as well as

individuals of varying health status. All of these factors influence the robustness of the ATSDR value, and as a result, this MRL was not selected for use in the assessment.

The OMOE (2008) present 1-hour and 24-hour air standards for sulphur dioxide of 680 and 275 µg/m^3, both based on the protection of health and vegetation. However, no detailed supporting documentation is available for these standards. As a result, they were not used in the assessment.

The OEHHA (2008a, 2008b) presents a 1-hour value of 660 µg/m^3 based on a NOAEL of 0.25 ppm (660 µg/m^3), which is based on a review of multiple studies of clinical SO_2 exposure in humans. The studies reviewed by the OEHHA included normal, healthy individuals as well as asthmatics and atopic individuals, with exposure to SO_2 taking place during exercise as well as rest. Very limited information regarding study design or individual study results was provided, and uncertainty factors were not applied to the NOAEL in the derivation of the REL (OEHHA 2008b). Due to the existence of a more conservative value from the US EPA that is supported by documentation, the OEHHA value was not used in the assessment.

WHO (2006) presents a 24-hour value of 20 µg/m^3. However, the basis of this value with respect to human effect thresholds is not particularly clear. In addition, the supporting document (WHO 2006) notes that it is not certain whether or not the effects observed in large-scale epidemiological studies are attributable to SO_2 or another air contaminant such as ultrafine particulate. Given the lack of clarity regarding the basis of this guideline, and due to the existence of the more robust US EPA value, the WHO value was not selected for use in the assessment.

SO_2 also was assessed using a 10-minute AQG of **500 µg/m³** developed by the WHO (2000). This AQG is based on changes in lung function in asthmatics (WHO 2000). The 10-minute exposure period is relevant, given that the effects of sulphur dioxide exposure in humans primarily involved irritation at the point of contact (irritation) and 'peak' in severity within the first moments of exposure (WHO 2000).

Using the above objectives and guidelines, the acute assessment for sulphur dioxide was completed on a 10-minute and 1-hour basis.

B24.1.2 Chronic Inhalation Exposure Limits

Table B24.2 Chronic Inhalation Exposure Limits for Sulphur Dioxide

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	Annual AAQO	20	AENV 2011
ATSDR	–	–	ATSDR 2011
HEALTH CANADA	–	–	Health Canada 2009, 2004
OEHHA	–	–	OEHHA 2009 OEHHA 2008a
RIVM	–	–	RIVM 2009, 2001
TCEQ	–	–	TCEQ 2011
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

− = Not available

AENV provides an annual AAQO of 20 µg/m³ (AENV 2011). This AAQO was adopted from the European Union, but was not used in the assessment as it is based on ecosystem effects rather than human health, and no supporting documentation is available.

The toxicity search was expanded to include occupational TLV-TWA values from the ACGIH (2011), intermediate inhalation MRLs from ATSDR (2011), and PPRTVs from the US EPA (2011c). The search did not identify any SO_2 criteria from any of these additional sources, therefore SO_2 was not assessed on a chronic basis.

B24.2 Oral Exposure Limits

B24.2.1 Chronic Oral Exposure Limits

Sulphur dioxide is a gaseous criteria air contaminant which acts on the point of contact once it is inhaled, (i.e., the respiratory system). As such, it was not evaluated in the multiple pathway assessment.

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B25.0 TOLUENE

B25.1 Inhalation Exposure Limits

B25.1.1 Acute Inhalation Exposure Limits

Table B25.1 Acute Inhalation Exposure Limits for Toluene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	1-hour AAQO 24-hour AAQO	1,880 400	AENV 2011, 2004

ATSDR	24-hour MRL	3,800	ATSDR 2011, 2000
OEHHA	1-hour REL	37,000	OEHHA 2008a, 2008b
OMOE	–	–	OMOE 2008
TCEQ	1-hour ReV	15,000	TCEQ 2011, 2008
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

− = Not available

The same key study (Anderson et al., 1983) was chosen by the TCEQ, the ATSDR and OEHHA as the basis for their values.

As reported by Andersen et al. (1983), 16 healthy subjects with no previous exposure to organic solvents were exposed to toluene for 6 hours/day over 4 consecutive days. The concentration of toluene was 0, 10, 40, or 100 ppm with each group exposed to a different toluene concentration each day. After 1-hour of exposure to the desired toluene concentration, physiological measurements and performance assessments test were carried out on all subjects. The tests were repeated in the 5th and 6th hours of exposure. No adverse effects were reported at the 10 and 40 ppm levels, but statistically significant increased irritation was experienced in the eyes and nose at the 100 ppm concentration. There was also a statistically significant increase in the occurrence of headaches, dizziness, and feeling of intoxication. A NOAEL of 40 ppm (150 mg/m³) was identified.

The TCEQ, ATSDR and OEHHA share the opinion that the NOAEL of 40 ppm (150 mg/m³) is appropriate for short-term inhalation of toluene and that an uncertainty factor of 10 is sufficiently protective of the general population. The discrepancies between the limits derived arise from the duration adjustments applied by the individual regulatory agencies.

The TCEQ (2008) elected not to adjust the exposure duration based on a weight of evidence that suggests that concentration rather than duration is the primary determinant of the effects of toluene. The TCEQ (2008) only applied the uncertainty factor of 10 for intraspecies variability to the NOAEL of 40 ppm (150 mg/m³). The result is an acute ReV of **15,000 µg/m³,** which was selected as the 1-hour exposure limit in the acute effects assessment of toluene, as it represents the most conservative value that takes into account the short-term, concentration-related effects of toluene.

The ATSDR (2000) adjusted the NOAEL of 40 ppm to account for intermittent exposure (6/24 hours × 4/7 days). An uncertainty factor of 10 was applied to the adjusted NOAEL to account for intraspecies variability, resulting in an MRL 0f 0.6 ppm, which was rounded to 1 ppm (3,800 µg/m³). This value was not selected due to the adjustment to a 24 hour MRL.

The OEHHA (2008a, 2008b) converted the 6-hour exposure duration to a 1-hour REL of 98 ppm (370 mg/m³) based on a modified Haber's Law, and applied an uncertainty factor for intraspecies variability (10), resulting in an acute 1-hour REL of 37,000 µg/m³. This value was not used as the TCEQ value is more conservative.

Alberta Environment (AENV 2011) has established a 1-hour AAQO of 1,880 µg/m³, which was adopted from the TCEQ ESL. However, TCEQ has since updated their health based acute ReVs and ESLs and therefore the AENV limit is not up to date. The AENV also provides a 24-

hour AAQO of 400 µg/m³ adopted from the Michigan Department of Environmental Quality and the Washington Department of Ecology (AENV 2011, 2004). These regulatory agencies based their 24-hour guidelines on the US EPA chronic inhalation RfC of 400 µg/m³ (2011) which has since been revised to be 5,000 µg/m³. As the AENV values are based on out-dated chronic information, they were not considered further for use in the assessment.

B25.1.2 Chronic Inhalation Exposure Limits

Table B25.2 Chronic Inhalation Exposure Limits for Toluene

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	300	ATSDR 2011, 2000
HEALTH CANADA	TC	3,800	Health Canada 2009
OEHHA	REL	300	OEHHA 2008a, 2000
RIVM	TCA	400	RIVM 2001
TCEQ	ReV	4,100	TCEQ 2011, 2008
US EPA	RfC	5,000	US EPA 2011, 2005
WHO	–	–	WHO 2000

− = Not available

The US EPA (2011, 2005) has derived an inhalation RfC based on the findings of 10 human studies, each of which examined the neurological effects in occupationally exposed workers. These studies are more recent than the studies used by Health Canada and the ATSDR. An average NOAEL of 34 ppm (128 mg/m³) was identified from the meta-analysis. This NOAEL was adjusted for the differences in breathing rates between workers and members of the public and the reduced weekly exposure time (US EPA 2005):

$$NOAEL_{ADJ} = NOAEL \times \frac{MV_{ho}}{MV_h} \times \frac{Exp_{ho}}{Exp_h}$$

Where:

$NOAEL_{ADJ}$ = no-observable-adverse-effects level in the human population from continuous exposure to toluene (mg/m³)

NOAEL = no-observable-adverse-effects level for discontinuous exposure in an occupational setting (128 mg/m³)

MV_{ho} = amount of air used by a worker during an 8-hour work period (10 m³/d)

MV_h = amount of air used by an individual in the general population during a day (20 m³/d)

Exp_{ho} = days per week a worker is exposed (5-days)

Exp_h = days per week an individual in the general population is exposed (7-days)

The US EPA (2005) also applied an uncertainty factor of 10 to the $NOAEL_{ADJ}$ to account for human variability. The US EPA RfC of **5,000 µg/m³** represents the most recent analysis of the available scientific literature and therefore was used in the current assessment.

The ATSDR (2011, 2000) has derived a chronic inhalation MRL of 0.08 ppm (300 µg/m³) based on colour vision impairment in workers exposed to toluene. Three groups of Croatian workers were examined through interviews, medical examinations and colour vision testing (Zavalic et al. 1998). A LOAEL of 35 ppm (130 mg/m³) was determined for alcohol- and age-adjusted colour vision impairment. The LOAEL was adjusted for intermittent exposure (8/24 hours × 5/7 days) to a concentration of 8 ppm (30 mg/m³). The ATSDR (2000) applied an uncertainty factor of 100 to the duration-adjusted LOAEL to account for intraspecies variability (10), and the use of a LOAEL (10). This MRL was not used as the chronic exposure limit for toluene as it was developed from a LOAEL, as opposed to the NOAEL used in the US EPA derivation.

Health Canada (2009) established its chronic tolerable concentration of 3,800 µg/m³ on the same lowest reported NOAEL of 150 mg/m³ (40 ppm) for neurological effects and respiratory irritation in human volunteers as used by the ATSDR to derive the acute MRL (Andersen et al. 1983; Government of Canada 1992). The study NOAEL was adjusted from 6-hour daily dosing to continuous exposure and an uncertainty factor of 10 was applied to account for intraspecies variability. This value was not selected for use as it was not based on an actual chronic study duration.

The OEHHA (2008, 2000) has derived a chronic REL of 300 µg/m³ based on a rat study and supported by human data. In the key animal study, male rats were exposed to 0, 40, 80, 160 or 320 ppm for 6 hours/day, 5 days/week for 4 weeks. Significantly decreased brain weights (specifically the caudate-putamen and subcortical limbic areas), and altered dopaminergic nerve receptor activity were observed at concentrations of 80 ppm and above. A human occupational study of female workers in an electronics assembly plant exposed on average to toluene vapours for about 5.7 years also suggested a LOAEL of about 88 ppm. The OEHHA selected 40 ppm as a LOAEL. This value was adjusted for continuous exposure (6/24hours, 5/7days) to a $LOAEL_{ADJ}$ of 7 ppm. The OEHHA (2000) applied a cumulative uncertainty factor of 100 to account for the use of a LOAEL (10), and human variability (10). This value was not used in the chronic effects assessment, as although it is verified by some human data, its basis is primarily derived from an animal study. Further, the REL is derived from a LOAEL, rather than a NOAEL (as in the US EPA RfC derivation process).

The TCEQ (2011, 2008) derived the chronic ReV of 4,100 µg/m³ based on a human occupational study where workers were exposed to 0, 32 or 132 ppm for over 10 years. A significant increase in colour confusion was observed at 132 ppm and a NOAEL of 32 ppm for the incidence of neurological effects was identified. This NOAEL was determined by the TCEQ to be supported by the results of three other studies, where average LOAELs ranging from 50 to 140 ppm were reported. The NOAEL of 32 ppm was adjusted to account for differences in the air volume inhaled by workers versus the general public, and to adjust for continuous exposure (10/20 m³/day x 5/7 days). The $NOAEL_{ADJ}$ was determined to be about 11.4 ppm. The TCEQ applied an uncertainty factor of 10 to this value to account for human variability. Preference was given to the US EPA RfC because its NOAEL was derived from the analysis of 10 different studies and is based on a greater scientific weight of evidence.

The RIVM (2001) has developed a TCA of 400 µg/m³ for toluene. This TCA was adopted from a previous US EPA RfC, which has since been revised. As a result, the RIVM value was not used in the chronic inhalation effects assessment for toluene.

B25.2 Oral Exposure Limits

Toluene was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria to be defined as a non-volatile chemical. Thus, a chronic oral exposure limit was not required for toluene.

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B26.0 XYLENES

B26.1 Inhalation Exposure Limits

B26.1.1 Acute Inhalation Exposure Limits

Table B26.1 Acute Inhalation Exposure Limits for Xylenes

Regulatory Agency	*Type*	*Value (µg/m³)* [(a)]	*Reference*
AENV	1-hour AAQO 24-hour AAQO	2,300 700	AENV 2011
ATSDR	1-hour MRL	8,700	ATSDR 2011, 2007
OEHHA	1-hour REL	22,000	OEHHA 2008a, 2008b
OMOE	24-hour standard	730	OMOE 2008, 2005
TCEQ	1-hour ReV	7,400	TCEQ 2011, 2009
US EPA	–	–	US EPA 2011
WHO	–	–	WHO 2000

– = Not available

(a) Exposure limit provided for m-xylene, o-xylene, p-xylene or mixed isomers.

The TCEQ (2011, 2009) has derived an acute ReV of 1.7 ppm (7,400 µg/m³) for xylenes based on mild respiratory effects and subjective symptoms of neurotoxicity. Ernstgard et al. (2002)

was selected as the key study for the derivation of the acute ReV. In this study, 56 human volunteers were exposed to 50 ppm m-xylene, clean air, or 150 ppm 2-propanol for 2 hours in an inhalation chamber (TCEQ 2009). The TCEQ (2009) identified a LOAEL of 50 ppm based on breathing difficulty in both sexes and discomfort in the throat and airways of females. In addition, symptoms of neurotoxicity were reported, including fatigue, headache, dizziness, and a feeling of intoxication. All of these effects were considered minimal (TCEQ 2009). The LOAEL was not adjusted to a 1-hour exposure duration because the exposure concentration, as opposed to the duration of exposure, was identified as the primary determinant of the adverse effects of xylene (TCEQ 2009). An uncertainty factor of 10 was applied to the LOAEL to account for intraspecies variability and an uncertainty factor of 3 was applied to the LOAEL to account for use of a minimal LOAEL.

The ATSDR (2011, 2007) also selected the study by Ernstgard et al. (2002) as the basis of their MRL. A concentration of 50 ppm (200 mg/m³) was designated as a LOAEL for slight respiratory effects (e.g., reduced forced vital capacity, increased discomfort in throat and airways in women and breathing difficulties in both sexes) and subjective symptoms of neurotoxicity (e.g., headache, dizziness, feelings of intoxication). The LOAEL was considered minimal due to the minor nature of the effects observed (ATSDR 2007). The ATSDR (2007) applied an uncertainty factor of 30 for intraspecies variability (10) and use of a (minimal) LOAEL (3), resulting in an acute MRL of 2 ppm (8,700 µg/m³).

Although the TCEQ and ATSDR selected the same study and LOAEL, the exposure limits are slightly different due to rounding differences. Given that the TCEQ provides a lower limit, this acute ReV of **7,400 µg/m³** was used as a 1-hour exposure limit in the acute assessment.

The OEHHA (2008a, 2008b) has derived a REL for 1-hour exposure of 22,000 µg/m³ based on irritation of the eyes, nose, and throat. In the study by Hastings et al. (1984), 50 healthy human volunteers were exposed for 30 minutes to concentrations of 430, 860, or 1,720 mg/m³ of technical grade (mixed) xylene. A NOAEL of 100 ppm (430 mg/m³) was identified by Hastings et al. (1984) as it was observed that the incidence of eye irritation was comparable to what was reported in the control group. The NOAEL was adjusted to a 1-hour exposure of 50 ppm (C × 60 min = 100 ppm × 30 min). A cumulative uncertainty factor of 10 was applied to the NOAEL to account for intraspecies variation. The result is an acute REL of 5 ppm (22,000 µg/m³). As the OEHHA limit is less conservative than the limit provided by TCEQ (2011, 2009) this exposure limit was not selected for use in the acute assessment.

Alberta Environment (AENV 2011) adopted the OMOE's half-hour point-of-impingement of 2,300 µg/m³ as its 1-hour AAQO. However, this POI was based on odour perception and has since been updated (OMOE 2008). AENV (2011) also provides a 24-hour AAQO of 700 µg/m³ which was adopted from the OEHHA. However, as the OEHHA value is based on chronic studies, it was not considered appropriate for use in the acute assessment.

The OMOE (2008, 2005) has derived a 24-hour criteria of 730 µg/m³ based on adverse neurological effects. A LOAEL of 62 mg/m³ was established for headaches, eye and nasal irritation and light headedness (floating sensation) in approximately 300 workers, 175 of whom were occupationally exposed for an average of seven years. The LOAEL was adjusted by the OMOE (2005) to account for discontinuous exposure to a concentration of 22.1 mg/m³. As this 24-hour value is based on chronic exposure, it was not used in the assessment.

B26.1.2 Chronic Inhalation Exposure Limits

Table B26.2 Chronic Inhalation Exposure Limits for Xylenes

Regulatory Agency	*Type*	*Value (µg/m³)*	*Reference*
AENV	–	–	AENV 2011
ATSDR	MRL	220	ATSDR 2011, 2007
HEALTH CANADA	TC	180	Health Canada 2009
OEHHA	REL –	700 –	OEHHA 2008a, 2000 OEHHA 2009
RIVM	TCA	870	RIVM 2001
TCEQ	ReV	610	TCEQ 2011, 2009
US EPA	RfC	100	US EPA 2011, 2003
WHO	–	–	WHO 2000

– = Not available

The TCEQ (2011, 2009) has derived a chronic ReV of 610 µg/m³ based on a study by Uchida et al. (1993), in which a LOAEL of 14 ppm was identified from a population of 175 workers who were exposed to xylenes for an average of 7 years. Eye irritation, sore throat and mild neurological effects were reported as the critical effects. Two supporting rat studies that present NOAELs and LOAELs that are higher than the LOAEL of 14 ppm from the occupational study also are discussed by the TCEQ. No adjustments for continuous exposure were made by the TCEQ as xylene is quickly absorbed and excreted. A cumulative uncertainty factor of 100 was applied to the LOAEL of 14 ppm to account for the use of a minimal LOAEL (3), database uncertainties (3), and intraspecies variability (10). This resulting acute ReV of 0.14 ppm (**610 µg/m³)** was selected for use in the chronic effects assessment as it is based on human data.

The ATSDR (2011, 2007) provides a value of 220 µg/m³ as its chronic MRL. This value is based on a LOAEL of 50 ppm identified for slight respiratory effects and increased discomfort in airways in females, and breathing difficulties in both males and females after exposure to m-xylene (Ernstgard et al., 2002). Symptoms of neurotoxicity (headache, dizziness, a feeling of intoxication) were also reported at this concentration. The ATSDR justifies that the MRL is applicable for mixed xylenes and all individual isomers as the isomers have similar toxicokinetic properties and elicit similar toxicological effects.

In the study by Ernstgard et al., (2002), male and female volunteers (28 per sex) were exposed to either 50 ppm (200 mg/m^3) *m*-xylene, clean air or 150 ppm 2-propanol in a dynamic exposure chamber for 2 hours. 2 weeks later each volunteer was exposed to a different treatment, and then another two weeks after that. Individuals rated their level of discomfort using a visual analog scale (0–100 mm) in a questionnaire with 10 questions, three times during, and twice post-exposure.

Statistically significant rating increases occurred for all of the following symptoms: Discomfort in the eyes and nose, a solvent smell and feelings of intoxication were reported by both sexes after 60 and 118 minutes of exposure to *m*-xylene at 50 ppm, discomfort in the throat was reported only by females after 60 minutes. Both sexes reported difficulty breathing and nausea after 118 minutes, but females experienced also experienced both symptoms at 60 minutes. Males experienced headache and fatigue at both timepoints. Therefore a minimal LOAEL of 50

ppm (200,000 µg/m³) for respiratory effects was identified. The ATSDR applied an uncertainty factor of 30 (3 for use of a LOAEL, 10 for intraspecies variability) to the LOAEL, resulting in the MRL of 220 µg/m³. This value was not used in the assessment as the TCEQ value, which was also based on a human exposure study, had a more applicable chronic exposure duration.

The OEHHA (2008a, 2000) has developed a chronic REL of 700 µg/m³ based on the incidence of eye irritation, sore throat and mild neurological effects using the same study selected by the TCEQ (described above). The OEHHA also identified a LOAEL of 14 ppm, however the OEHHA adjusted the LOAEL to 5.1 ppm to account for continuous exposure (taking into account the differences in breathing air volumes/day between workers and the general public (10/20 m³/day) and the number of days in a work-week (5 days/week) whereas the TCEQ did not. The OEHHA applied an uncertainty factor of 30 to the adjusted LOAEL to account for the use of a LOAEL (3, due to the minor nature of the adverse effects) and for human variability (10). This value was not chosen as the TCEQ value is more conservative. The US EPA (2011, 2003) RfC of 100 µg/m³ was derived from a NOAEL of 217 mg/m³ for impaired motor coordination from a subchronic inhalation study in male rats (Korsak et al. 1994). In this study, male rats were exposed to 0, 50, or 100 ppm of m-xylene, n-butyl alcohol, or a 1:1 mixture of toluene and xylenes for 6 hours/day, 5 days/week for a 3-month duration. A LOAEL of 100 ppm and a NOAEL of 50 ppm were identified based on neurological effects (decreased rotarod performance and response to heat). The NOAEL of 50 ppm (217 mg/m³) was adjusted for continuous exposure (6/24 hours, 5/7 days). A safety factor of 300 was applied to the adjusted NOAEL to account for laboratory animal-to-human differences (3), intraspecies uncertainty to account for human variability and sensitive populations (10), extrapolation from subchronic to chronic duration (3), and uncertainties in the database (3). Although this value is the most conservative of those presented in the table above, it is based on animal data, and thus is associated with a greater degree of uncertainty. This value was not used, due to the existence of a defensible human-based value.

Health Canada (2009) provides a provisional TC of 180 µg/m³. This value is based on a LOAEL of 250,000 reported in a rat study in which pregnant rats were exposed to xylenes 24 hours/day for gestational days 7 to 15. The dose of 250,000 µg/m³ was the LOAEL for maternal effects as well as fetal retardation, increased fetal mortality and re-absorption. This value was adjusted to a human–child equivalent dose of 180,000 µg/m³. An uncertainty factor of 1,000 (intraspecies variability (10), interspecies variability (10), use of a LOAEL and study limitations (10)) was applied, resulting in a tolerable concentration of 180 µg/m³. This value was not used, due to the existence of a defensible human-based value.

The RIVM (2001) has developed a TCA of 870 µg/m³ for developmental neurotoxicity. In the key study, decreased rotarod performance was observed in the offspring of rats exposed to 200 ppm (870 mg/m³) technical grade xylene for 6 hours/day on gestational days 6 through 20 (Hass and Jakobsen 1993). The inhaled xylene concentration of 870 mg/m³ was reported by RIVM as the study LOAEL (no other exposure levels were reported and no NOAEL was identified). A cumulative uncertainty factor of 1,000 was applied to the LOAEL to account for interspecies variability (10), intraspecies variability (10), and use of a LOAL instead of a NOAEL (10). In a later study by the same group of investigators, Hass et al. (1995) questioned the rotarod performance test in the original study, as it was not conducted by experimenters who were blind to the exposure status of the rats. Further, decreased rotarod performance was not observed in the later Hass et al. (1995) study, which exposed rats to 500 ppm (2,200 mg/m³) mixed xylenes for 6 hours/day on gestation days 7 through 20. As well, offspring of rats exposed to 800 or

1,600 ppm (6,900 mg/m³) p-xylene for 6 hours/day on gestation days 7 through 16 performed similarly to offspring of non-exposed rats in tests of central nervous system development (Rosen et al. 1986). Due to the inconclusive significance of the toxicological endpoint (rotarod performance), and the existence of a human-based value, this TCA was not used in the chronic inhalation assessment for xylenes.

B26.2 Oral Exposure Limits

B26.2.1 Chronic Oral Exposure Limits

Xylene was not incorporated into the multiple pathway exposure assessment because it did not exceed the physical-chemical criteria to be defined as a non-volatile chemical. Thus, a chronic oral exposure limit was not required for xylenes.

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Glossary

µg/kg bw/d	microgram per kilogram of body weight per day
µg/L	Microgram per litre
µg/m³	microgram per metre squared
AAQG	Ambient Air Quality Guideline
AAQO	Ambient Air Quality Objective
ACGIH	American Conference of Governmental Hygienists Inc.
ADJ	Adjusted value
AEGL-1	Acute Exposure Guideline Level 1
AENV	Alberta Environment
AQG	Air quality guideline
ATSDR	Agency for Toxic Substances and Disease Registry
BMC	Benchmark Concentration
BMCL ($_{01}$, $_{05}$, $_{10}$)	Benchmark Concentration 95% lower confidence interval
BMD	Benchmark Dose
CARB	California Air Resources Board
CCME	Canadian Council of Ministers of the Environment
CEPA	Canadian Environmental Protection Act
CEPA/FPAC	Canadian Environmental Protection Act/Federal–Provincial Advisory Committee
CNS	Central Nervous System
COHb	carboxyhemoglobin in blood
COPC	Chemical of Potential Concern
CR	Carcinogenic Risk
CWS	Canada-Wide Standard
ESL	Effects Screening Level
FEV	Forced Expiratory Volume
GD	Gestational Day
HEC	Human Equivalent Concentration
HHRA	Human Health Risk Assessment
IARC	International Agency for Research on Cancer
IOM	Institute of Medicine
kg	kilogram
L/d	litre per day
LOAEL	Lowest-Observed-Adverse-Effect level
MA DEP	Massachusetts Department of Environmental Protection
mg/kg bw/d	millogram per kilogram of body weight per day
mg/m³	milligram per metre squared

MRL	Minimal Risk Level
n	number (as in n = 8)
NAAQO	National Ambient Air Quality Objective
NAAQS	National Ambient Air Quality Standards
NOAEL	No-Observed-Adverse-Effect level
NTP	National Toxicology Program
OEHHA	California Office of Environmental Health Hazard Assessment
OMOE	Ontario Ministry of the Environment
PAH	Polycyclic Aromatic Hydrocarbon
PEF	Potency Equivalence Factor
$PM_{2.5}$	Particulate matter less than 2.5 micrograms
POI	Point of Impingement
ppb	parts per billion
ppm	parts per million
PPRTV	Provisional Peer Review Toxicity Value
REL	Reference Exposure Level
ReV	Reference Exposure Value
RfC	Reference Concentration
RfD	Reference Dose
RGDR	Regional Gas Dose Ratio
RIVM	Netherlands, National Institute of Public Health and the Environment, NIPHE).
RsC	Risk-specific Concentration
RsD	Risk-specific Dose
SF	Slope Factor
STEL	Short-Term Exposure Limit
TC	Tolerable Concentration
TCA	Tolerable Concentration in Air
TCEQ	Texas Commission on Environmental Quality
TDI	Tolerable Daily Intake
TEF	Toxic Equivalency Factor
TEQ	Toxic Equivalency Quotient
TLV	Threshold Limit Value
TLV-TWA	Threshold Limit Value – Time Weighted Average
TPHCWG	Total Petroleum Hydrocarbon Criteria Working Group
TRV	Toxicological Reference Value
U.S. EPA	United States Environmental Protection Agency
U.S. EPA IRIS	United States Environmental Protection Agency Integrated Risk Information System
WHO	World Health Organization

APPENDIX C

Model Description and Worked Example

APPENDIX C: MODEL DESCRIPTION AND WORKED EXAMPLE

Table of Contents

C1.0 INTRODUCTION

The human health risk assessment (HHRA) focused on direct and indirect health risks associated with air emissions from the Southern Pacific Resource Corp. Mackay Thermal Project (the Project). The Project will emit chemicals of potential concern (COPC) directly into air from various sources, thus people residing or working near the Project, as well as people visiting the area could be directly exposed to the COPC via inhalation.

In addition to the primary pathway of exposure (e.g., inhalation), people that live or work in the area might be exposed to the COPC via secondary exposure pathways. Some COPC emitted to the atmosphere via air emissions may be deposited onto the soils and plants surrounding the Project area. Depending on the fate, transport and persistence of the COPC in the environment, chemical deposition could affect the chemical concentrations in soils, water and foods (i.e., plants, game and fish) derived from the local study area (LSA).

Health risks from air emissions were characterized by comparing modelled long-term air concentrations of COPC with regulatory criteria considered protective of human health and these air concentrations were incorporated into the multimedia exposure model. Health risks from the consumption of game and other country foods were characterized through a detailed multimedia exposure model used to predict long term exposures from non-volatile, persistent or bioaccumulative chemicals. Estimated long-term exposures also were compared with COPC exposure limits considered protective of human health.

This appendix provides an example of the calculations used to estimate media concentrations and human exposures to the chemicals of potential concern (COPC) from long-term (chronic) multiple pathway way exposures to the emissions resulting from the proposed Mackay Thermal Project – Phase 2 (the Project) by Southern Pacific Resource Corp. (STP). Many of the methods, equations and assumptions used to predict concentrations in various environmental media were provided by the United States Environmental Protection Agency Office of Solid Waste (US EPA OSW 2005) and Health Canada (2009a). Potential multiple pathway exposures to the COPCs were predicted for residents and workers using the highest annual average concentrations and the highest incremental increase in concentrations.

C2.0 ENVIRONMENTAL MEDIA CONCENTRATIONS

In order to quantify potential human exposures (and associated health impacts) through the oral pathway as a result of emissions from the project, predicted chemical concentrations in various environmental media were required to estimate exposures and characterize risks. Chemical concentrations in the following media were estimated based on predicted annual air concentrations:

- Soil
- Surface water (i.e., ponds)
- Forage, traditional foods and vegetation (berries, plants)
- Dusts
- Wild game meat (moose, grouse, snowshoe hare)
- Fish

In addition to predicting media concentrations based on Project emissions, the multiple pathway exposure model also included Baseline sample data where applicable (See Section D.5-3.2.2). This worked example is presented for a resident toddler exposed to formaldehyde in the Application Case.

C2.1 Chemical Concentrations in Air

The maximum predicted annual average ground-level air concentration of the local maximum point of impingement (MPOI) was used to predict environmental concentrations for calculating game meat, surface water and fish meat concentrations. Maximum annual air concentrations were used to estimate soil, forage, surface water and invertebrate concentrations to which wildlife are exposed. The maximum annual average concentration of formaldehyde for all locations as a result of the Application Case was determined to be 0.1037 µg/m³ or *1.04E-01 µg/m³*. All media concentrations used to predict human and animal exposures can be found in Appendix D and Appendix E, respectively.

The maximum predicted annual average ground-level air concentration of all resident locations (which also includes cabin locations) was used to predict concentrations of garden produce (above and below ground) and traditional plants (cattail, Labrador tea, and berries). This air concentration was also used to estimate soil and dust concentrations to which humans could be exposed. The maximum annual average concentration of formaldehyde for the resident locations in the Application Case is the same value as determined for the animal exposures prediction, the value of 0.1037 µg/m³ or *1.04E-01 µg/m³*.

C2.1.1 Chemical Deposition

C2.1.1.1 Dry Deposition

Dry deposition rates were estimated with the following equation:

$$D_{dry} = C_a \times V_d \times CF1 \times CF2$$

Where:

D_{dry} = deposition rate of COPC (mg/m²/year)

C_a = COPC concentration in air (µg/m³)

V_d = dry deposition velocity for COPC (2.00E-02 m/s, extrapolated from Wesley and Hicks 2000)

CF1 = conversion factor from seconds per day (31,536,000 sec/year)

CF2 = conversion factor from µg to mg (0.001 mg)

Example C-1 **Dry deposition rate of formaldehyde for prediction of animal exposure**

$$D_{dry} = 1.04E-01 \times 0.02 \times 31{,}536{,}000 \times 0.001$$

$$D_{dry} = 6.56E+01\ mg/m^2/yr$$

Example C-2 **Dry deposition rate of formaldehyde for prediction of human exposure**

Same calculation as above

C2.1.1.2 Wet Deposition

Wet deposition rates were estimated with the following equation:

$$D_{wet} = C_a \times V_w \times CF1 \times CF2$$

Where:

D_{wet} = deposition rate of COPC (mg/m²/year)

C_a = COPC concentration in air (µg/m³)

V_w = wet deposition velocity for COPC (0.00289 m/s, extrapolated from Mackay 1991)

CF1 = conversion factor from seconds per day (31,536,000 sec/year)

CF2 = conversion factor from µg to mg (0.001 mg)

Example C-3 **Wet deposition rate of formaldehyde for prediction of animal tissue concentrations**

$$D_{wet} = 1.04E-01 \times 2.89E-03 \times 31{,}536{,}000 \times 0.001$$

$$D_{wet} = 9.48E+00\ mg/m^2/yr$$

Example C-4 **Wet deposition rate of formaldehyde for prediction of human exposure**

Same calculation as above

C2.1.1.3 Total Deposition

Total deposition rates were estimated with the following equation:

$$D_{tot} = D_{dry} + D_{wet}$$

Where:

D_{tot} = deposition rate of COPC (mg/m²/year)

D_{dry} = dry deposition (mg/m²/year)

D_{wet} = wet deposition (mg/m²/year)

Example C-5 **Total deposition rate of formaldehyde for prediction of animal tissue concentrations**

$$D_{tot} = 6.56E+01 + 9.48E+00$$

$$D_{tot} = 7.5E+00\ mg/m^2/yr$$

Example C-6 **Total deposition rate of formaldehyde for prediction of human exposure**

Same calculation as above

C2.2 Chemical Concentrations in Water

Surface water concentrations were used to predict exposure to wildlife via ingestion, and human exposure via fish consumption, dermal exposure and ingestion (as a drinking water source and incidentally while swimming). Surface water concentrations were predicted at a pond called SP16 which was one of the largest ponds identified in the project area with sufficient parameter information (e.g., area, depth and flow rate) to predict concentrations, for both wildlife and human exposure. The surface area, flow rate and depth of the pond along with the calculated amount of deposition were used to predict the surface water concentration.

C2.2.1 Mass of Deposition to Pond Surface

The deposition at pond SP16 was calculated using the maximum predicted annual average ground-level air concentration *1.04E-01 µg/m³***,** which corresponds with a deposition rate of *7.5E+01 mg/m²/yr.*

The total amount of formaldehyde deposited to the pond surface in a year was estimated with the following equation:

$$TML_{sw} = D_{tot} \times PA$$

Where:

TML_{sw} = total mass load to the pond surface over period of deposition (mg/yr)

D_{tot} = deposition rate of COPC (7.5E+01, mg/m²/year)

PA = pond area (2,250; m²)

Example C-7 **Mass of formaldehyde loaded to pond SP16 for the prediction of surface water concentrations**

$$TML_{sw} = 7.5E+01 \times 2{,}250$$

$$TML_{sw} = 1.7E+05\ mg/yr$$

C2.2.2 Surface Water Concentrations

Surface water concentrations in pond SP16 were calculated with the following modified equation (US EPA OSW 2005):

$$C_{sw} = \frac{TML_{sw} \times CF}{P_f \times P_{wc} + K_{sw} \times V_p}$$

Where:

C_{sw} = concentration in surface water (mg/L)

TML_{sw} = total mass load to the pond over period of deposition (1.7E+05 mg/yr)

P_f = pond flow rate (m³/year)

P_{wc} = fraction of total water body for mixing (assumed 100%)

K_{sw} = COPC surface water loss constant (6.33E+01 yr^{-1})

V_p = pond volume (m³)

CF = conversion factor from m³ to Litres (0.001 m³/L)

Example C-8 **Concentration of formaldehyde in pond SP16**

$$C_{sw} = \frac{1.7E+05 \times 0.001}{652{,}795 \times 1 + 6.33E+01 \times 2{,}475}$$

$$C_{sw} = 2.08E-04\ mg/L$$

C2.3 Chemical Concentrations in Soil

C2.3.1 Predicted Chemical Concentrations in Soil

Soil concentrations were estimated based on the calculated chemical-specific deposition rates. Deposition to soil on a mass basis was calculated using the following equation:

$$D_s = \frac{D_{tot}}{Z_s \times BD}$$

Where:

D_s = chemical-specific deposition (mg/kg/year)

D_{tot} = chemical-specific deposition rate (mg/yr)

Z_s = soil mixing zone depth (0.02 m or 0.2 m)

BD = soil bulk density (1,500 kg/m³)

For the current assessment, the bulk density was assumed to be 1,500 kg/m³, and soil concentrations were predicted for two mixing depths (i.e., 2 cm and 20 cm) to calculate surface soil and soil concentrations, respectively.

Example C-9 **Deposition of formaldehyde to surface soil for prediction of animal tissue concentrations**

$$D_s = \frac{7.5E+01}{0.02 \times 1{,}500}$$

$$D_s = 2.5E+00\ mg/kg/yr$$

Example C-10 **Deposition of formaldehyde to surface soil for prediction of human exposure**

Same calculation as above

Example C-11 **Deposition of formaldehyde to soil for prediction of animal tissue concentrations**

$$D_s = \frac{7.5E+01}{0.2 \times 1{,}500}$$

$$D_s = 2.5E-01\, mg/kg/yr$$

Example C-12 **Deposition of formaldehyde to soil for prediction of human exposure**

Same calculation as above

C2.3.2 Calculating Chemical Loss Constants

Chemicals may be lost from soil by leaching, runoff, erosion, biotic and abiotic degradation, and volatilization. Only abiotic and biotic degradation and volatilization processes were considered for this assessment. The total rate at which a chemical is lost from soil was designated as *kt*.

C2.3.2.4 Chemical Loss via Biotic and Abiotic Degradation

The soil half-life values for abiotic and biotic degradation (i.e., ks) were obtained from the Canadian Council of Ministries of the Environment (CCME 2008), the US EPA OSW (2005) or literature. The US EPA OSW (2005) recommends a soil loss constant (ks) of 36 yrs^{-1} for formaldehyde.

C2.3.2.5 Chemical Loss via Volatilization

Chemical loss from volatilization was predicted as follows (Swan et al. 1979):

$$t_{1/2} = 1.58E-08 \times \left(\frac{K_{oc} \times S}{VP} \right)$$

Where:

$t_{1/2}$ = soil half-life (days)

K_{oc} = organic carbon partition coefficient (7.94 L/kg)

S = water solubility (4.0E+05 mg/L)

VP = vapour pressure (3890 mmHg)

The half-life is then converted to a rate constant (yrs^{-1}) using the following equation:

$$kv = \frac{0.693}{\left(t_{1/2} / 365\right)}$$

Example C-13 Chemical loss or degradation from soil as a result of volatilization of formaldehyde

Soil half-life:

$$t_{1/2} = 1.58E-08 \times \left(\frac{7.94 \times 4.0E+05}{3.9E+03}\right)$$

$$t_{1/2} = 1.29E-05\ days$$

Loss as a result of volatilization:

$$kv = \frac{0.693}{\left(1.29E-05 / 365\right)}$$

$$kv = 1.96E+07\ yrs^{-1}$$

C2.3.2.6 Total Soil Loss Constant

$$kt = ks + kv$$

Where:

kt = chemical-specific soil loss constant as a result of all processes (yrs^{-1})

ks = chemical-specific soil loss constant as a result of abiotic and biotic degradation (36 yrs^{-1})

kv = chemical-specific soil loss constant as a result of volatilization (0.057 yrs^{-1})

Example C-14 Total soil loss constant as a result of all processes for formaldehyde

$$kt = 36 + 1.9E+07$$

$$kt = 1.96E+07\ yrs^{-1}$$

C2.3.3 Calculation of Soil Concentrations

Soil concentrations were calculated on a mass per mass basis (mg/kg) based on the following equation:

$$C_s = \frac{D_s \times \left[1 - \exp\left(-kt \times tD\right)\right]}{kt}$$

Where:

C_s = average soil concentration over exposure duration (mg/kg soil)

D_s = deposition to surface soil or soil (mg of chemical/kg of soil/year)

kt = chemical soil loss constant due to all processes (degradation or loss due to volatilization) (1.96E+07 yrs^{-1})

tD = time period over which deposition occurs (80 years)

Example C-15 **Concentration of formaldehyde in surface soil for prediction of animal tissue concentrations**

$$C_s = \frac{2.5E+00 \times \left[1 - \exp\left(-1.96E+07 \times 80\right)\right]}{1.96E+07}$$

$$C_s = 1.27E-07\ mg/kg$$

Example C-16 **Concentration of formaldehyde in surface soil for prediction of human exposure**

Same calculation as above

Example C-17 **Concentration of formaldehyde in soil for prediction of animal tissue concentrations**

$$C_s = \frac{2.5E-01 \times \left[1 - \exp\left(-1.96E+07 \times 80\right)\right]}{1.96E+07}$$

$$C_s = 1.27E-08\ mg/kg$$

Example C-18 **Concentration of formaldehyde in soil for prediction of human exposure**

Same calculation as above

C2.4 Chemical Concentrations in Dust

The chemical concentrations in dust were calculated using the measured and/or predicted soil concentration, as follows:

$$C_{dust} = DL \times C_s \times CF$$

Where:

C_{dust} = chemical concentration in dust (µg/m³)

DL = dust level (kg/m³)

C_s = surface soil concentration from deposition over time (mg/kg)

CF = conversion factor from mg to µg (1,000 µg/mg)

A dust level (DL) of 0.76 µg/m³ (7.6E-10 kg/m³) was measured by Health Canada (2004) based on the average airborne concentration of respirable particulate matter (<10 µm aerodynamic diameter). Worker exposure based on dust level of 250 µg/m³ (2.5E-07 kg/m³)

Example C-19 **Concentration of formaldehyde in dust for prediction of animal tissue concentrations**

$$C_{dust} = 7.6E-10 \times 1.27E-07 \times 1{,}000$$

$$C_{dust} = 9.7E-14\ \mu g / m^3$$

Example C-20 **Concentration of formaldehyde in dust for prediction of human exposure**

Same calculation as above

C2.5 Chemical Concentrations in Vegetation

The methodology used to estimate the contribution from each route of the chemical uptake in vegetation is described in the following sections. The following mechanisms were included when estimating the uptake of the chemicals into the tissue of plants.

- air to above-ground plants (particle deposition to leaves or foliage)
- air to above-ground plants (vapour transfer to leaves or foliage)
- soil to above-ground plants (root uptake)
- soil to below-ground plants (root uptake)

C2.5.1 Aboveground Leafy Plant Concentrations as a Result of Direct Deposition

C2.5.1.7 Concentrations in Aboveground Forage/Browse Consumed by Wildlife

Atmospheric deposition was only considered for plants whose edible portions are above ground and where the chemical potentially exists in particulate form.

The following equation was used to predict concentrations of browse and aboveground plants for consumption by wildlife as a result of deposition processes on a dry weight (DW) basis:

$$Pd = \frac{\left[D_d + \left(D_w \times 0.6\right)\right] \times Rp \times \left[1.0 - \exp\left(-kp \times Tp\right)\right]}{Yp \times kp}$$

Where:

Pd = browse concentration as a result of direct deposition (mg/kg DW)

D_d = dry deposition, particle fraction = (D_{dry} x (1-Fv)) (6.56E+01 x (1 – 1) = 0 mg/m²/yr)

D_w = wet deposition, particle fraction = (D_{wet} x (1-Fv)) (9.48+00 x (1- 1) = 0 mg/m²/yr)

Fv = fraction that is volatile (100% for formaldehyde (US EPA OSW 2005))

Rp = intercept fraction of edible portions of plant (0.5; unitless)

kp = plant surface loss coefficient (18 yr^{-1})

Tp = length of plant exposure to deposition per harvest of the edible portion of the ith plant group (0.12 yr)

Yp = yield or productivity (0.24 kg DW/m²)

The US EPA OSW (2005) recommends the use of the default intercept fraction of edible portions of plant (*Rp*) value (unitless), because it represents the most current information available with respect to productivity and relative ingestion rates. A default *Rp* value of 0.5 was recommended for forage/browse.

The *kp* value is a measure of the amount of contaminant lost as a result of removal by wind and water and growth dilution. The US EPA OSW (2005) recommends a default *kp* value of 18 yr^{-1} for both forage/browse and produce, which corresponds to a 14-day half-life.

The US EPA OSW (2005) recommends using a *Yp* value of 0.24 kg DW/m² for forage/browse vegetation.

Example C-21 **Concentration of formaldehyde in forage/browse as a result of direct deposition for prediction of animal tissue concentrations**

$$Pd = \frac{\left[0 + (0 \times 0.6)\right] \times \left[1.0 - \exp\left(-18 \times 0.12\right)\right]}{0.24 \times 18}$$

$$Pd = 0\ mg/kg\ DW$$

C2.5.1.8 Concentrations in Aboveground Garden Produce Consumed by Humans

The same equation was used to predict concentrations in above ground garden plants for human consumption as a result of direct deposition. The plant concentration was calculated on a wet weight (WW) basis with the following equation.

$$Pd = \left(\frac{\left[D_d + \left(D_w \times 0.6 \right) \right] \times Rp \times \left[1.0 - \exp\left(- kp \times Tp \right) \right]}{Yp \times kp} \right) \times WPF \times \left(1 - WC \right)$$

Where:

Pd = plant concentration as a result of direct deposition (mg/kg WW)

D_d = dry deposition, particle fraction = (D_{dry} x (1-Fv)) (*6.56E+01* x (1 – 1) = 0 mg/m²/yr)

D_w = wet deposition, particle fraction = (D_{wet} x (1-Fv)) (*9.48+00* x (1- 1) = 0 mg/m²/yr)

Fv = fraction that is volatile (100% for formaldehyde (US EPA OSW 2005))

Rp = intercept fraction of edible portions of plant (0.39; unitless)

kp = plant surface loss coefficient (18 yr^{-1})

Tp = length of plant exposure to deposition per harvest of the edible portion of the ith plant group (0.16 yr)

Yp = yield or productivity (2.24 kg DW/m²)

WPF = washing and peeling factor (1.0; unitless)

WC = water or moisture content of plant (85%, US EPA OSW 2005)

The US EPA OSW (2005) recommends the use of the default intercept fraction of edible portions of plant (*Rp*) value, (unitless), because it represents the most current information available with respect to productivity and relative ingestion rates. A default *Rp* value 0.39 was recommended for garden produce (US EPA OSW 2005).

The *kp* value is a measure of the amount of contaminant lost as a result of removal by wind and water and growth dilution. The US EPA OSW (2005) recommends a default *kp* value of 18 yr^{-1} for both forage/browse and produce, which corresponds to a 14-day half-life.

The US EPA OSW (2005) recommends using a *Yp* value of 2.24 kg DW/m² for garden produce ingested by humans.

The current assessment did not adjust concentrations with a washing and peeling factorto account for potential exposures where washing or peeling occurs.

Example C-22 Concentration of formaldehyde in aboveground garden produce as a result of direct deposition for prediction of human exposure

$$Pd = \left(\frac{\left[0 + (0 \times 0.6)\right] \times 0.39 \times \left[1.0 - \exp(-18 \times 0.16)\right]}{2.24 \times 18} \right) \times 1.0 \times (1 - 0.85)$$

$$Pd = 0 \; mg / kg \; WW$$

C2.5.2 Aboveground Plant Concentrations as a Result of Vapour Uptake

The concentration of chemicals in aboveground plants (e.g., forage, garden produce) from direct vapour uptake was calculated using a mass-based air-to-plant biotransfer factor, which was derived from the volumetric air-to-plant biotransfer factor.

C2.5.2.9 Volumetric air-to-plant biotransfer factor

$$\log B_{vol} = 1.065 \times \log K_{ow} - \log\left(\frac{H}{R \times T} \right) - 1.654$$

Where:

B_{vol} = volumetric air-to-plant biotransfer factor (unitless; WW basis)

$\log K_{ow}$ = log of the octanol-water partition coefficient (unitless)

H = Henry's Law constant of the compound (atm m³/mol)

R = gas constant (0.000082 atm m³/ mol)

T = room temperature in Kelvin (288 K)

Example C-23 Volumetric air-to-plant biotransfer factor of formaldehyde

$$\log B_{vol} = 1.065 \times 0.35 - \log\left(\frac{3.37E-07}{8.2E-05 \times 288} \right) - 1.654$$

$$B_{vol} = 3.7E+03$$

C2.5.2.10 Mass-based air-to-plant biotransfer factor

$$B_v = \frac{\rho_{air} \times B_{vol}}{(1 - WC) \times \rho_{forage}}$$

Where:

B_v = mass-based air-to-plant biotransfer factor ([µg/g DW plant] / [µg/g air])

P_{air} = density of air (1.19 g/L; Weast 1981)

B_{vol} = volumetric air-to-plant biotransfer factor (unitless; WW basis)

WC = water or moisture content of plant (e.g. 62% for forage; 85% for garden produce)

P_{forage} = density of forage (770 g/L; McCrady and Maggard 1993)

Example C-24 **Mass-based air-to-plant biotransfer factor for formaldehyde in forage for prediction of animal tissue concentrations**

$$B_v = \frac{1.19 \times 3.7E+03}{(1-0.62) \times 770}$$

$$B_v = 1.5E+01 \left[\mu g / g\ DW\ \ plant\right] / \left[\mu g / g\ air\right]$$

Example C-25 **Mass-based air-to-plant biotransfer factor for formaldehyde in aboveground garden produce for prediction of human exposure**

$$B_v = \frac{1.19 \times 3.7E+03}{(1-0.85) \times 770}$$

$$B_v = 3.8E+01 \left[\mu g / g\ DW\ \ plant\right] / \left[\mu g / g\ air\right]$$

C2.5.2.11 Concentrations in Aboveground Forage/Browse Consumed by Wildlife

The following equation was used to calculate aboveground plant tissue concentrations as a result of vapour uptake:

$$Pv = \frac{C_{air} \times \left(B_v / RF\right) \times F_v}{\rho_{air}}$$

Where:

Pv = COPC concentration in browse as a result of vapour uptake (mg/kg DW)

C_{air} = COPC concentration in air (1.04E-01 µg/m³)

B_v = mass-based air-to-plant biotransfer factor ([µg/g DW plant] / [µg/g air])

RF = reduction factor (100 for VOCs)

F_v = fraction of chemical in vapour phase (100% for formaldehyde)

P_{air} = density of air (1,200 g/m³; Weast 1981)

As recommended by the US EPA OSW (2005), the biotransfer factor for organics (except dioxins and furans) should be reduced by a factor of 100.

Example C-26 Concentration of formaldehyde in forage/browse as a result of vapour uptake for prediction of animal tissue concentrations

$$Pv = \frac{1.04E-01 \times (1.5E+01/100) \times 1}{1{,}200}$$

$$Pv = 1.3E-05\ mg/kg\ DW$$

C2.5.2.12 Concentrations in Aboveground Garden Produce Consumed by Humans

The following equation was used to calculate aboveground plant tissue concentrations as a result of vapour uptake:

$$Pv = \frac{C_{air} \times (B_v / RF) \times F_v \times VG_{ag}}{\rho_{air}} \times WPF \times (1 - WC)$$

Where:

Pv = COPC concentration in plant as a result of vapour uptake (mg/kg WW)

C_{air} = COPC concentration in air (1.04E-01 µg/m³)

B_v = mass-based air-to-plant biotransfer factor ([µg/g DW plant] / [µg/g air])

RF = reduction factor (100 for VOCs)

F_v = fraction of chemical in vapour phase (100% for formaldehyde)

VG_{ag} = empirical correction factor (0.01 or 1.0; US EPA OSW 2005)

P_{air} = density of air (1,200 g/m³; Weast 1981)

WPF = washing and peeling factor (1.0; unitless)

WC = water or moisture content of produce (85%, US EPA OSW 2005)

In the current assessment no adjustment was for washing and peeling.

As recommended by the US EPA OSW (2005), the biotransfer factor for organics (except dioxins and furans) should be reduced by a factor of 100. In addition the US EPA OSW (2005) also recommends an empirical correction factor (i.e., VG_{ag}) of 0.01 for COPCs with a log K_{ow} greater than 4 and an empirical correction factor of 1 for COPCs with a log K_{ow} less than 4. This additional empirical correction factor was not applied to the exposure pathways for ingestion of forage/browse by wildlife, but was applied to the exposure pathway for ingestion of plants for the human exposure assessment. A conversion from dry weight to wet weight (1 - WC) was also made to calculated concentrations in garden produce.

Example C-27 Concentration of formaldehyde in aboveground garden produce as a result of vapour uptake for prediction of human exposure

$$Pv = \frac{1.04E-01 \times (3.8E+01/100) \times 1 \times 1}{1{,}200} \times 1.0 \times (1-0.85)$$

$$Pv = 4.9E-6\ mg/kg\ WW$$

C2.5.3 Aboveground Plant Concentrations as a Result of Root Uptake

Contaminants present in soil can be taken up into edible portions of aboveground plants. The US EPA OSW (2005) provides an equation to predict aboveground plant concentrations as a result of root uptake using soil concentrations and plant-to-soil bioconcentration factors (BCFs) for aboveground produce and forage/browse.

C2.5.3.13 Soil-to-Plant Bioconcentration Factor

The soil-to-plant BCFs for forage/browse and garden produce were calculated based on the following equation recommended by the US EPA OSW (2005), adopted from Travis and Arms (1988):

$$\log BCF = 1.588 - 0.578 \times \log K_{ow}$$

Where:

BCF = plant-soil bioconcentration factor for aboveground produce (kg soil/kg plant DW)

log K_{ow} = log of the octanol-water partition coefficient (unitless)

The above equation was derived from experiments conducted on compounds with log K_{ow} values ranging from 1.15 to 9.35. Thus, BCF values for compounds with a log K_{ow} value less than 1.15 should be calculated using a log K_{ow} value of 1.15 and BCF values for compounds with a log K_{ow} greater than 9.35 should be calculated using a log K_{ow} value of 9.35 (US EPA OSW 2005).

A log K_{ow} value of 14 was used for formaldehyde.

Example C-28 Plant-to-soil bioconcentration factor for formaldehyde

$$\log BCF = 1.588 - 0.578 \times \log(14)$$

$$BCF = 8.4E + 00\ kg\ soil / kg\ \ plant\ DW$$

C2.5.3.14 Concentrations in Aboveground Forage/Browse Consumed by Wildlife

The following equation was used to predict the chemical concentration in aboveground forage/browse as a result of root uptake (US EPA OSW 2005).

$$\mathrm{Pr} = C_s \times BCF$$

Where:

Pr = chemical concentration in aboveground plant as a result of root uptake (mg/kg DW)

C_s = chemical concentration in soil (mg/kg)

BCF = plant-soil bioconcentration factor for aboveground produce (kg soil/kg plant DW)

Example C-29 Concentration of formaldehyde in forage/browse as a result of root uptake for the prediction of animal tissue concentrations

$$\mathrm{Pr} = 1.27E - 08 \times 8.42$$

$$\mathrm{Pr} = 1.07E - 07\ mg / kg\ DW$$

C2.5.3.15 Concentrations in Aboveground Garden Produce Consumed by Humans

The same equation was used to calculate the chemical concentration in aboveground garden produce, with adjustments made for washing and peeling and the moisture content of the plant.

$$\mathrm{Pr} = C_s \times BCF \times WPF \times (1 - WC)$$

Where:

Pr = chemical concentration in aboveground plant as a result of root uptake (mg/kg WW)

C_s = chemical concentration in soil (mg/kg)

BCF = plant-soil bioconcentration factor for aboveground produce (kg soil/kg plant DW)

WPF = washing and peeling factor (1.0; unitless)

WC = water or moisture content of produce (85%, US EPA OSW 2005)

In the current assessment no adjustment was made for washing and peeling.

Example C-30 **Concentration of formaldehyde in aboveground garden produce as a result of root uptake for the prediction of human exposure**

$$\mathrm{Pr} = 1.27E-08 \times 8.42 \times 1.0 \times (1 - 0.85)$$

$$\mathrm{Pr} = 1.6E-08\ mg/kg\ WW$$

C2.5.4 Total Chemical Concentration in Leafy Vegetables

The following equation was used to estimate the chemical concentration in above ground produce as a result of direct deposition, vapour uptake, and root uptake.

$$C_{plant} = (Pd + Pv + \mathrm{Pr})$$

Where:

C_{plant} = total chemical concentration in plant (mg/kg).

Pd = plant concentration as a result of direct deposition (mg/kg WW)

Pv = COPC concentration in plant as a result of vapour uptake (mg/kg WW)

Pr = chemical concentration in aboveground plants as a result of root uptake (mg/kg WW)

Example C-31 **Concentration of formaldehyde in aboveground vegetables as a result of direct deposition, vapour uptake and root uptake for the prediction of human exposure**

$$C_{plant} = (0 + 4.9E-06 + 1.6E-08)$$

$$C_{plant} = 4.9E-06\ mg/kg$$

C2.5.5 Belowground Plant Concentrations as a Result of Root Uptake

Chemicals present in soil also can be taken up into edible portions of belowground produce (i.e., root vegetables). The US EPA OSW (2005) provides an equation to predict belowground plant concentrations as a result of root uptake using soil concentrations and plant-to-soil BCFs in root vegetables.

Belowground produce refers to all root vegetables and therefore concentrations derived using this methodology only applied to root vegetable consumption rates. Given that wildlife were assumed to not consume root vegetables, a belowground forage/browse concentration was not required. The belowground produce concentration for root vegetables was calculated as follows (US EPA OSW 2005):

$$\mathrm{Pr}_{root} = C_s \times BCF \times WPF \times (1 - WC)$$

Where:

Pr_{root} = chemical concentration in belowground produce as a result of root uptake (mg/kg WW)

C_s = chemical concentration in soil (mg/kg)

BCF = plant-to-soil bioconcentration factor for belowground plants (kg soil/kg plant DW)

WPF = washing and peeling factor (1.0; unitless)

WC = water or moisture content of root vegetables (85%, US EPA OSW 2005)

In the current assessment no adjustment was made for washing and peeling.

Example C-32 **Concentration of formaldehyde in root vegetables as a result of root uptake for the prediction of human exposure**

$$\mathrm{Pr}_{root} = 1.27E-08 \times 3.05E+02 \times 1.0 \times (1 - 0.85)$$

$$\mathrm{Pr}_{root} = 5.8E-07\ mg/kg\ WW$$

C2.5.6 Chemical Concentrations in Labrador Tea

The chemical concentration in Labrador tea was derived using the methods employed for predicting aboveground plant concentrations based on the following uptake mechanisms:

- direct deposition;
- vapour uptake; and
- uptake from soil by roots to above ground portion of plants

The only difference when calculating Labrador tea concentrations is the use of 54% for moisture content in the calculations to convert from dry weight to wet weight.

Example C-33 **Concentration of formaldehyde in Labrador tea as a result of deposition, vapour uptake and root uptake for the prediction of human exposure**

$$C_{labtea} = 0 + 4.90E-06 + 4.93E-08$$

$$C_{labtea} = 4.95E-06\ mg/kg\ WW$$

C2.5.7 Chemical Concentrations in Fruit and Wild Berries

The chemical concentration in berries was derived using soil concentrations and plant-to-soil BCFs for aboveground produce.

The following equation was used to predict the chemical concentration in fruits and wild berries as a result of root uptake based on the equation provided by the US EPA OSW (2005) for aboveground produce. Given that wildlife were assumed to not consume berries, a berry concentration was not required for the prediction of animal tissue concentrations. However, berry concentrations were calculated for harvesting by humans.

$$Pb = C_s \times BCF \times WPF \times (1 - WC)$$

Where:

Pb = chemical concentration in fruit or berries as a result of root uptake (mg/kg WW)

C_s = chemical concentration in soil (mg/kg)

BCF = plant-to-soil bioconcentration factor for aboveground produce (kg soil/kg plant DW)

WPF = washing and peeling factor (1.0; unitless)

WC = water or moisture content of berries (80%, site-specific)

In the current assessment no adjustment was made for washing and peeling.

Example C-34 **Concentration of formaldehyde in berries as a result of root uptake for the prediction of human exposure**

$$Pb = 1.27E-08 \times 8.42 \times 1.0 \times (1 - 0.80)$$

$$Pb = 2.14E-08\ mg/kg\ WW$$

C2.5.8 Chemical Concentrations in Cattail

The chemical concentration in cattail was derived using soil concentrations and plant-to-soil BCFs for plants.

The following equation was used to predict the chemical concentration in cattail as a result of root uptake (US EPA OSW 2005). Given that wildlife were assumed to not consume cattail, a cattail concentration was not required for the prediction of animal tissue concentrations.

$$C_{cattail} = C_s \times BCF \times WPF \times (1 - WC)$$

Where:

$C_{cattail}$ = chemical concentration in cattail as a result of root uptake (mg/kg WW)

C_s = chemical concentration in soil (mg/kg)

BCF = plant-to-soil bioconcentration factor (kg soil/kg plant DW)

WPF = washing and peeling factor (1.0; unitless)

WC = water or moisture content of Cattail (77%, site-specific)

In the current assessment no adjustment was made for washing and peeling.

Example C-35 Concentration of formaldehyde in cattail as a result of root uptake for the prediction of human exposure

$$C_{cattail} = 1.27E-08 \times 8.42 \times 1.0 \times (1 - 0.77)$$

$$C_{cattail} = 2.47E-08\ mg/kg\ WW$$

C2.5.9 Chemical Concentrations in Aquatic Plants

The chemical concentration in aquatic plants was derived using surface water concentrations and water-to-aquatic plant BCFs. Aquatic plant concentrations were predicted only for the calculation of animal tissue concentrations. The water-to-aquatic plant BCFs were provided by the US EPA OSW (1999) or US EPA (2011).The following equation was used to predict the chemical concentration in aquatic plants:

$$C_{aqplant} = C_{sw} \times BCF$$

Where:

$C_{aqplant}$ = chemical concentration in aquatic plants (mg/kg DW)

C_{sw} = chemical concentration in surface water (mg/L)

BCF = water-to-aquatic plant bioconcentration factor (L water/kg plant DW)

Example C-36 Concentration of formaldehyde in aquatic plants for the prediction of animal tissue concentrations

$$C_{aqplant} = 2.08E-04 \times 0.409$$

$$C_{aqplant} = 8.51E-05\ mg/kg\ DW$$

C2.5.10 Chemical Concentrations in Invertebrates

The chemical concentration in invertebrates was derived using soil concentrations and soil-to-soil invertebrate BCFs. Invertebrate concentrations were predicted only for the calculation of animal tissue concentrations. The soil-to-soil invertebrate BCFs were provided by the US EPA OSW (1999).

The following equation was used to predict the chemical concentration in terrestrial invertebrates:

$$C_{invert} = C_s \times BCF$$

Where:

C_{invert} = chemical concentration in invertebrates (mg/kg DW)

C_s = chemical concentration in soil (mg/kg)

BCF = soil-to-soil invertebrate bioconcentration factor (kg soil/kg invertebrate DW)

Example C-37 Concentration of formaldehyde in terrestrial invertebrates for the prediction of animal tissue concentrations

$$C_{invert} = 1.27E-08 \times 0.839$$

$$C_{invert} = 1.07E-08\ mg/kg\ DW$$

C2.5.11 Chemical Concentrations in Fish

The chemical concentration in fish was derived using predicted surface water concentrations for Pond SP16 and surface water-to-fish BCFs. Fish concentrations were predicted only for the calculation of human exposure. The BCF values for formaldehyde are provided by the ATSDR (1995).

The following equation was used to predict the chemical concentration in fish:

$$C_{fish} = C_{sw} \times BCF$$

Where:

C_{fish} = chemical concentration in fish (Table B1-9; mg/kg WW)

C_{sw} = chemical concentration in surface water (Table B1-9; 4.8E-09 mg/L)

BCF = surface water-to-fish bioconcentration factor (Table B1-35; 55 L water/kg fish WW)

Example C-38 Concentration of formaldehyde in fish for the prediction of human exposure

$$C_{fish} = 2.08E-04 \times 3.16$$

$$C_{fish} = 6.6E-04\ mg/kg\ WW$$

C2.6 Wildlife Exposure Calculations

Tissue concentrations were calculated following the US EPA OSW (2005) methodology. To estimate tissue concentrations, animals were assumed to be exposed to chemicals through consumption of affected soil, water and food. The following sections provide the equations used to calculate the total daily dose of a chemical via the individual exposure pathways for wildlife (moose, grouse and snowshoe hare) and the corresponding tissue concentrations. The following example calculation is for moose.

C2.6.1 Food Ingestion Rates

The food ingestion rate is influenced by a number of factors, such as the metabolic rate and composition of the diet. The rate of food consumption that an animal must achieve to meet its metabolic needs can be calculated by dividing its free-living (or field) metabolic rate (FMR) by the metabolizable energy in its food (US EPA 1993; Nagy 1987).

C2.6.1.16 Metabolizable Energy

Metabolizable energy (ME) is the gross energy (GE) in a unit of food consumed minus the energy lost in feces and urine (US EPA 1993). Assimilation efficiency (AE) equals the ratio of metabolizable energy to gross energy, or the fraction of gross energy that is metabolizable (US EPA 1993). Thus, the metabolizable energy for dietary items can be calculated as follows:

$$ME = GE \times AE$$

Where:

ME = metabolizable energy of dietary item (kcal/kg)

GE = gross energy of dietary item (kcal/kg DW)

AE = assimilation efficiency of dietary item (%)

The assimilation efficiency and gross energy values for the different dietary items were provided by the US EPA (1993).

Example C-39 Metabolizable energy of browse for moose

$$ME = 4{,}200 \times 0.41$$

$$ME = 1.7E + 03\ kcal/kg$$

C2.6.1.17 Free-living Metabolic Rate (Normalized)

Nagy (1987) provides allometric equations to estimate FMRs based on doubly-labelled water measurements of CO_2 production in free-living animals (US EPA 1993). The equations provided by Nagy (1987) are based on the following formula:

$$FMR = \frac{a \times BW^{b}}{4.184\ kJ/kcal}$$

Where:

FMR = free-living metabolic rate (kcal/d)

a = slope of the allometric equation for the FMR (unitless)

BW = body weight (g)

b = y-intercept of the allometric equation for the FMR (unitless)

Nagy et al. (1999) provide a number of slope and y-intercept values for FMRs specific to orders and trophic levels (e.g., rodentia, galliformes, and herbivores). These values were used to estimate the FMR values for each species. Note: The equation used to calculate the FMR for moose does not require the conversion to kcal units; thus the conversion factor of 4.184 kJ/kcal is not needed. However, the conversion factor of 4.184 kJ/kcal is needed in the calculation of the FMR for grouse and snowshoe hare.

Example C-40 Free-living metabolic rate for moose

$$FMR = 1.52 \times 4.5E + 05^{0.73}$$

$$FMR = 2.0E + 04\ kcal/d$$

To normalize the FMR to body weight, the FMR was divided by the body weight of the species:

$$NFMR = \frac{FMR}{BW}$$

Where:

NFMR = normalized free-living metabolic rate (kcal/kg bw/d)

FMR = free-living metabolic rate (kcal/d)

BW = body weight (kg)

Example C-41 Normalized free-living metabolic rate for moose.

$$NFMR = \frac{2.0E+04}{450}$$

$$NFMR = 4.5E+01\ kcal/kg\ bw/d$$

C2.6.1.18 Ingestion Rates

The estimated ingestion rate for each dietary item was calculated as follows:

$$FIR_i = \frac{FMR \times P_i}{ME_i}$$

Where:

FIR_i = food ingestion rate for the 'i' dietary item (kg/d)

FMR = free-living metabolic rate (kcal/d)

P_i = portion of diet consisting of 'i' dietary item (%)

ME_i = metabolizable energy of 'i' dietary item (kcal/kg)

Moose were assumed to consume a diet consisting of 80% browse and 20% aquatic plants.

Example C-42 Estimated browse ingestion rate for moose

$$FIR_{browse} = \frac{2.0E+04 \times 0.80}{1{,}722}$$

$$FIR_{browse} = 9.4\ kg/d$$

Example C-43 Estimated aquatic plant ingestion rate for moose

$$FIR_{aqplant} = \frac{2.0E+04 \times 0.20}{3{,}139}$$

$$FIR_{aqplant} = 1.3\ kg/d$$

The total ingestion rate for all dietary items was estimated by summing the individual ingestion rates for each dietary item:

$$FIR_{total} = FIR_{invert} + FIR_{browse} + FIR_{aqplant}$$

Where:

FIR_{total} = total food ingestion rate for all dietary items (kg/d)

FIR_{invert} = food ingestion rate for invertebrates (kg/d)

FIR_{browse} = food ingestion rate for browse (kg/d)

$FIR_{aqplant}$ = food ingestion rate for aquatic plants (kg/d)

Example C-44 Total food ingestion rate for moose

$$FIR_{total} = 0.0 + 9.44 + 1.3$$

$$FIR_{total} = 1.07E+01\ kg/d$$

To normalize the total food ingestion rate to body weight, the FIR_{total} was divided by the body weight of the species:

$$NFIR_{total} = \frac{FIR_{total}}{BW}$$

Where:

$NFIR_{total}$ = normalized total food ingestion rate (kg food/kg bw/d)

FIR_{total} = total food ingestion rate for all dietary items (kg/d)

BW = body weight (kg)

Example C-45 Normalized total food ingestion rate for moose

$$NFIR_{total} = \frac{1.07E+01}{450}$$

$$NFIR_{total} = 2.4E-02\ kg\ \ food/kg\ bw/d$$

C2.6.2 Soil Ingestion Rates

The soil ingestion rates were calculated as a percentage of the total estimated food ingestion rate for all dietary items. The percentage of soil in the diet for each of the wildlife species was obtained from the US EPA OSW (2005) and/or Suter et al. (2000).

The soil ingestion rates were calculated as follows:

$$SIR = P_{soil} \times FIR_{total}$$

Where:

SIR = soil ingestion rate (kg/d)

P_{soil} = percent of soil in diet (%)

FIR_{total} = total food ingestion rate for all dietary items (kg/d)

Example C-46 Soil ingestion rate for moose

$$SIR = 0.02 \times 1.07E+01$$

$$SIR = 2.15E-01\ kg/d$$

C2.6.3 Estimated Daily Intake of Chemicals in Wildlife via All Media

C2.6.3.19 Soil Ingestion

The estimated daily intake of a chemical through incidental ingestion of soil by wildlife was calculated by applying the soil ingestion rate to the chemical concentration in the soil.

$$EDI_{soil} = C_s \times SIR$$

Where:

EDI_{soil} = estimated daily intake of chemical in soil (mg/d)

C_s = chemical concentration in surface soil (mg/kg)

SIR = soil ingestion rate (kg/d)

Example C-47 Estimated daily intake of formaldehyde from ingestion of soil by moose

$$EDI_{soil} = 1.27E-07 \times 2.15E-01$$

$$EDI_{soil} = 2.7E-08\ mg/d$$

C2.6.3.20 Consumption of Browse

The estimated daily intake of a chemical through consumption of browse by wildlife was calculated by applying the browse food ingestion rate to the chemical concentration in vegetation.

$$EDI_{browse} = P_{total} \times FIR_{browse}$$

Where:

EDI_{browse} = estimated daily intake of chemical in browse (mg/d)

P_{total} = chemical concentration in browse from deposition, vapour uptake, and root uptake (mg/kg DW)

FIR_{browse} = browse ingestion rate (kg/d)

Example C-48 Estimated daily intake of formaldehyde from consumption of browse by moose

$$EDI_{browse} = 1.3E-05 \times 9.44$$

$$EDI_{browse} = 1.2E-04\ mg/d$$

C2.6.3.21 Consumption of Aquatic Plants

The estimated daily intake of a chemical through consumption of aquatic plants by wildlife was calculated by applying the aquatic plant food ingestion rate to the chemical concentration in aquatic plants.

$$EDI_{aqplant} = C_{aqplant} \times FIR_{aqplant}$$

Where:

$EDI_{aqplant}$ = estimated daily intake of chemical in aquatic plants (mg/d)

$C_{aqplant}$ = chemical concentration in aquatic plants (mg/kg DW)

$FIR_{aqplant}$ = aquatic plant ingestion rate (kg/d)

Example C-49 **Estimated daily intake of formaldehyde from consumption of aquatic plants by moose**

$$EDI_{aqplant} = 8.51E-05 \times 1.3$$

$$EDI_{aqplant} = 1.1E-04\ mg/d$$

C2.6.3.22 Consumption of Invertebrates

The estimated daily intake of a chemical through consumption of invertebrates by wildlife was calculated by applying the invertebrate food ingestion rate to the chemical concentration in invertebrates. It was assumed that moose do not consume invertebrates; therefore ruffed grouse was used as an example for the calculation of invertebrate ingestion.

$$EDI_{invert} = C_{invert} \times FIR_{invert}$$

Where:

EDI_{invert} = estimated daily intake of chemical in invertebrates (mg/d)

C_{invert} = chemical concentration in invertebrates (mg/kg DW)

FIR_{invert} = invertebrate ingestion rate (kg/d)

Example C-50 **Estimated daily intake of formaldehyde from consumption of invertebrates by ruffed grouse**

$$EDI_{invert} = 1.07E-08 \times 5.6E-03$$

$$EDI_{invert} = 5.99E-11\ mg/d$$

C2.6.3.23 Ingestion of Water

The estimated daily intake of a chemical through ingestion of surface water by wildlife was calculated by applying the water ingestion rate to the predicted surface water concentration in the pond SP16.

$$EDI_{water} = C_{sw} \times WIR$$

Where:

EDI_{waterr} = estimated daily intake of chemical in surface water (mg/d)

C_{sw} = chemical concentration in pond SP16 surface water (mg/L)

WIR = water ingestion rate (24.2 L/d)

Example C-51 Estimated daily intake of formaldehyde from consumption of surface water by moose

$$EDI_{water} = 2.08E-04 \times 24.2$$

$$EDI_{water} = 5.0E-03\, mg/d$$

C2.6.3.24 Inhalation of Air

The air inhalation rate for wildlife was predicted using allometric equations for birds and mammals, as provided by the US EPA (1993).

Inhalation rate for birds:

$$AIR = 0.4089 \times BW^{0.77}$$

Inhalation rate for mammals:

$$AIR = 0.5458 \times BW^{0.80}$$

Where:

AIR = predicted air inhalation rate (m^3/d)

BW = body weight (kg)

Example C-52 Predicted inhalation rate for moose

$$AIR = 0.5458 \times 450^{0.80}$$

$$AIR = 7.2E+01\, m^3/d$$

The estimated daily intake of a chemical through inhalation of predicted ground-level air concentrations by moose was calculated by applying the air inhalation rate to the predicted air concentration.

$$EDI_{inh} = (C_{air} + C_{dust}) \times AIR \times CF$$

Where:

EDI_{inh} = estimated daily intake of chemical via inhalation (mg/d)

C_{air} = chemical concentration in air (µg/m³)

C_{dust} = chemical concentration in dust (µg/m³)

AIR = air inhalation rate (m³/d)

CF = conversion factor from µg to mg (0.001 mg/µg)

Example C-53 Estimated daily intake of formaldehyde by moose via inhalation

$$EDI_{inh} = (1.04E-01 + 9.67E-14) \times 7.2E+01 \times 0.001$$

$$EDI_{inh} = 7.5E-03\ mg/d$$

C2.6.4 Estimated Total Daily Intake

The estimated daily intake for wildlife and game from all potential pathways of exposure was calculated as follows:

$$EDI_{total} = EDI_{soil} + EDI_{browse} + EDI_{aqplant} + EDI_{invert} + EDI_{water} + EDI_{inh}$$

Where:

EDI_{total} = total estimated daily intake of chemical via all routes of exposure (mg/d)

EDI_{soil} = estimated daily intake of chemical from ingestion of soil (2.7E-08 mg/d)

EDI_{browse} = estimated daily intake of chemical from consumption of browse (1.2E-04 mg/d)

$EDI_{aqplant}$ = estimated daily intake of chemical from consumption of aquatic plants (1.1E-04 mg/d)

EDI_{invert} = estimated daily intake of chemical from consumption of invertebrates (0.0 mg/d)

EDI_{water} = estimated daily intake of chemical from ingestion of water (5.0E-03 mg/d)

EDI_{inh} = estimated daily intake of chemical from inhalation of air (7.5E-03 mg/d)

Example C-54 Total estimated daily intake of formaldehyde from all routes of exposure for moose.

$$EDI_{total} = 2.7E-08 + 1.2E-04 + 1.1E-04 + 0 + 5.0E-03 + 7.5E-03$$

$$EDI_{total} = 1.3E-02\ mg/d$$

C2.7 Animal Tissue Concentrations

C2.7.1 Biotransfer Factors

Biotransfer factors (BTFs) are used to translate an estimated dose of a chemical to a tissue concentration. Biotransfer models have been developed by the Research Triangle Institute (RTI 2005) and were incorporated within the current assessment, as recommended by the US EPA OSW (2005) for organic chemicals. The following equation was developed to predict the transfer rate of the chemical intake into fat tissue.

$$\log BTF = -0.099 \times \log K_{ow}{}^2 + 1.07 \times \log K_{ow} - 3.56$$

Where:

BTF = biotransfer factor ([mg/kg fat] / [mg/d])

log K_{ow} = log of the octanol-water partition coefficient (unitless)

The BTF equation is appropriate for organic chemicals lacking empirical biotransfer data and having a log K_{ow} between -0.67 and 8.2.

Example C-55 Biotransfer factor for formaldehyde

$$\log BTF = -0.099 \times 0.35^2 + 1.07 \times 0.35 - 3.56$$

$$BTF = 6.3E-04\ [mg/kg\ fat]/[mg/d]$$

C2.7.2 Adjusted Biotransfer Factors

The fat tissue concentration can be converted to a tissue concentration by adjusting the BTF with the fat content of desired tissue (e.g., moose, grouse, snowshoe hare). The fat content for wild game was assumed to be: (US EPA OSW 2005):

- 19% for moose and snowshoe hare
- 14% for ruffed grouse

The BTF was adjusted to account for the amount of fat in the tissue based on the following equation:

$$BTF_a = BTF \times FC$$

Where:

BTF_a = adjusted biotransfer factor for fat content of tissue ([mg/kg tissue] / [mg/d])

BTF = biotransfer factor ([mg/kg fat] / [mg/d])

FC = fat content of tissue (%)

Example C-56 Adjusted biotransfer factor for formaldehyde for fat content of meat in moose

$$BTF_a = 6.3E-04 \times 0.19$$

$$BTF_a = 1.2E-04\ [mg/kg\ tissue]/[mg/d]$$

C2.7.3 Metabolism Factors

As provided in the methodology for predicting cattle BTFs (RTI 2005, US EPA OSW 2005), the equation that is used to estimate BTF values might overestimate biotransfer of highly metabolized chemicals. The dataset used to estimate the polynomial relationship between BTFs and K_{ow} is based on anthropogenic chemicals that are persistent (e.g., pesticides) and potentially biomagnify (e.g., pesticides, polychlorinated biphenyls (PCBs), dioxins, and furans). Polycyclic aromatic hydrocarbons (PAHs) were not included in the dataset used to develop the empirical relationship and were identified as potentially highly metabolized chemicals by mammals. Depending on the compound, lipophilicity or K_{ow} measures are not always a good predictor of tissue concentrations (Hofelt et al. 2001).

Evidence strongly suggests that PAHs are extensively metabolized and eliminated. Ramesh et al. (2004), Laurent et al. (2001; 2002), and Grova et al. (2002) investigated the transfer of PAHs in the food chain to goats and pigs. Their studies demonstrate that PAHs are poorly absorbed from diet or readily metabolized and excreted. Hofelt et al. (2001) overcame these limitations for human health assessment by deriving PAH metabolism factors (MF) for use in multipathway hazard assessments. MF values reported for some PAHs are provided in Table C-1. The MF values are derived for use with diverse matrices such as milk, beef, chicken, eggs, and pork (Ramesh et al. 2004).

Table C-1 Metabolism Factors for PAHs

Chemical	Animal Model	Metabolism Factor (MF)
Benz(a)anthracene	Rat	0.001
Benzo(a)pyrene	Mouse	0.004
Pyrene	Rat	0.003

Hofelt et al. (2001) recommends a MF of 0.01 for PAHs. The MF is applied to the adjusted BTF for fat content of tissue to derive an adjusted BTF for metabolism, as follows:

$$BTF_{adj} = BTF_a \times MF$$

Where:

BTF_{adj} = adjusted biotransfer factor for metabolism ([mg/kg tissue] / [mg/d])

BTF_a = adjusted biotransfer factor for fat content of tissue ([mg/kg tissue] / [mg/d])

MF = metabolism factor (PAHs=0.01, VOCs=1.0, unitless)

Example C-57 Adjusted biotransfer factor for formaldehyde metabolism in moose

$$BTF_{adj} = 1.2E-04 \times 1.0$$

$$BTF_{adj} = 1.2E-04\ [mg/kg\ tissue]/[mg/d]$$

C2.7.4 Tissue Concentrations

Chemical concentrations in animal meat were predicted based on the following equation:

$$C_{animal} = BTF_{adj} \times EDI_{total}$$

Where:

C_{animal} = chemical concentration in game meat (mg/kg WW)

BTF_{adj} = adjusted biotransfer factor for metabolism ([mg/kg tissue] / [mg/d])

EDI_{total} = total estimated daily intake of chemical via all routes of exposure (1.3E-02mg/d)

Example C-58 Predicted concentration of formaldehyde in moose meat

$$C_{moose} = 1.2E-04 \times 1.3E-02$$

$$C_{moose} = 1.5E-06\ mg/kg\ WW$$

Similar methods were applied to the calculation of grouse and snowshoe hare concentrations.

C3.0 HUMAN EXPOSURE ESTIMATES

C3.1 Ingestion of Soil (Incidental)

The following equation was used to estimate human exposure via incidental ingestion of soil. Soil ingestion rates were based on recommendations from Health Canada (2009a).

$$EDI_{soil} = C_s \times SIR$$

Where:

EDI_{soil} = estimated daily intake of chemical via ingestion of soil (µg/d)

C_s = chemical concentration in surface soil (mg/kg)

SIR = incidental soil ingestion rate (g/d)

Example C-59 **Estimated daily intake of formaldehyde by a toddler resident from incidental ingestion of soil**

$$EDI_{soil} = 1.27E-07 \times 0.08$$

$$EDI_{soil} = 1.0E-08 \mu g/d$$

C3.2 Ingestion of Drinking Water

It was assumed that residents consumed local raw surface water from Pond SP16. Water ingestion rates were based on recommendations from Health Canada (2009a) and exposures were based on the following equation:

$$EDI_{water} = C_{sw} \times WIR \times CF$$

Where:

EDI_{water} = estimated daily intake of chemical via ingestion of water (µg/d)

C_{sw} = chemical concentration in surface water (mg/L)

WIR = water ingestion rate (L/d)

CF = conversion factor from mg to µg (1,000 µg/mg)

Example C-60 **Estimated daily intake of formaldehyde by a toddler resident from ingestion of surface water**

$$EDI_{water} = 2.08E-04 \times 0.6 \times 1{,}000$$

$$EDI_{water} = 1.25E-01 \mu g/d$$

C3.3 Inhalation of Dust

The following equation was used to estimate human exposure via inhalation of dust. Air inhalation rates were based on recommendations from Health Canada (2009a).

$$EDI_{dust} = C_{dust} \times AIR$$

Where:

EDI_{dust} = estimated daily intake of chemical via inhalation of dust (µg/d)

C_{dust} = chemical concentration in dust (µg/m³)

AIR = air inhalation rate (m³/d)

Example C-61 Estimated daily intake of formaldehyde by a toddler resident from inhalation of dust

$$EDI_{dust} = 9.67E-14 \times 8.3$$

$$EDI_{dust} = 8.03E-13\ \mu g/d$$

C3.4 Ingestion of Plants

C3.4.1 Leafy Vegetables

The following equation was used to estimate human exposure via consumption of leafy vegetables or wild leafy plants. Consumption rates were obtained from Health Canada (2009a).

$$EDI_{plant} = C_{plant} \times IR_{plant}$$

Where:

EDI_{plant} = estimated daily intake of chemical via consumption of aboveground leafy plants (µg/d)

C_{plant} = total chemical concentration in leafy plant (mm/kg ww)

IR_{plant} = leafy plant ingestion rate (g/d)

Example C-62 **Estimated daily intake of formaldehyde by a toddler resident from consumption of aboveground leafy plants**

$$EDI_{plant} = 4.91E-06 \times 67$$

$$EDI_{plant} = 3.29E-04\ \mu g/d$$

C3.4.2 Root Vegetables

The following equations were used to estimate human exposure via consumption of root vegetables. Consumption rates were obtained from Health Canada (2009a).

The estimated exposure from consumption of root vegetables is:

$$EDI_{root} = \mathrm{Pr}_{root} \times IR_{root}$$

Where:

EDI_{root} = estimated daily intake of chemical via consumption of root vegetables (µg/d)

Pr_{root} = chemical concentration in root vegetables from root uptake (mg/kg WW)

IR_{root} = root vegetable ingestion rate (g/d)

Example C-63 **Estimated daily intake of formaldehyde by an adult aboriginal resident from consumption of root vegetables**

$$EDI_{root} = 5.82E-7 \times 105$$

$$EDI_{root} = 6.11E-05\ \mu g/d$$

C3.4.3 Fruit and Wild Berries

The following equation was used to estimate human exposure via consumption of fruit and wild berries. Consumption rates were obtained from Wein (1989).

$$EDI_{berry} = Pb \times IR_{berry}$$

Where:

EDI_{berry} = estimated daily intake of chemical via consumption of fruit and berries (µg/d)

Pb = chemical concentration in fruit and berries from root uptake (mg/kg WW)

IR_{berry} = fruit and berry ingestion rate (g/d)

Example C-64 **Estimated daily intake of formaldehyde by a toddler resident from consumption of berries**

$$EDI_{berry} = 4.92E-06 \times 5$$

$$EDI_{berry} = 2.46E-05\ \mu g/d$$

C3.4.4 Labrador Tea

The following equation was used to estimate human exposure via consumption of Labrador tea. Consumption rates were obtained from Wein (1989).

$$EDI_{labtea} = C_{labtea} \times IR_{labtea}$$

Where:

EDI_{labtea}= estimated daily intake of chemical via consumption of Labrador tea (µg/d)

C_{labtea} = chemical concentration in Labrador tea (mg/kg WW)

IR_{labtea}= Labrador tea ingestion rate (g/d)

Example C-65 **Estimated daily intake of formaldehyde by a toddler resident from consumption of Labrador tea**

$$EDI_{labtea} = 4.95E-06 \times 1$$

$$EDI_{labtea} = 4.95E-06\ \mu g/d$$

C3.4.5 Cattail

The following equation was used to estimate human exposure via consumption of cattail. Consumption rates were obtained from Wein et al. (1989).

$$EDI_{cattail} = C_{cattail} \times IR_{cattail}$$

Where:

$EDI_{cattail}$ = estimated daily intake of chemical via consumption of cattail (µg/d)

$C_{cattail}$ = chemical concentration in cattail (mg/kg WW)

$IR_{cattail}$ = cattail ingestion rate (g/d)

Example C-66 **Estimated daily intake of formaldehyde by a toddler resident from consumption of cattail**

$$EDI_{cattail} = 2.47E-08 \times 1$$

$$EDI_{cattail} = 2.47E-08\ \mu g/d$$

C3.5 Ingestion of Wild Game and Fish

The following equation was used to estimate human exposure via consumption of fish or wild game.

$$EDI_{animal} = C_{animal} \times IR_{animal}$$

Where:

EDI_{animal} = estimated daily intake of chemical via consumption of fish or wild game (µg/d)

C_{animal} = chemical concentration in animal tissue (mg/kg WW)

IR_{animal} = fish or wild game ingestion rate (g/d)

Example C-67 **Estimated daily intake of formaldehyde by a toddler resident from consumption of moose**

$$EDI_{moose} = 1.54E-06 \times 65$$

$$EDI_{moose} = 1.0E-04\ \mu g/d$$

Example C-68 **Estimated daily intake of formaldehyde by a toddler resident from consumption of ruffed grouse**

$$EDI_{grouse} = 3.79E-09 \times 7$$

$$EDI_{grouse} = 2.65E-08\ \mu g/d$$

Example C-69 **Estimated daily intake of formaldehyde by a toddler resident from consumption of snowshoe hare**

$$EDI_{hare} = 1.25E-08 \times 14$$

$$EDI_{hare} = 1.75E-07 \mu g/d$$

Example C-70 **Estimated daily intake of formaldehyde by a toddler resident from consumption of fish**

$$EDI_{fish} = 6.58E-04 \times 20$$

$$EDI_{fish} = 1.32E-02 \mu g / d$$

C3.6 Swimming Exposure Through Dermal and Ingestion Pathways

C3.6.1 Dermal Exposure to Surface Water

The following equation was used to estimate dermal exposure from swimming based on recommendations from US EPA (2004) and Health Canada (2009a).

$$EDI_{derm+swim} = C_{sw} \times Kp \times SEF \times SAT \times CF1 \times CF2$$

Where:

$EDI_{derm+swim}$ = estimated daily intake of chemical from dermal contact with surface water (µg/d)

C_{sw} = chemical concentration in local surface water (Pond SP16) (mg/L)

Kp = dermal permeability coefficient in water (cm/hr)

SEF = swim exposure factor (hr/d)

SAT = surface area total (cm²)

CF1 = conversion factor from mg to µg (1,000 µg/mg)

CF2 = conversion factor from L to cm³ (0.001 L/cm³)

Example C-71 **Estimated daily intake of formaldehyde by a toddler resident from dermal uptake during swimming**

$$EDI_{derm+swim} = 2.08E-04 \times 1.83E-03 \times 0.255 \times 6130 \times 1{,}000 \times 0.001$$

$$EDI_{derm+swim} = 5.95E-04 \ \mu g / d$$

C3.6.2 Incidental Ingestion of Surface Water during Swimming

The following equation was used to estimate ingestion exposure from swimming based on recommendations from US EPA (2004) and Health Canada (2004).

$$EDI_{ing+swim} = C_{sw} \times SEF \times SWIR \times CF1$$

Where:

$EDI_{ing+swim}$ = estimated daily intake of chemical from ingestion of surface water during swimming (µg/d)

C_{sw} = chemical concentration in local surface water (Pond SP16) (mg/L)

SEF = swim exposure factor (hr/d)

SWIR = swimming ingestion rate (L/d)

CF1 = conversion factor from mg to µg (1,000 µg/mg)

Example C-72 Estimated daily intake of formaldehyde by a toddler resident from ingestion of surface water during swimming

$$EDI_{ing+swim} = 2.08E-04 \times 0.255 \times 0.05 \times 1{,}000$$

$$EDI_{ing+swim} = 2.65E-03\ \mu g/d$$

C3.6.3 Total Exposure to Surface Water during Swimming

The following equation was used to estimate total ingestion and dermal exposure from swimming.

$$EDI_{tot\_swim} = EDI_{derm+swim} + EDI_{ing+swim}$$

Where:

EDI_{tot_swim} = estimated daily intake of chemical from ingestion of and dermal contact with surface water during swimming (µg/d)

$EDI_{derm+swim}$ = estimated daily intake of chemical from dermal contact with surface water during swimming (µg/d)

$EDI_{ing+swim}$ = estimated daily intake of chemical from ingestion of surface water during swimming (µg/d)

Example C-73 **Estimated daily intake of formaldehyde by a toddler resident from ingestion of and dermal contact with surface water during swimming**

$$EDI_{tot\_swim} = 5.95E-04 + 2.65E-03$$

$$EDI_{tot\_swim} = 3.25E-03\ \mu g/d$$

C3.7 Dermal Exposures

C3.7.1 Dermal Exposures from Soils

Potential dermal exposure was estimated by applying soil loading rates to exposed skin, skin surface areas, and dermal absorption factors to measured or predicted soil concentrations. Dermal exposures were estimated separately for hands only and for surfaces other than hands (e.g., arms and legs).

C3.7.1.25 Dermal Exposure to Hands

The following equation was used to estimate dermal exposure for hands only. Dermal exposures were based on recommendations from Health Canada (2009b).

$$EDI_{dermal\_h} = C_s \times SAH \times SLH \times RAF_{dermal}$$

Where:

EDI_{dermal_h} = estimated daily intake of chemical from dermal contact of hands with soil (µg/d)

C_s = chemical concentration in surface soil (mg/kg)

SAH = skin surface area of hands (cm²)

SLH = soil loading rate to exposed skin on hands (g/cm²/event)

RAF_{dermal} = relative dermal absorption factor (10%)

Example C-74 **Estimated daily intake of formaldehyde by a toddler resident from dermal exposure to soil with hands only**

$$EDI_{dermal\_h} = 1.27E-07 \times 430 \times 0.0001 \times 0.10$$

$$EDI_{dermal\_h} = 5.5E-10\ \mu g/d$$

C3.7.1.26 Dermal Exposure to Surfaces Other than Hands

The following equation was used to estimate dermal exposure for surfaces other than hands. Dermal exposures were based on recommendations from Health Canada (2009b).

$$EDI_{dermal\_o} = C_s \times SAO \times SLO \times RAF_{dermal}$$

Where:

EDI_{dermal_o} = estimated daily intake of chemical from dermal contact of surfaces other than hands with soil (µg/d)

C_s = chemical concentration in surface soil (mg/kg)

SAO = skin surface area of upper and lower arms and legs (cm²)

SLH = soil loading rate to exposed skin on surfaces other than hands (g/cm²/event)

RAF_{dermal} = relative dermal absorption factor (10%)

Example C-75 Estimated daily intake of formaldehyde by a toddler resident from dermal exposure to soil with surfaces other than hands

$$EDI_{dermal\_o} = 1.27E-07 \times 2{,}580 \times 1.0E-05 \times 0.10$$

$$EDI_{dermal\_o} = 3.28E-10\ \mu g/d$$

C3.8 Ingestion of Breast Milk by Infants

The potential health effects associated with the ingestion of the chemical-affected breast milk by nursing infants was considered in the current assessment. The estimated exposure from consumption of breast milk was calculated as the product of the breast milk consumption rate and predicted chemical concentration in breast milk. The equations used to predict the chemical concentration in breast milk are described in the following sections. The multiple pathway exposure model assumed that infants (i.e., 0 to 6 months of age) derived their nutrients entirely from breast milk, and not from solid foods derived from the study area (e.g., traditional plants and game meat).

C3.8.1 Breast Milk Biotransfer Factor

The BTF for breast milk was used to convert the adult mother's total predicted exposure to a chemical concentration in her breast milk. The maximum fraction of the chemical expected to bioaccumulate was calculated using the following approach (McKone 1992):

$$BTF_{BM} = 2.0E-07 \times K_{ow}$$

Where:

BTF_{BM} = breast milk biotransfer factor ([µg/kg milk] / [µg/d intake])

K_{ow} = octanol-water partition coefficient (unitless)

As only infants were assumed to consume breast milk, the sample calculations below is based on a resident infant.

Example C-76 Breast milk biotransfer factor for formaldehyde for an infant resident

$$BTF_{BM} = 2.0E-07 \times 2.24$$

$$BTF_{BM} = 4.48E-07\ [\mu g / kg\ milk] / [\mu g / d\ \text{int}ake]$$

C3.8.2 Chemical Concentration in Breast Milk

The predicted breast milk concentration was calculated as follows:

$$C_{BM} = \frac{EDI_{mother} \times BTF_{BM}}{CF}$$

Where:

C_{BM} = predicted concentration of chemical in breast milk (µg/g milk)

EDI_{mother} = mother's total daily exposure to chemical via all routes (µg/d)

BTF_{BM} = breast milk biotransfer factor ([µg/kg milk] / [µg/d intake])

CF = conversion factor from kg to g (1,000 g/kg)

Example C-77 Concentration of formaldehyde in breast milk for an infant resident

$$C_{BM} = \frac{3.43E-01 \times 4.48E-07}{1{,}000}$$

$$C_{BM} = 1.54E-10\ \mu g / g\ milk$$

C3.8.3 Breast Milk Consumption

The estimated exposure from consumption of breast milk for infants was calculated as follows:

$$EDI_{BM} = C_{BM} \times IR_{BM}$$

Where:

EDI_{BM} = estimated daily intake of chemical from consumption of breast milk (µg/d)

C_{BM} = concentration of chemical in breast milk (µg/g milk)

IR_{BM} = breast milk ingestion rate (664 g/d; O'Connor and Richardson 1997)

Example C-78 Estimated daily intake of formaldehyde for an infant resident from breast milk consumption

$$EDI_{BM} = 1.54E-10 \times 664$$

$$EDI_{BM} = 1.02E-07\ \mu g/d\ milk$$

C3.9 Total Human Exposure

Total exposure was calculated by summing the individual exposures from each medium (i.e., soil, water, dust, and vegetation) for all relevant exposure pathways on a per chemical and per life stage basis:

$$EDI_{total} = EDI_{soil} + EDI_{water} + EDI_{dust} + EDI_{food} + EDI_{tot\_swim} + EDI_{dermal\_h} + EDI_{dermal\_o} + EDI_{BM}$$

Where:

EDI_{total} = total estimated daily intake of chemical via all routes (µg/d)

EDI_{soil} = estimated daily intake of chemical from soil ingestion (µg/d)

EDI_{water} = estimated daily intake of chemical from ingestion of water (µg/d)

EDI_{dust} = estimated daily intake of chemical from dust inhalation (µg/d)

EDI_{food} = estimated daily intake of chemical from consumption of all food types (µg/d [sum of leafy plants, root vegetables, berries, Labrador tea, cattail, fish, moose, grouse, and snowshoe hare])

EDI_{tot_swim} = estimated daily intake of chemical from dermal contact and incidental ingestion of surface water during swimming (µg/d)

EDI_{dermal_h} = estimated daily intake of chemical from dermal contact of hands with soil (µg/d)

EDI_{dermal_o} = estimated daily intake of chemical from dermal contact of surfaces other than hands with soil (µg/d)

EDI_{BM} = estimated daily intake of chemical from breast milk consumption (µg/d)

Example C-79 Total estimated daily intake of formaldehyde for a toddler resident from all routes of exposure

$$EDI_{total} = 1.02E-08 + 1.25E-01 + 8.03E-13 + 1.37E-02 + 3.25E-03 + 5.47E-10 + 3.28E-10 + 0$$

$$EDI_{total} = 1.42E-01 \mu g/d$$

The total estimated daily intake was normalized to body weight as follows:

$$EDI_{total\_BW} = \frac{EDI_{total}}{BW}$$

Where:

EDI_{total_BW} = total estimated daily intake of chemical via all routes adjusted to body weight (µg/kg bw/d)

EDI_{total} = total estimated daily intake of chemical via all routes (µg/d)

BW = body weight (kg)

Example C-80 Total estimated daily intake of formaldehyde for a toddler resident from all routes of exposure adjusted to body weight

$$EDI_{total\_BW} = \frac{1.42E-01}{16.5}$$

$$EDI_{total\_BW} = 8.6E-03 \ \mu g/kg\ bw/d$$

C4.0 HUMAN HAZARD CALCULATIONS

Risk quotients (RQs) for non–carcinogens and incremental lifetime cancer hazards (ILCRs) for carcinogens were estimated using the following equations and the calculated exposure estimates.

C4.1 Non-Carcinogens

The following equation was used to calculate the hazard quotients for non–carcinogens:

$$RQ_i = \frac{EDI_{total\_BW}}{RfD}$$

Where:

RQ_i = risk quotient of chemical for the 'i' lifestage of the residents (unitless)

EDI_{total_BW} = total estimated daily intake of chemical via all routes adjusted to body weight for the 'i' lifestage (µg/kg bw/d)

RfD = chemical-specific reference dose (µg/kg bw/d)

The maximum RQ value of all the life stages (i.e., infant, toddler, child, adolescent, and adult) was presented in the HHRA report for non-carcinogens. The toddler lifestage had the highest RQ of all the lifestages.

Example C-81 **Risk quotient for formaldehyde for the toddler life-stage of the resident in the application case**

$$RQ_i = \frac{8.6E-03}{150}$$

$$RQ_i = 5.7E-05$$

C4.2 Carcinogens

The following equation was used to calculate the lifetime cancer risks and incremental lifetime cancer risks for carcinogens.

$$ILCR_i = \left(\frac{EDI_{total\_BW}}{RsD} \right) \times LAF_i$$

Where:

$ILCR_i$ = incremental lifetime cancer risk for the 'i' lifestage of the residents (unitless)

EDI_{total_BW} = total estimated daily intake of chemical via all routes adjusted to body weight for the 'i' lifestage (µg/kg bw/d)

RsD = chemical-specific risk-specific dose (µg/kg bw/d)

LAF_i = life adjustment factor for the 'i' lifestage (yr-lifestage/yr-lifespan)

As formaldehyde was not considered an oral carcinogen in this assessment, benzo(a)pyrene was used in the example for the calculation of incremental lifetime cancer risk.

Example C-82 Incremental lifetime cancer risk from benzo(a)pyrene for a toddler resident

$$ILCR_i = \left(\frac{2.04E-04}{0.0014} \right) \times 0.06$$

$$ILCR_i = 8.6E-03$$

For carcinogens, cancer risks were presented for lifetime exposure using a composite receptor. The cancer risk for the composite receptor was calculated by summing the cancer risks for each life stage.

$$ILCR_{composite} = \sum ILCR_i$$

$$ILCR_{composite} = ILCR_{\text{inf } ant} + ILCR_{toddler} + ILCR_{child} + ILCR_{adolescent} + ILCR_{adult}$$

Where:

$ILCR_{composite}$ = incremental lifetime cancer risk for a composite receptor (unitless)

$ILCR_i$ = lifetime cancer risk or incremental lifetime cancer risk for the lifestages (unitless)

Example C-83 Incremental lifetime cancer risk from benzo(a)pyrene for a composite resident

$$ILCR_{composite} = 8.9E-04 + 8.6E-03 + 9.2E-03 + 7.8E-03 + 6.0E-02$$

$$ILCR_{composite} = 8.6E-02$$

The calculation above provides estimated carcinogenic risks for a life time of exposure.

C5.0 REFERENCES

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Appendix D
Human Health Risk Assessment
Exposure Model

Table D-1 Summary of Risk Quotient (RQ) Values for the Resident Receptor (Unitless)

Chemical	Baseline	Application	PDC	Project	Future
Non-carcinogens					
2-methylnaphthalene	8.6E-02	8.6E-02	8.6E-02	1.4E-06	3.4E-04
3-methylcholanthrene	7.9E-06	7.9E-06	8.4E-06	1.3E-06	8.4E-07
Acenaphthene	2.1E-06	2.1E-06	3.7E-06	5.7E-08	1.6E-06
Acenaphthylene	4.0E-05	4.0E-05	7.1E-05	4.0E-08	3.2E-05
Anthracene	1.0E-06	1.0E-06	1.8E-06	2.7E-08	8.1E-07
Fluorene	2.9E-04	2.9E-04	3.0E-04	7.6E-08	1.5E-06
Pyrene	3.1E-06	3.1E-06	5.4E-06	3.9E-08	2.4E-06
C9-C18 aromatics	1.4E-02	1.4E-02	2.7E-02	3.1E-05	1.2E-02
C9-C18 aromatics group	2.3E-02	2.3E-02	3.6E-02	3.1E-05	1.3E-02
Formaldehyde	5.7E-05	5.7E-05	1.0E-04	1.9E-04	5.7E-05
Carcinogens					
Benzo(a)pyrene Equivalent	4.9E-01	4.9E-01	6.0E-01	2.6E-02	1.2E-01
Mixtures					
Renal toxicants	1.4E-02	1.4E-02	2.7E-02		

Table D-2 Summary of Risk Quotient (RQ) Values for the Worker Receptor (Unitless)

Chemical	Baseline	Application	PDC	Project	Future
Non-carcinogens					
2-methylnaphthalene	6.5E-05	6.5E-05	7.5E-05	4.2E-08	1.0E-05
3-methylcholanthrene	4.1E-09	4.3E-09	4.6E-09	9.9E-10	6.3E-10
Acenaphthene	1.2E-07	1.2E-07	2.1E-07	3.3E-09	9.2E-08
Acenaphthylene	2.3E-06	2.3E-06	4.1E-06	2.3E-09	1.8E-06
Anthracene	1.5E-07	1.5E-07	2.7E-07	4.1E-09	1.2E-07
Fluorene	5.5E-06	5.5E-06	5.7E-06	1.2E-08	2.3E-07
Pyrene	3.7E-07	3.7E-07	6.6E-07	5.7E-09	2.8E-07
C9-C18 aromatics	2.7E-03	2.7E-03	5.2E-03	5.9E-06	2.4E-03
C9-C18 aromatics group	2.7E-03	2.7E-03	5.2E-03	6.0E-06	2.4E-03
Formaldehyde	2.9E-05	2.9E-05	5.4E-05	9.9E-05	2.9E-05
Carcinogens					
Benzo(a)pyrene Equivalent	9.6E-03	1.0E-02	1.2E-02	2.4E-03	2.6E-03
Mixtures					
Renal toxicants	2.8E-03	2.8E-03	5.2E-03		

Table D-3 Detailed Summary of Risk Quotient (RQ) Values for Resident Receptors [Unitless]

Site	Case	Chemical/Chemical Mixture	Type	Infant	Toddler	Child	Adolescent	Adult	Max	LCR/ILCR	PEF	B(a)P IPM PEQ
RES	Baseline	2-methylnaphthalene	RfD	3.6E-04	8.6E-02	6.6E-02	5.1E-02	3.6E-02	8.6E-02	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	3-methylcholanthrene	RfD	7.9E-06	3.8E-06	2.8E-06	2.2E-06	2.6E-06	7.9E-06	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	7,12-Dimethylbenz(a)anthracene	RsD	1.7E-04	3.3E-03	3.5E-03	3.0E-03	2.3E-02	0.0E+00	3.3E-02	1.0E+01	3.3E-01
RES	Baseline	Acenaphthene	RfD	2.7E-07	2.1E-06	1.6E-06	1.1E-06	1.1E-06	2.1E-06	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	Acenaphthylene	RfD	5.3E-06	4.0E-05	3.1E-05	2.2E-05	2.1E-05	4.0E-05	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	Anthracene	RfD	3.9E-07	1.0E-06	7.9E-07	5.6E-07	5.8E-07	1.0E-06	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	Benzo(a)anthracene	RsD	1.2E-03	2.4E-02	2.6E-02	2.2E-02	1.7E-01	0.0E+00	2.4E-01	1.0E-01	2.4E-02
RES	Baseline	Benzo(a)pyrene	RsD	8.9E-04	8.6E-03	9.2E-03	7.8E-03	6.0E-02	0.0E+00	8.6E-02	1.0E+00	8.6E-02
RES	Baseline	Benzo(b)fluoranthene	RsD	2.5E-04	4.5E-03	4.9E-03	4.2E-03	3.2E-02	0.0E+00	4.6E-02	1.0E-01	4.6E-03
RES	Baseline	Benzo(g,h,i)perylene	RsD	4.6E-03	1.5E-02	1.6E-02	1.3E-02	1.0E-01	0.0E+00	1.5E-01	1.0E-02	1.5E-03
RES	Baseline	Benzo(k)fluoranthene	RsD	5.0E-04	5.3E-03	5.3E-03	4.5E-03	3.3E-02	0.0E+00	4.9E-02	1.0E-01	4.9E-03
RES	Baseline	Chrysene	RsD	7.1E-04	1.2E-02	1.2E-02	1.1E-02	7.7E-02	0.0E+00	1.1E-01	1.0E-02	1.1E-03
RES	Baseline	Dibenz(a,h)anthracene	RsD	1.1E-03	2.7E-03	2.8E-03	2.4E-03	1.9E-02	0.0E+00	2.8E-02	1.0E+00	2.8E-02
RES	Baseline	Fluoranthene	RsD	1.9E-04	3.6E-03	4.0E-03	3.3E-03	2.5E-02	0.0E+00	3.6E-02	1.0E-03	3.6E-05
RES	Baseline	Fluorene	RfD	4.1E-06	2.9E-04	2.2E-04	1.7E-04	1.3E-04	2.9E-04	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	Indeno(1,2,3-cd)pyrene	RsD	5.7E-04	1.6E-03	1.7E-03	1.4E-03	1.1E-02	0.0E+00	1.6E-02	1.0E-01	1.6E-03
RES	Baseline	Phenanthrene	RsD	4.8E-03	1.4E+00	1.5E+00	1.5E+00	9.0E+00	0.0E+00	1.4E+01	1.0E-03	1.4E-02
RES	Baseline	Pyrene	RfD	1.2E-06	3.1E-06	2.3E-06	1.7E-06	1.7E-06	3.1E-06	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	C9-C18 aromatics	RfD	5.5E-03	1.4E-02	1.1E-02	7.4E-03	7.2E-03	1.4E-02	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	Formaldehyde	RfD	5.1E-05	5.7E-05	3.9E-05	2.7E-05	3.2E-05	5.7E-05	0.0E+00	0.0E+00	0.0E+00
RES	Baseline	Benzo(a)pyrene Equivalent	RsD									4.9E-01
RES	Application	2-methylnaphthalene	RfD	3.6E-04	8.6E-02	6.6E-02	5.1E-02	3.6E-02	8.6E-02	0.0E+00	0.0E+00	0.0E+00
RES	Application	3-methylcholanthrene	RfD	7.9E-06	3.8E-06	2.8E-06	2.2E-06	2.6E-06	7.9E-06	0.0E+00	0.0E+00	0.0E+00
RES	Application	7,12-Dimethylbenz(a)anthracene	RsD	1.7E-04	3.3E-03	3.5E-03	3.0E-03	2.3E-02	0.0E+00	3.3E-02	1.0E+01	3.3E-01
RES	Application	Acenaphthene	RfD	2.7E-07	2.1E-06	1.6E-06	1.1E-06	1.1E-06	2.1E-06	0.0E+00	0.0E+00	0.0E+00
RES	Application	Acenaphthylene	RfD	5.3E-06	4.0E-05	3.1E-05	2.2E-05	2.1E-05	4.0E-05	0.0E+00	0.0E+00	0.0E+00
RES	Application	Anthracene	RfD	3.9E-07	1.0E-06	7.9E-07	5.6E-07	5.8E-07	1.0E-06	0.0E+00	0.0E+00	0.0E+00
RES	Application	Benzo(a)anthracene	RsD	1.2E-03	2.4E-02	2.6E-02	2.2E-02	1.7E-01	0.0E+00	2.4E-01	1.0E-01	2.4E-02
RES	Application	Benzo(a)pyrene	RsD	8.9E-04	8.6E-03	9.2E-03	7.8E-03	6.0E-02	0.0E+00	8.6E-02	1.0E+00	8.6E-02
RES	Application	Benzo(b)fluoranthene	RsD	2.5E-04	4.5E-03	4.9E-03	4.2E-03	3.2E-02	0.0E+00	4.6E-02	1.0E-01	4.6E-03
RES	Application	Benzo(g,h,i)perylene	RsD	4.6E-03	1.5E-02	1.6E-02	1.3E-02	1.0E-01	0.0E+00	1.5E-01	1.0E-02	1.5E-03
RES	Application	Benzo(k)fluoranthene	RsD	5.0E-04	5.3E-03	5.3E-03	4.5E-03	3.3E-02	0.0E+00	4.9E-02	1.0E-01	4.9E-03
RES	Application	Chrysene	RsD	7.1E-04	1.2E-02	1.2E-02	1.1E-02	7.7E-02	0.0E+00	1.1E-01	1.0E-02	1.1E-03
RES	Application	Dibenz(a,h)anthracene	RsD	1.1E-03	2.7E-03	2.8E-03	2.4E-03	1.9E-02	0.0E+00	2.8E-02	1.0E+00	2.8E-02
RES	Application	Fluoranthene	RsD	1.9E-04	3.6E-03	4.0E-03	3.3E-03	2.5E-02	0.0E+00	3.6E-02	1.0E-03	3.6E-05
RES	Application	Fluorene	RfD	4.1E-06	2.9E-04	2.2E-04	1.7E-04	1.3E-04	2.9E-04	0.0E+00	0.0E+00	0.0E+00
RES	Application	Indeno(1,2,3-cd)pyrene	RsD	5.7E-04	1.6E-03	1.7E-03	1.4E-03	1.1E-02	0.0E+00	1.6E-02	1.0E-01	1.6E-03
RES	Application	Phenanthrene	RsD	4.8E-03	1.4E+00	1.5E+00	1.5E+00	9.0E+00	0.0E+00	1.4E+01	1.0E-03	1.4E-02
RES	Application	Pyrene	RfD	1.2E-06	3.1E-06	2.3E-06	1.7E-06	1.7E-06	3.1E-06	0.0E+00	0.0E+00	0.0E+00
RES	Application	C9-C18 aromatics	RfD	5.5E-03	1.4E-02	1.1E-02	7.4E-03	7.2E-03	1.4E-02	0.0E+00	0.0E+00	0.0E+00
RES	Application	Formaldehyde	RfD	5.1E-05	5.7E-05	3.9E-05	2.7E-05	3.2E-05	5.7E-05	0.0E+00	0.0E+00	0.0E+00
RES	Application	Benzo(a)pyrene Equivalent	RsD									4.9E-01
RES	PDC	2-methylnaphthalene	RfD	3.9E-04	8.6E-02	6.6E-02	5.1E-02	3.6E-02	8.6E-02	0.0E+00	0.0E+00	0.0E+00
RES	PDC	3-methylcholanthrene	RfD	8.4E-06	4.0E-06	3.0E-06	2.3E-06	2.8E-06	8.4E-06	0.0E+00	0.0E+00	0.0E+00
RES	PDC	7,12-Dimethylbenz(a)anthracene	RsD	1.8E-04	3.5E-03	3.7E-03	3.2E-03	2.4E-02	0.0E+00	3.5E-02	1.0E+01	3.5E-01
RES	PDC	Acenaphthene	RfD	4.8E-07	3.7E-06	2.9E-06	2.0E-06	2.0E-06	3.7E-06	0.0E+00	0.0E+00	0.0E+00
RES	PDC	Acenaphthylene	RfD	9.5E-06	7.1E-05	5.6E-05	3.9E-05	3.8E-05	7.1E-05	0.0E+00	0.0E+00	0.0E+00
RES	PDC	Anthracene	RfD	7.0E-07	1.8E-06	1.4E-06	1.0E-06	1.0E-06	1.8E-06	0.0E+00	0.0E+00	0.0E+00
RES	PDC	Benzo(a)anthracene	RsD	2.1E-03	4.1E-02	4.5E-02	3.8E-02	2.9E-01	0.0E+00	4.2E-01	1.0E-01	4.2E-02
RES	PDC	Benzo(a)pyrene	RsD	1.6E-03	1.5E-02	1.6E-02	1.4E-02	1.1E-01	0.0E+00	1.5E-01	1.0E+00	1.5E-01
RES	PDC	Benzo(b)fluoranthene	RsD	4.3E-04	7.6E-03	8.4E-03	7.1E-03	5.5E-02	0.0E+00	7.9E-02	1.0E-01	7.9E-03
RES	PDC	Benzo(g,h,i)perylene	RsD	8.3E-03	2.6E-02	2.8E-02	2.4E-02	1.9E-01	0.0E+00	2.7E-01	1.0E-02	2.7E-03
RES	PDC	Benzo(k)fluoranthene	RsD	8.9E-04	9.4E-03	9.4E-03	8.0E-03	5.9E-02	0.0E+00	8.7E-02	1.0E-01	8.7E-03
RES	PDC	Chrysene	RsD	1.3E-03	2.2E-02	2.2E-02	1.9E-02	1.4E-01	0.0E+00	2.0E-01	1.0E-02	2.0E-03
RES	PDC	Dibenz(a,h)anthracene	RsD	8.8E-04	2.2E-03	2.3E-03	2.0E-03	1.5E-02	0.0E+00	2.2E-02	1.0E+00	2.2E-02
RES	PDC	Fluoranthene	RsD	3.3E-04	6.3E-03	7.0E-03	5.8E-03	4.4E-02	0.0E+00	6.4E-02	1.0E-03	6.4E-05
RES	PDC	Fluorene	RfD	4.5E-06	3.0E-04	2.2E-04	1.7E-04	1.4E-04	3.0E-04	0.0E+00	0.0E+00	0.0E+00
RES	PDC	Indeno(1,2,3-cd)pyrene	RsD	4.7E-04	1.3E-03	1.4E-03	1.2E-03	8.8E-03	0.0E+00	1.3E-02	1.0E-01	1.3E-03

Table D-3 Detailed Summary of Risk Quotient (RQ) Values for Resident Receptors [Unitless]

Site	Case	Chemical/Chemical Mixture	Type	Infant	Toddler	Child	Adolescent	Adult	Max	LCR/ILCR	PEF	B(a)P IPM PEQ
RES	PDC	Phenanthrene	RsD	5.2E-03	1.5E+00	1.5E+00	1.5E+00	9.1E+00	0.0E+00	1.4E+01	1.0E-03	1.4E-02
RES	PDC	Pyrene	RfD	2.1E-06	5.4E-06	4.1E-06	2.9E-06	3.0E-06	5.4E-06	0.0E+00	0.0E+00	0.0E+00
RES	PDC	C9-C18 aromatics	RfD	1.0E-02	2.7E-02	2.0E-02	1.4E-02	1.4E-02	2.7E-02	0.0E+00	0.0E+00	0.0E+00
RES	PDC	Formaldehyde	RfD	9.3E-05	1.0E-04	7.1E-05	4.9E-05	5.9E-05	1.0E-04	0.0E+00	0.0E+00	0.0E+00
RES	PDC	Benzo(a)pyrene Equivalent	RsD									6.0E-01
RES	Project	2-methylnaphthalene	RfD	9.9E-08	1.4E-06	1.1E-06	7.7E-07	6.7E-07	1.4E-06	0.0E+00	0.0E+00	0.0E+00
RES	Project	3-methylcholanthrene	RfD	1.3E-06	5.8E-07	4.3E-07	3.3E-07	4.1E-07	1.3E-06	0.0E+00	0.0E+00	0.0E+00
RES	Project	7,12-Dimethylbenz(a)anthracene	RsD	1.1E-05	1.5E-04	1.7E-04	1.4E-04	1.3E-03	0.0E+00	1.8E-03	1.0E+01	1.8E-02
RES	Project	Acenaphthene	RfD	7.5E-09	5.7E-08	4.5E-08	3.1E-08	3.1E-08	5.7E-08	0.0E+00	0.0E+00	0.0E+00
RES	Project	Acenaphthylene	RfD	5.4E-09	4.0E-08	3.2E-08	2.2E-08	2.2E-08	4.0E-08	0.0E+00	0.0E+00	0.0E+00
RES	Project	Anthracene	RfD	1.1E-08	2.7E-08	2.1E-08	1.5E-08	1.5E-08	2.7E-08	0.0E+00	0.0E+00	0.0E+00
RES	Project	Benzo(a)anthracene	RsD	1.5E-04	2.0E-03	2.2E-03	1.9E-03	1.7E-02	0.0E+00	2.3E-02	1.0E-01	2.3E-03
RES	Project	Benzo(a)pyrene	RsD	2.0E-05	1.5E-04	1.6E-04	1.4E-04	1.3E-03	0.0E+00	1.7E-03	1.0E+00	1.7E-03
RES	Project	Benzo(b)fluoranthene	RsD	4.8E-06	6.6E-05	7.2E-05	6.2E-05	5.5E-04	0.0E+00	7.6E-04	1.0E-01	7.6E-05
RES	Project	Benzo(g,h,i)perylene	RsD	1.1E-04	2.8E-04	3.0E-04	2.7E-04	2.5E-03	0.0E+00	3.4E-03	1.0E-02	3.4E-05
RES	Project	Benzo(k)fluoranthene	RsD	1.4E-05	1.1E-04	1.2E-04	1.1E-04	9.4E-04	0.0E+00	1.3E-03	1.0E-01	1.3E-04
RES	Project	Chrysene	RsD	9.7E-06	1.1E-04	1.3E-04	1.1E-04	9.1E-04	0.0E+00	1.3E-03	1.0E-02	1.3E-05
RES	Project	Dibenz(a,h)anthracene	RsD	1.5E-04	3.0E-04	3.2E-04	2.8E-04	2.5E-03	0.0E+00	3.6E-03	1.0E+00	3.6E-03
RES	Project	Fluoranthene	RsD	6.2E-06	1.1E-04	1.2E-04	1.0E-04	8.0E-04	0.0E+00	1.1E-03	1.0E-03	1.1E-06
RES	Project	Fluorene	RfD	2.7E-08	7.6E-08	5.9E-08	4.1E-08	4.2E-08	7.6E-08	0.0E+00	0.0E+00	0.0E+00
RES	Project	Indeno(1,2,3-cd)pyrene	RsD	8.1E-05	1.8E-04	2.0E-04	1.7E-04	1.5E-03	0.0E+00	2.1E-03	1.0E-01	2.1E-04
RES	Project	Phenanthrene	RsD	3.0E-05	7.1E-04	7.9E-04	6.4E-04	5.0E-03	0.0E+00	7.2E-03	1.0E-03	7.2E-06
RES	Project	Pyrene	RfD	1.7E-08	3.9E-08	3.0E-08	2.1E-08	2.2E-08	3.9E-08	0.0E+00	0.0E+00	0.0E+00
RES	Project	C9-C18 aromatics	RfD	1.2E-05	3.1E-05	2.4E-05	1.6E-05	1.6E-05	3.1E-05	0.0E+00	0.0E+00	0.0E+00
RES	Project	Formaldehyde	RfD	1.7E-04	1.9E-04	1.3E-04	8.9E-05	1.1E-04	1.9E-04	0.0E+00	0.0E+00	0.0E+00
RES	Project	Benzo(a)pyrene Equivalent	RsD									2.6E-02
RES	Future	2-methylnaphthalene	RfD	2.4E-05	3.4E-04	2.8E-04	1.9E-04	1.6E-04	3.4E-04	0.0E+00	0.0E+00	0.0E+00
RES	Future	3-methylcholanthrene	RfD	8.4E-07	4.0E-07	3.0E-07	2.3E-07	2.8E-07	8.4E-07	0.0E+00	0.0E+00	0.0E+00
RES	Future	7,12-Dimethylbenz(a)anthracene	RsD	1.3E-05	2.5E-04	2.6E-04	2.2E-04	1.8E-03	0.0E+00	2.5E-03	1.0E+01	2.5E-02
RES	Future	Acenaphthene	RfD	2.1E-07	1.6E-06	1.2E-06	8.6E-07	8.5E-07	1.6E-06	0.0E+00	0.0E+00	0.0E+00
RES	Future	Acenaphthylene	RfD	4.2E-06	3.2E-05	2.5E-05	1.7E-05	1.7E-05	3.2E-05	0.0E+00	0.0E+00	0.0E+00
RES	Future	Anthracene	RfD	3.1E-07	8.1E-07	6.2E-07	4.4E-07	4.5E-07	8.1E-07	0.0E+00	0.0E+00	0.0E+00
RES	Future	Benzo(a)anthracene	RsD	8.7E-04	1.7E-02	1.9E-02	1.6E-02	1.2E-01	0.0E+00	1.8E-01	1.0E-01	1.8E-02
RES	Future	Benzo(a)pyrene	RsD	7.1E-04	6.8E-03	7.3E-03	6.2E-03	4.8E-02	0.0E+00	6.8E-02	1.0E+00	6.8E-02
RES	Future	Benzo(b)fluoranthene	RsD	1.8E-04	3.2E-03	3.5E-03	2.9E-03	2.3E-02	0.0E+00	3.3E-02	1.0E-01	3.3E-03
RES	Future	Benzo(g,h,i)perylene	RsD	3.6E-03	1.1E-02	1.2E-02	1.0E-02	8.2E-02	0.0E+00	1.2E-01	1.0E-02	1.2E-03
RES	Future	Benzo(k)fluoranthene	RsD	3.9E-04	4.1E-03	4.1E-03	3.5E-03	2.6E-02	0.0E+00	3.8E-02	1.0E-01	3.8E-03
RES	Future	Chrysene	RsD	5.5E-04	9.5E-03	9.8E-03	8.3E-03	6.1E-02	0.0E+00	8.9E-02	1.0E-02	8.9E-04
RES	Future	Dibenz(a,h)anthracene	RsD	1.6E-04	3.4E-04	3.7E-04	3.2E-04	2.7E-03	0.0E+00	3.9E-03	1.0E+00	3.9E-03
RES	Future	Fluoranthene	RsD	1.4E-04	2.7E-03	3.0E-03	2.5E-03	1.9E-02	0.0E+00	2.7E-02	1.0E-03	2.7E-05
RES	Future	Fluorene	RfD	5.2E-07	1.5E-06	1.1E-06	7.9E-07	8.1E-07	1.5E-06	0.0E+00	0.0E+00	0.0E+00
RES	Future	Indeno(1,2,3-cd)pyrene	RsD	9.0E-05	2.2E-04	2.3E-04	2.0E-04	1.7E-03	0.0E+00	2.4E-03	1.0E-01	2.4E-04
RES	Future	Phenanthrene	RsD	3.6E-04	8.5E-03	9.5E-03	7.7E-03	6.0E-02	0.0E+00	8.6E-02	1.0E-03	8.6E-05
RES	Future	Pyrene	RfD	9.3E-07	2.4E-06	1.8E-06	1.3E-06	1.3E-06	2.4E-06	0.0E+00	0.0E+00	0.0E+00
RES	Future	C9-C18 aromatics	RfD	4.9E-03	1.2E-02	9.6E-03	6.6E-03	6.4E-03	1.2E-02	0.0E+00	0.0E+00	0.0E+00
RES	Future	Formaldehyde	RfD	5.0E-05	5.7E-05	3.9E-05	2.6E-05	3.2E-05	5.7E-05	0.0E+00	0.0E+00	0.0E+00
RES	Future	Benzo(a)pyrene Equivalent	RsD						0.0E+00			1.2E-01
RES	Baseline	Renal toxicants		5.6E-03	1.4E-02	1.1E-02	7.4E-03	7.3E-03	1.4E-02			
RES	Application	Renal toxicants		5.6E-03	1.4E-02	1.1E-02	7.4E-03	7.3E-03	1.4E-02			
RES	PDC	Renal toxicants		1.1E-02	2.7E-02	2.1E-02	1.4E-02	1.4E-02	2.7E-02			

NOTES:
Maximum RQ value for non-carcinogens
Sum of cancer risk estimates for each lifestage = lifetime risk
Benzo(a)pyrene equivalent based on adjustment with potency exposure factors (PEFs)

Table D-4 Detailed Summary of Risk Quotient (RQ) Values for Worker Receptors [Unitless]

Site	Case	Chemical/Chemical Mixture	Type	Adult	Max	LCR/ILCR	PEF	B(a)P IPM PEQ
WORK	Baseline	2-methylnaphthalene	RfD	6.5E-05	6.5E-05	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	3-methylcholanthrene	RfD	4.1E-09	4.1E-09	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	7,12-Dimethylbenz(a)anthracene	RsD	6.8E-04	0.0E+00	6.8E-04	1.0E+01	6.8E-03
WORK	Baseline	Acenaphthene	RfD	1.2E-07	1.2E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	Acenaphthylene	RfD	2.3E-06	2.3E-06	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	Anthracene	RfD	1.5E-07	1.5E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	Benzo(a)anthracene	RsD	4.8E-03	0.0E+00	4.8E-03	1.0E-01	4.8E-04
WORK	Baseline	Benzo(a)pyrene	RsD	1.1E-03	0.0E+00	1.1E-03	1.0E+00	1.1E-03
WORK	Baseline	Benzo(b)fluoranthene	RsD	1.5E-03	0.0E+00	1.5E-03	1.0E-01	1.5E-04
WORK	Baseline	Benzo(g,h,i)perylene	RsD	1.2E-03	0.0E+00	1.2E-03	1.0E-02	1.2E-05
WORK	Baseline	Benzo(k)fluoranthene	RsD	9.1E-04	0.0E+00	9.1E-04	1.0E-01	9.1E-05
WORK	Baseline	Chrysene	RsD	3.3E-03	0.0E+00	3.3E-03	1.0E-02	3.3E-05
WORK	Baseline	Dibenz(a,h)anthracene	RsD	5.1E-04	0.0E+00	5.1E-04	1.0E+00	5.1E-04
WORK	Baseline	Fluoranthene	RsD	5.1E-03	0.0E+00	5.1E-03	1.0E-03	5.1E-06
WORK	Baseline	Fluorene	RfD	5.5E-06	5.5E-06	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	Indeno(1,2,3-cd)pyrene	RsD	3.8E-04	0.0E+00	3.8E-04	1.0E-01	3.8E-05
WORK	Baseline	Phenanthrene	RsD	3.3E-01	0.0E+00	3.3E-01	1.0E-03	3.3E-04
WORK	Baseline	Pyrene	RfD	3.7E-07	3.7E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	C9-C18 aromatics	RfD	2.7E-03	2.7E-03	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	Formaldehyde	RfD	2.9E-05	2.9E-05	0.0E+00	0.0E+00	0.0E+00
WORK	Baseline	Benzo(a)pyrene Equivalent	RsD					9.6E-03
WORK	Application	2-methylnaphthalene	RfD	6.5E-05	6.5E-05	0.0E+00	0.0E+00	0.0E+00
WORK	Application	3-methylcholanthrene	RfD	4.3E-09	4.3E-09	0.0E+00	0.0E+00	0.0E+00
WORK	Application	7,12-Dimethylbenz(a)anthracene	RsD	7.3E-04	0.0E+00	7.3E-04	1.0E+01	7.3E-03
WORK	Application	Acenaphthene	RfD	1.2E-07	1.2E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Application	Acenaphthylene	RfD	2.3E-06	2.3E-06	0.0E+00	0.0E+00	0.0E+00
WORK	Application	Anthracene	RfD	1.5E-07	1.5E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Application	Benzo(a)anthracene	RsD	4.8E-03	0.0E+00	4.8E-03	1.0E-01	4.8E-04
WORK	Application	Benzo(a)pyrene	RsD	1.1E-03	0.0E+00	1.1E-03	1.0E+00	1.1E-03
WORK	Application	Benzo(b)fluoranthene	RsD	1.5E-03	0.0E+00	1.5E-03	1.0E-01	1.5E-04
WORK	Application	Benzo(g,h,i)perylene	RsD	1.2E-03	0.0E+00	1.2E-03	1.0E-02	1.2E-05
WORK	Application	Benzo(k)fluoranthene	RsD	9.8E-04	0.0E+00	9.8E-04	1.0E-01	9.8E-05
WORK	Application	Chrysene	RsD	3.4E-03	0.0E+00	3.4E-03	1.0E-02	3.4E-05
WORK	Application	Dibenz(a,h)anthracene	RsD	5.6E-04	0.0E+00	5.6E-04	1.0E+00	5.6E-04
WORK	Application	Fluoranthene	RsD	5.1E-03	0.0E+00	5.1E-03	1.0E-03	5.1E-06
WORK	Application	Fluorene	RfD	5.5E-06	5.5E-06	0.0E+00	0.0E+00	0.0E+00
WORK	Application	Indeno(1,2,3-cd)pyrene	RsD	4.2E-04	0.0E+00	4.2E-04	1.0E-01	4.2E-05
WORK	Application	Phenanthrene	RsD	3.3E-01	0.0E+00	3.3E-01	1.0E-03	3.3E-04
WORK	Application	Pyrene	RfD	3.7E-07	3.7E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Application	C9-C18 aromatics	RfD	2.7E-03	2.7E-03	0.0E+00	0.0E+00	0.0E+00
WORK	Application	Formaldehyde	RfD	2.9E-05	2.9E-05	0.0E+00	0.0E+00	0.0E+00

Table D-4 Detailed Summary of Risk Quotient (RQ) Values for Worker Receptors [Unitless]

Site	Case	Chemical/Chemical Mixture	Type	Adult	Max	LCR/ILCR	PEF	B(a)P IPM PEQ
WORK	Application	Benzo(a)pyrene Equivalent	RsD					1.0E-02
WORK	PDC	2-methylnaphthalene	RfD	7.5E-05	7.5E-05	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	3-methylcholanthrene	RfD	4.6E-09	4.6E-09	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	7,12-Dimethylbenz(a)anthracene	RsD	7.8E-04	0.0E+00	7.8E-04	1.0E+01	7.8E-03
WORK	PDC	Acenaphthene	RfD	2.1E-07	2.1E-07	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	Acenaphthylene	RfD	4.1E-06	4.1E-06	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	Anthracene	RfD	2.7E-07	2.7E-07	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	Benzo(a)anthracene	RsD	8.2E-03	0.0E+00	8.2E-03	1.0E-01	8.2E-04
WORK	PDC	Benzo(a)pyrene	RsD	1.9E-03	0.0E+00	1.9E-03	1.0E+00	1.9E-03
WORK	PDC	Benzo(b)fluoranthene	RsD	2.6E-03	0.0E+00	2.6E-03	1.0E-01	2.6E-04
WORK	PDC	Benzo(g,h,i)perylene	RsD	2.0E-03	0.0E+00	2.0E-03	1.0E-02	2.0E-05
WORK	PDC	Benzo(k)fluoranthene	RsD	1.4E-03	0.0E+00	1.4E-03	1.0E-01	1.4E-04
WORK	PDC	Chrysene	RsD	5.7E-03	0.0E+00	5.7E-03	1.0E-02	5.7E-05
WORK	PDC	Dibenz(a,h)anthracene	RsD	4.8E-04	0.0E+00	4.8E-04	1.0E+00	4.8E-04
WORK	PDC	Fluoranthene	RsD	8.9E-03	0.0E+00	8.9E-03	1.0E-03	8.9E-06
WORK	PDC	Fluorene	RfD	5.7E-06	5.7E-06	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	Indeno(1,2,3-cd)pyrene	RsD	3.5E-04	0.0E+00	3.5E-04	1.0E-01	3.5E-05
WORK	PDC	Phenanthrene	RsD	3.4E-01	0.0E+00	3.4E-01	1.0E-03	3.4E-04
WORK	PDC	Pyrene	RfD	6.6E-07	6.6E-07	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	C9-C18 aromatics	RfD	5.2E-03	5.2E-03	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	Formaldehyde	RfD	5.4E-05	5.4E-05	0.0E+00	0.0E+00	0.0E+00
WORK	PDC	Benzo(a)pyrene Equivalent	RsD					1.2E-02
WORK	Project	2-methylnaphthalene	RfD	4.2E-08	4.2E-08	0.0E+00	0.0E+00	0.0E+00
WORK	Project	3-methylcholanthrene	RfD	9.9E-10	9.9E-10	0.0E+00	0.0E+00	0.0E+00
WORK	Project	7,12-Dimethylbenz(a)anthracene	RsD	1.8E-04	0.0E+00	1.8E-04	1.0E+01	1.8E-03
WORK	Project	Acenaphthene	RfD	3.3E-09	3.3E-09	0.0E+00	0.0E+00	0.0E+00
WORK	Project	Acenaphthylene	RfD	2.3E-09	2.3E-09	0.0E+00	0.0E+00	0.0E+00
WORK	Project	Anthracene	RfD	4.1E-09	4.1E-09	0.0E+00	0.0E+00	0.0E+00
WORK	Project	Benzo(a)anthracene	RsD	2.5E-03	0.0E+00	2.5E-03	1.0E-01	2.5E-04
WORK	Project	Benzo(a)pyrene	RsD	1.1E-04	0.0E+00	1.1E-04	1.0E+00	1.1E-04
WORK	Project	Benzo(b)fluoranthene	RsD	4.5E-05	0.0E+00	4.5E-05	1.0E-01	4.5E-06
WORK	Project	Benzo(g,h,i)perylene	RsD	1.1E-04	0.0E+00	1.1E-04	1.0E-02	1.1E-06
WORK	Project	Benzo(k)fluoranthene	RsD	2.2E-04	0.0E+00	2.2E-04	1.0E-01	2.2E-05
WORK	Project	Chrysene	RsD	1.8E-04	0.0E+00	1.8E-04	1.0E-02	1.8E-06
WORK	Project	Dibenz(a,h)anthracene	RsD	2.2E-04	0.0E+00	2.2E-04	1.0E+00	2.2E-04
WORK	Project	Fluoranthene	RsD	1.8E-04	0.0E+00	1.8E-04	1.0E-03	1.8E-07
WORK	Project	Fluorene	RfD	1.2E-08	1.2E-08	0.0E+00	0.0E+00	0.0E+00
WORK	Project	Indeno(1,2,3-cd)pyrene	RsD	2.0E-04	0.0E+00	2.0E-04	1.0E-01	2.0E-05
WORK	Project	Phenanthrene	RsD	1.3E-03	0.0E+00	1.3E-03	1.0E-03	1.3E-06
WORK	Project	Pyrene	RfD	5.7E-09	5.7E-09	0.0E+00	0.0E+00	0.0E+00
WORK	Project	C9-C18 aromatics	RfD	5.9E-06	5.9E-06	0.0E+00	0.0E+00	0.0E+00

Table D-4 Detailed Summary of Risk Quotient (RQ) Values for Worker Receptors [Unitless]

Site	Case	Chemical/Chemical Mixture	Type	Adult	Max	LCR/ILCR	PEF	B(a)P IPM PEQ
WORK	Project	Formaldehyde	RfD	9.9E-05	9.9E-05	0.0E+00	0.0E+00	0.0E+00
WORK	Project	Benzo(a)pyrene Equivalent	RsD					2.4E-03
WORK	Future	2-methylnaphthalene	RfD	1.0E-05	1.0E-05	0.0E+00	0.0E+00	0.0E+00
WORK	Future	3-methylcholanthrene	RfD	6.3E-10	6.3E-10	0.0E+00	0.0E+00	0.0E+00
WORK	Future	7,12-Dimethylbenz(a)anthracene	RsD	1.2E-04	0.0E+00	1.2E-04	1.0E+01	1.2E-03
WORK	Future	Acenaphthene	RfD	9.2E-08	9.2E-08	0.0E+00	0.0E+00	0.0E+00
WORK	Future	Acenaphthylene	RfD	1.8E-06	1.8E-06	0.0E+00	0.0E+00	0.0E+00
WORK	Future	Anthracene	RfD	1.2E-07	1.2E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Future	Benzo(a)anthracene	RsD	3.4E-03	0.0E+00	3.4E-03	1.0E-01	3.4E-04
WORK	Future	Benzo(a)pyrene	RsD	8.0E-04	0.0E+00	8.0E-04	1.0E+00	8.0E-04
WORK	Future	Benzo(b)fluoranthene	RsD	1.1E-03	0.0E+00	1.1E-03	1.0E-01	1.1E-04
WORK	Future	Benzo(g,h,i)perylene	RsD	8.1E-04	0.0E+00	8.1E-04	1.0E-02	8.1E-06
WORK	Future	Benzo(k)fluoranthene	RsD	5.1E-04	0.0E+00	5.1E-04	1.0E-01	5.1E-05
WORK	Future	Chrysene	RsD	2.4E-03	0.0E+00	2.4E-03	1.0E-02	2.4E-05
WORK	Future	Dibenz(a,h)anthracene	RsD	8.9E-05	0.0E+00	8.9E-05	1.0E+00	8.9E-05
WORK	Future	Fluoranthene	RsD	3.8E-03	0.0E+00	3.8E-03	1.0E-03	3.8E-06
WORK	Future	Fluorene	RfD	2.3E-07	2.3E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Future	Indeno(1,2,3-cd)pyrene	RsD	8.7E-05	0.0E+00	8.7E-05	1.0E-01	8.7E-06
WORK	Future	Phenanthrene	RsD	1.5E-02	0.0E+00	1.5E-02	1.0E-03	1.5E-05
WORK	Future	Pyrene	RfD	2.8E-07	2.8E-07	0.0E+00	0.0E+00	0.0E+00
WORK	Future	C9-C18 aromatics	RfD	2.4E-03	2.4E-03	0.0E+00	0.0E+00	0.0E+00
WORK	Future	Formaldehyde	RfD	2.9E-05	2.9E-05	0.0E+00	0.0E+00	0.0E+00
WORK	Future	Benzo(a)pyrene Equivalent	RsD					2.6E-03
WORK	Baseline	Renal toxicants		2.8E-03	2.8E-03			
WORK	Application	Renal toxicants		2.8E-03	2.8E-03			
WORK	PDC	Renal toxicants		5.2E-03	5.2E-03			

NOTES:
Maximum RQ value for non-carcinogens
Sum of cancer risk estimates for each lifestage = lifetime risk
Benzo(a)pyrene equivalent based on adjustment with potency exposure factors (PEFs)

Table D-5 Summary of Fish Concentrations Used to Estimate Human Exposures [mg/kg-WW]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	1.3E-03	1.3E-03	2.4E-03	4.3E-06	1.1E-03
3-methylcholanthrene	RES	5.1E-06	5.1E-06	5.5E-06	9.0E-07	5.7E-07
7,12-Dimethylbenz(a)anthracene	RES	2.2E-06	2.2E-06	2.4E-06	3.8E-07	2.4E-07
Acenaphthene	RES	4.6E-05	4.6E-05	8.1E-05	1.3E-06	3.5E-05
Acenaphthylene	RES	8.7E-04	8.7E-04	1.6E-03	8.9E-07	6.9E-04
Anthracene	RES	1.6E-05	1.6E-05	2.8E-05	4.2E-07	1.2E-05
Benzo(a)anthracene	RES	2.3E-05	2.3E-05	3.9E-05	6.4E-06	1.6E-05
Benzo(a)pyrene	RES	4.6E-06	4.6E-06	8.2E-06	2.6E-07	3.6E-06
Benzo(b)fluoranthene	RES	7.2E-06	7.2E-06	1.2E-05	2.0E-07	5.1E-06
Benzo(g,h,i)perylene	RES	4.7E-06	4.7E-06	8.3E-06	2.7E-07	3.7E-06
Benzo(k)fluoranthene	RES	2.3E-06	2.3E-06	4.1E-06	2.0E-07	1.8E-06
Chrysene	RES	1.4E-05	1.4E-05	2.5E-05	4.2E-07	1.1E-05
Dibenz(a,h)anthracene	RES	1.0E-06	1.0E-06	7.5E-07	3.6E-07	3.1E-07
Fluoranthene	RES	2.4E-05	2.4E-05	4.3E-05	8.4E-07	1.8E-05
Fluorene	RES	3.9E-05	3.9E-05	5.6E-05	1.2E-06	2.3E-05
Indeno(1,2,3-cd)pyrene	RES	8.5E-07	8.6E-07	6.4E-07	3.8E-07	3.1E-07
Phenanthrene	RES	1.0E-04	1.0E-04	1.7E-04	6.3E-06	7.5E-05
Pyrene	RES	2.9E-05	2.9E-05	5.1E-05	4.1E-07	2.2E-05
C9-C18 aromatics	RES	2.8E-01	2.8E-01	5.3E-01	6.2E-04	2.5E-01
Formaldehyde	RES	6.6E-04	6.6E-04	1.2E-03	2.2E-03	6.5E-04

Table D-6 Summary of Cattail Concentrations Used to Estimate Human Exposures [mg/kg-WW]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	2.1E-03	2.1E-03	2.1E-03	8.8E-13	7.0E-09
3-methylcholanthrene	RES	6.6E-09	6.6E-09	7.0E-09	2.6E-11	4.2E-10
7,12-Dimethylbenz(a)anthracene	RES	1.9E-07	1.9E-07	2.0E-07	7.3E-10	1.2E-08
Acenaphthene	RES	6.1E-09	6.1E-09	1.1E-08	4.8E-12	4.7E-09
Acenaphthylene	RES	1.5E-07	1.5E-07	2.7E-07	4.3E-12	1.2E-07
Anthracene	RES	4.5E-08	4.5E-08	8.0E-08	3.4E-11	3.5E-08
Benzo(a)anthracene	RES	6.4E-07	6.4E-07	1.1E-06	3.0E-10	4.6E-07
Benzo(a)pyrene	RES	3.7E-07	3.7E-07	6.6E-07	5.8E-10	2.9E-07
Benzo(b)fluoranthene	RES	5.9E-08	5.9E-08	1.0E-07	4.7E-11	4.1E-08
Benzo(g,h,i)perylene	RES	2.3E-07	2.3E-07	4.0E-07	3.9E-10	1.8E-07
Benzo(k)fluoranthene	RES	7.3E-07	7.3E-07	1.3E-06	1.8E-09	5.7E-07
Chrysene	RES	1.9E-06	1.9E-06	3.4E-06	1.6E-09	1.5E-06
Dibenz(a,h)anthracene	RES	6.5E-08	6.5E-08	5.5E-08	7.5E-10	3.6E-09
Fluoranthene	RES	3.4E-07	3.4E-07	5.9E-07	3.3E-10	2.5E-07
Fluorene	RES	1.4E-03	1.4E-03	1.4E-03	3.4E-11	2.3E-08
Indeno(1,2,3-cd)pyrene	RES	4.5E-08	4.5E-08	3.8E-08	6.4E-10	3.0E-09
Phenanthrene	RES	6.9E-03	6.9E-03	6.9E-03	1.9E-09	7.7E-07
Pyrene	RES	6.4E-07	6.4E-07	1.1E-06	2.6E-10	4.9E-07
C9-C18 aromatics	RES	6.7E-06	6.7E-06	1.4E-05	2.1E-10	7.0E-06
Formaldehyde	RES	2.5E-08	2.5E-08	3.3E-08	1.6E-10	1.1E-08

Table D-7 Summary of Labrador Tea Concentrations Used to Estimate Human Exposures [mg/kg-WW]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	5.5E-02	5.5E-02	5.5E-02	4.0E-11	3.2E-07
3-methylcholanthrene	RES	3.8E-06	3.8E-06	4.0E-06	1.5E-08	2.4E-07
7,12-Dimethylbenz(a)anthracene	RES	3.4E-05	3.4E-05	3.6E-05	1.3E-07	2.1E-06
Acenaphthene	RES	6.3E-08	6.3E-08	1.1E-07	4.9E-11	4.8E-08
Acenaphthylene	RES	1.9E-06	1.9E-06	3.5E-06	5.6E-11	1.5E-06
Anthracene	RES	9.8E-08	9.8E-08	1.7E-07	7.5E-11	7.6E-08
Benzo(a)anthracene	RES	2.4E-04	2.4E-04	4.2E-04	1.1E-07	1.8E-04
Benzo(a)pyrene	RES	7.4E-05	7.4E-05	1.3E-04	1.2E-07	5.9E-05
Benzo(b)fluoranthene	RES	7.9E-06	7.9E-06	1.4E-05	6.3E-09	5.6E-06
Benzo(g,h,i)perylene	RES	9.5E-05	9.5E-05	1.7E-04	1.6E-07	7.4E-05
Benzo(k)fluoranthene	RES	3.9E-05	3.9E-05	6.9E-05	9.4E-08	3.0E-05
Chrysene	RES	8.2E-05	8.2E-05	1.5E-04	7.0E-08	6.4E-05
Dibenz(a,h)anthracene	RES	2.1E-05	2.1E-05	1.8E-05	2.4E-07	1.1E-06
Fluoranthene	RES	1.1E-06	1.1E-06	1.9E-06	1.1E-09	8.3E-07
Fluorene	RES	2.7E-03	2.7E-03	2.7E-03	7.3E-11	4.9E-08
Indeno(1,2,3-cd)pyrene	RES	1.6E-05	1.6E-05	1.4E-05	2.3E-07	1.1E-06
Phenanthrene	RES	7.4E-02	7.4E-02	7.4E-02	2.0E-08	8.3E-06
Pyrene	RES	1.5E-06	1.5E-06	2.6E-06	5.9E-10	1.1E-06
C9-C18 Aromatics	RES	4.0E-05	4.0E-05	8.2E-05	1.3E-09	4.2E-05
Formaldehyde	RES	4.9E-06	4.9E-06	6.6E-06	3.2E-08	2.3E-06

Table D-8 Summary of Berry Concentrations Used to Estimate Human Exposures [mg/kg-WW]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	1.8E-03	1.8E-03	1.8E-03	1.8E-11	1.4E-07
3-methylcholanthrene	RES	1.7E-06	1.7E-06	1.8E-06	6.6E-09	1.1E-07
7,12-Dimethylbenz(a)anthracene	RES	1.5E-05	1.5E-05	1.6E-05	5.8E-08	9.3E-07
Acenaphthene	RES	5.6E-08	5.6E-08	9.9E-08	4.4E-11	4.3E-08
Acenaphthylene	RES	1.8E-06	1.8E-06	3.2E-06	5.1E-11	1.4E-06
Anthracene	RES	4.7E-08	4.7E-08	8.4E-08	3.6E-11	3.7E-08
Benzo(a)anthracene	RES	1.1E-04	1.1E-04	1.8E-04	5.0E-08	7.6E-05
Benzo(a)pyrene	RES	3.5E-05	3.5E-05	6.3E-05	5.6E-08	2.8E-05
Benzo(b)fluoranthene	RES	7.9E-06	7.9E-06	1.3E-05	6.3E-09	5.6E-06
Benzo(g,h,i)perylene	RES	5.5E-05	5.5E-05	9.8E-05	9.5E-08	4.3E-05
Benzo(k)fluoranthene	RES	1.8E-05	1.8E-05	3.2E-05	4.4E-08	1.4E-05
Chrysene	RES	3.6E-05	3.6E-05	6.5E-05	3.1E-08	2.9E-05
Dibenz(a,h)anthracene	RES	1.1E-05	1.1E-05	8.9E-06	1.2E-07	5.8E-07
Fluoranthene	RES	7.2E-07	7.2E-07	1.3E-06	7.0E-10	5.5E-07
Fluorene	RES	1.2E-03	1.2E-03	1.2E-03	3.5E-11	2.3E-08
Indeno(1,2,3-cd)pyrene	RES	7.0E-06	7.0E-06	6.0E-06	1.0E-07	4.6E-07
Phenanthrene	RES	6.0E-03	6.0E-03	6.0E-03	1.7E-09	7.2E-07
Pyrene	RES	7.4E-07	7.4E-07	1.3E-06	3.0E-10	5.7E-07
C9-C18 Aromatics	RES	3.2E-05	3.2E-05	6.7E-05	1.0E-09	3.4E-05
Formaldehyde	RES	4.9E-06	4.9E-06	6.5E-06	3.2E-08	2.2E-06

Table D-9 Summary of Plant Concentrations Used to Estimate Human Exposures [mg/kg-WW]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	1.4E-03	1.4E-03	1.4E-03	1.7E-11	1.4E-07
3-methylcholanthrene	RES	1.3E-06	1.3E-06	1.3E-06	5.0E-09	8.0E-08
7,12-Dimethylbenz(a)anthracene	RES	1.1E-05	1.1E-05	1.2E-05	4.3E-08	7.0E-07
Acenaphthene	RES	5.5E-08	5.5E-08	9.7E-08	4.3E-11	4.2E-08
Acenaphthylene	RES	1.7E-06	1.7E-06	3.1E-06	5.0E-11	1.4E-06
Anthracene	RES	3.7E-08	3.7E-08	6.6E-08	2.8E-11	2.9E-08
Benzo(a)anthracene	RES	8.0E-05	8.0E-05	1.4E-04	3.7E-08	5.7E-05
Benzo(a)pyrene	RES	2.7E-05	2.7E-05	4.9E-05	4.4E-08	2.2E-05
Benzo(b)fluoranthene	RES	7.9E-06	7.9E-06	1.3E-05	6.3E-09	5.5E-06
Benzo(g,h,i)perylene	RES	4.7E-05	4.7E-05	8.4E-05	8.1E-08	3.7E-05
Benzo(k)fluoranthene	RES	1.4E-05	1.4E-05	2.5E-05	3.4E-08	1.1E-05
Chrysene	RES	2.8E-05	2.8E-05	4.9E-05	2.4E-08	2.2E-05
Dibenz(a,h)anthracene	RES	8.6E-06	8.6E-06	7.3E-06	1.0E-07	4.7E-07
Fluoranthene	RES	6.5E-07	6.5E-07	1.1E-06	6.3E-10	4.9E-07
Fluorene	RES	8.9E-04	8.9E-04	8.9E-04	2.7E-11	1.8E-08
Indeno(1,2,3-cd)pyrene	RES	5.3E-06	5.3E-06	4.5E-06	7.5E-08	3.5E-07
Phenanthrene	RES	1.7E-03	1.7E-03	1.7E-03	5.8E-10	2.4E-07
Pyrene	RES	6.1E-07	6.1E-07	1.1E-06	2.5E-10	4.6E-07
C9-C18 Aromatics	RES	3.1E-05	3.1E-05	6.4E-05	9.8E-10	3.3E-05
Formaldehyde	RES	4.9E-06	4.9E-06	6.5E-06	3.2E-08	2.2E-06

Table D-10 Summary of Root Concentrations Used to Estimate Human Exposures [mg/kg-WW]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	5.2E-02	5.2E-02	5.2E-02	2.2E-11	1.7E-07
3-methylcholanthrene	RES	1.5E-06	1.5E-06	1.6E-06	5.8E-09	9.3E-08
7,12-Dimethylbenz(a)anthracene	RES	4.3E-07	4.3E-07	4.5E-07	1.7E-09	2.7E-08
Acenaphthene	RES	4.1E-09	4.1E-09	7.1E-09	3.2E-12	3.1E-09
Acenaphthylene	RES	1.0E-07	1.0E-07	1.8E-07	2.9E-12	8.1E-08
Anthracene	RES	4.3E-08	4.3E-08	7.6E-08	3.3E-11	3.3E-08
Benzo(a)anthracene	RES	2.2E-06	2.2E-06	3.8E-06	1.0E-09	1.6E-06
Benzo(a)pyrene	RES	1.3E-06	1.3E-06	2.3E-06	2.1E-09	1.0E-06
Benzo(b)fluoranthene	RES	2.5E-06	2.5E-06	4.2E-06	2.0E-09	1.8E-06
Benzo(g,h,i)perylene	RES	1.6E-06	1.6E-06	2.8E-06	2.7E-09	1.2E-06
Benzo(k)fluoranthene	RES	2.6E-06	2.6E-06	4.5E-06	6.2E-09	2.0E-06
Chrysene	RES	7.0E-06	7.0E-06	1.2E-05	6.0E-09	5.5E-06
Dibenz(a,h)anthracene	RES	3.5E-07	3.5E-07	3.0E-07	4.1E-09	1.9E-08
Fluoranthene	RES	8.2E-07	8.2E-07	1.4E-06	8.0E-10	6.2E-07
Fluorene	RES	1.1E-03	1.1E-03	1.1E-03	2.8E-11	1.9E-08
Indeno(1,2,3-cd)pyrene	RES	3.0E-07	3.0E-07	2.5E-07	4.2E-09	2.0E-08
Phenanthrene	RES	3.0E-03	3.0E-03	3.0E-03	8.2E-10	3.4E-07
Pyrene	RES	1.0E-06	1.0E-06	1.8E-06	4.2E-10	7.9E-07
C9-C18 Aromatics	RES	3.6E-06	3.6E-06	7.5E-06	1.2E-10	3.8E-06
Formaldehyde	RES	5.8E-07	5.8E-07	7.7E-07	3.8E-09	2.7E-07

Table D-11 Summary of Surface Water Concentrations Used to Estimate Drinking and Swimming Exposures [mg/L]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	2.5E-06	2.5E-06	4.4E-06	8.0E-09	1.9E-06
3-methylcholanthrene	RES	4.5E-09	4.5E-09	4.8E-09	7.9E-10	5.0E-10
7,12-Dimethylbenz(a)anthracene	RES	4.0E-08	4.1E-08	4.3E-08	7.0E-09	4.5E-09
Acenaphthene	RES	2.3E-07	2.3E-07	4.0E-07	6.3E-09	1.7E-07
Acenaphthylene	RES	4.3E-06	4.3E-06	7.8E-06	4.4E-09	3.5E-06
Anthracene	RES	2.9E-07	2.9E-07	5.1E-07	7.7E-09	2.2E-07
Benzo(a)anthracene	RES	4.1E-07	4.1E-07	7.1E-07	1.2E-07	3.0E-07
Benzo(a)pyrene	RES	8.3E-08	8.3E-08	1.5E-07	4.7E-09	6.6E-08
Benzo(b)fluoranthene	RES	1.3E-07	1.3E-07	2.2E-07	3.7E-09	9.2E-08
Benzo(g,h,i)perylene	RES	8.5E-08	8.5E-08	1.5E-07	4.9E-09	6.6E-08
Benzo(k)fluoranthene	RES	4.2E-08	4.2E-08	7.4E-08	3.6E-09	3.2E-08
Chrysene	RES	2.5E-07	2.5E-07	4.5E-07	7.6E-09	2.0E-07
Dibenz(a,h)anthracene	RES	1.9E-08	1.9E-08	1.4E-08	6.6E-09	5.7E-09
Fluoranthene	RES	4.4E-07	4.4E-07	7.8E-07	1.5E-08	3.3E-07
Fluorene	RES	7.0E-07	7.0E-07	1.0E-06	2.2E-08	4.3E-07
Indeno(1,2,3-cd)pyrene	RES	1.6E-08	1.6E-08	1.2E-08	6.8E-09	5.7E-09
Phenanthrene	RES	1.8E-06	1.8E-06	3.2E-06	1.2E-07	1.4E-06
Pyrene	RES	5.2E-07	5.2E-07	9.2E-07	7.5E-09	4.0E-07
C9-C18 Aromatics	RES	5.2E-03	5.2E-03	9.7E-03	1.1E-05	4.6E-03
Formaldehyde	RES	2.1E-04	2.1E-04	3.8E-04	7.0E-04	2.1E-04

Table D-12 Summary of Soil Concentrations Used to Estimate Human Exposures [mg/kg]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	4.0E-02	4.0E-02	4.0E-02	1.7E-11	1.3E-07
3-methylcholanthrene	RES	3.8E-06	3.8E-06	4.0E-06	1.5E-08	2.4E-07
7,12-Dimethylbenz(a)anthracene	RES	4.7E-05	4.7E-05	5.0E-05	1.8E-07	3.0E-06
Acenaphthene	RES	1.3E-07	1.3E-07	2.2E-07	9.9E-11	9.6E-08
Acenaphthylene	RES	3.2E-06	3.2E-06	5.7E-06	9.2E-11	2.5E-06
Anthracene	RES	1.9E-06	1.9E-06	3.4E-06	1.4E-09	1.5E-06
Benzo(a)anthracene	RES	1.5E-04	1.5E-04	2.6E-04	7.2E-08	1.1E-04
Benzo(a)pyrene	RES	1.4E-04	1.4E-04	2.6E-04	2.3E-07	1.1E-04
Benzo(b)fluoranthene	RES	1.4E-05	1.4E-05	2.5E-05	1.2E-08	1.0E-05
Benzo(g,h,i)perylene	RES	1.7E-04	1.7E-04	3.1E-04	3.0E-07	1.3E-04
Benzo(k)fluoranthene	RES	2.8E-04	2.8E-04	5.0E-04	6.8E-07	2.2E-04
Chrysene	RES	4.9E-04	4.9E-04	8.8E-04	4.2E-07	3.9E-04
Dibenz(a,h)anthracene	RES	5.8E-05	5.8E-05	4.9E-05	6.8E-07	3.2E-06
Fluoranthene	RES	3.6E-05	3.6E-05	6.4E-05	3.5E-08	2.7E-05
Fluorene	RES	4.0E-02	4.0E-02	4.0E-02	9.9E-10	6.7E-07
Indeno(1,2,3-cd)pyrene	RES	3.8E-05	3.8E-05	3.2E-05	5.3E-07	2.5E-06
Phenanthrene	RES	1.1E-01	1.1E-01	1.1E-01	3.0E-08	1.2E-05
Pyrene	RES	4.7E-05	4.7E-05	8.4E-05	1.9E-08	3.6E-05
C9-C18 Aromatics	RES	9.0E-05	9.0E-05	1.9E-04	2.9E-09	9.5E-05
Formaldehyde	RES	1.3E-08	1.3E-08	1.7E-08	8.3E-11	5.8E-09
2-methylnaphthalene	WORK	4.0E-02	4.0E-02	4.0E-02	2.5E-10	3.8E-09
3-methylcholanthrene	WORK	7.2E-07	8.7E-07	9.2E-07	3.3E-07	2.1E-07
7,12-Dimethylbenz(a)anthracene	WORK	8.9E-06	1.1E-05	1.1E-05	4.1E-06	2.6E-06
Acenaphthene	WORK	1.2E-08	1.2E-08	1.2E-08	8.6E-10	-2.1E-10
Acenaphthylene	WORK	7.5E-08	7.5E-08	7.9E-08	8.5E-10	4.7E-09
Anthracene	WORK	8.5E-08	8.9E-08	1.0E-07	1.2E-08	1.7E-08
Benzo(a)anthracene	WORK	4.1E-06	4.3E-06	5.7E-06	4.3E-05	1.6E-06
Benzo(a)pyrene	WORK	4.9E-06	5.6E-06	7.0E-06	1.9E-06	2.0E-06
Benzo(b)fluoranthene	WORK	8.5E-07	8.9E-07	1.0E-06	1.1E-07	1.5E-07
Benzo(g,h,i)perylene	WORK	8.4E-06	9.1E-06	1.0E-05	2.1E-06	1.9E-06
Benzo(k)fluoranthene	WORK	1.6E-05	1.8E-05	2.1E-05	6.6E-06	5.0E-06
Chrysene	WORK	1.8E-05	1.9E-05	2.2E-05	3.5E-06	4.8E-06
Dibenz(a,h)anthracene	WORK	1.1E-05	1.3E-05	1.2E-05	5.4E-06	8.8E-07
Fluoranthene	WORK	2.9E-06	3.0E-06	3.0E-06	2.9E-07	1.9E-07
Fluorene	WORK	4.0E-02	4.0E-02	4.0E-02	7.9E-09	-1.4E-08
Indeno(1,2,3-cd)pyrene	WORK	7.2E-06	8.7E-06	8.0E-06	4.5E-06	7.8E-07
Phenanthrene	WORK	1.1E-01	1.1E-01	1.1E-01	2.3E-07	-9.2E-08
Pyrene	WORK	2.9E-06	3.0E-06	3.2E-06	2.1E-07	3.2E-07
C9-C18 Aromatics	WORK	1.4E-05	1.4E-05	3.3E-05	1.3E-07	1.9E-05
Formaldehyde	WORK	2.8E-09	3.3E-09	4.8E-09	4.3E-08	1.9E-09

Table D-13 Summary of Surface Soil Concentrations Used to Estimate Human Exposures [mg/kg]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	4.0E-02	4.0E-02	4.0E-02	1.7E-10	1.3E-06
3-methylcholanthrene	RES	3.8E-05	3.8E-05	4.0E-05	1.5E-07	2.4E-06
7,12-Dimethylbenz(a)anthracene	RES	4.7E-04	4.7E-04	5.0E-04	1.8E-06	3.0E-05
Acenaphthene	RES	1.3E-06	1.3E-06	2.2E-06	9.9E-10	9.6E-07
Acenaphthylene	RES	3.2E-05	3.2E-05	5.7E-05	9.2E-10	2.5E-05
Anthracene	RES	1.9E-05	1.9E-05	3.4E-05	1.4E-08	1.5E-05
Benzo(a)anthracene	RES	1.5E-03	1.5E-03	2.6E-03	7.2E-07	1.1E-03
Benzo(a)pyrene	RES	1.4E-03	1.4E-03	2.6E-03	2.3E-06	1.1E-03
Benzo(b)fluoranthene	RES	1.4E-04	1.4E-04	2.5E-04	1.2E-07	1.0E-04
Benzo(g,h,i)perylene	RES	1.7E-03	1.7E-03	3.1E-03	3.0E-06	1.3E-03
Benzo(k)fluoranthene	RES	2.8E-03	2.8E-03	5.0E-03	6.8E-06	2.2E-03
Chrysene	RES	4.9E-03	4.9E-03	8.8E-03	4.2E-06	3.9E-03
Dibenz(a,h)anthracene	RES	5.8E-04	5.8E-04	4.9E-04	6.8E-06	3.2E-05
Fluoranthene	RES	3.6E-04	3.6E-04	6.4E-04	3.5E-07	2.7E-04
Fluorene	RES	4.0E-02	4.0E-02	4.0E-02	9.9E-09	6.7E-06
Indeno(1,2,3-cd)pyrene	RES	3.8E-04	3.8E-04	3.2E-04	5.3E-06	2.5E-05
Phenanthrene	RES	1.1E-01	1.1E-01	1.1E-01	3.0E-07	1.2E-04
Pyrene	RES	4.7E-04	4.7E-04	8.4E-04	1.9E-07	3.6E-04
C9-C18 Aromatics	RES	9.0E-04	9.0E-04	1.9E-03	2.9E-08	9.5E-04
Formaldehyde	RES	1.3E-07	1.3E-07	1.7E-07	8.3E-10	5.8E-08
2-methylnaphthalene	WORK	4.0E-02	4.0E-02	4.0E-02	2.5E-09	3.8E-08
3-methylcholanthrene	WORK	7.2E-06	8.7E-06	9.2E-06	3.3E-06	2.1E-06
7,12-Dimethylbenz(a)anthracene	WORK	8.9E-05	1.1E-04	1.1E-04	4.1E-05	2.6E-05
Acenaphthene	WORK	1.2E-07	1.2E-07	1.2E-07	8.6E-09	-2.1E-09
Acenaphthylene	WORK	7.5E-07	7.5E-07	7.9E-07	8.5E-09	4.7E-08
Anthracene	WORK	8.5E-07	8.9E-07	1.0E-06	1.2E-07	1.7E-07
Benzo(a)anthracene	WORK	4.1E-05	4.3E-05	5.7E-05	4.3E-04	1.6E-05
Benzo(a)pyrene	WORK	4.9E-05	5.6E-05	7.0E-05	1.9E-05	2.0E-05
Benzo(b)fluoranthene	WORK	8.5E-06	8.9E-06	1.0E-05	1.1E-06	1.5E-06
Benzo(g,h,i)perylene	WORK	8.4E-05	9.1E-05	1.0E-04	2.1E-05	1.9E-05
Benzo(k)fluoranthene	WORK	1.6E-04	1.8E-04	2.1E-04	6.6E-05	5.0E-05
Chrysene	WORK	1.8E-04	1.9E-04	2.2E-04	3.5E-05	4.8E-05
Dibenz(a,h)anthracene	WORK	1.1E-04	1.3E-04	1.2E-04	5.4E-05	8.8E-06
Fluoranthene	WORK	2.9E-05	3.0E-05	3.0E-05	2.9E-06	1.9E-06
Fluorene	WORK	4.0E-02	4.0E-02	4.0E-02	7.9E-08	-1.4E-07
Indeno(1,2,3-cd)pyrene	WORK	7.2E-05	8.7E-05	8.0E-05	4.5E-05	7.8E-06
Phenanthrene	WORK	1.1E-01	1.1E-01	1.1E-01	2.3E-06	-9.2E-07
Pyrene	WORK	2.9E-05	3.0E-05	3.2E-05	2.1E-06	3.2E-06
C9-C18 Aromatics	WORK	1.4E-04	1.4E-04	3.3E-04	1.3E-06	1.9E-04
Formaldehyde	WORK	2.8E-08	3.3E-08	4.8E-08	4.3E-07	1.9E-08

Table D-14 Summary of Dust Concentrations Used to Estimate Human Exposures [ug/m3]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	3.0E-08	3.0E-08	3.0E-08	1.3E-16	1.0E-12
3-methylcholanthrene	RES	2.9E-11	2.9E-11	3.1E-11	1.1E-13	1.8E-12
7,12-Dimethylbenz(a)anthracene	RES	3.6E-10	3.6E-10	3.8E-10	1.4E-12	2.3E-11
Acenaphthene	RES	9.7E-13	9.7E-13	1.7E-12	7.5E-16	7.3E-13
Acenaphthylene	RES	2.4E-11	2.4E-11	4.4E-11	7.0E-16	1.9E-11
Anthracene	RES	1.4E-11	1.4E-11	2.6E-11	1.1E-14	1.1E-11
Benzo(a)anthracene	RES	1.2E-09	1.2E-09	2.0E-09	5.5E-13	8.4E-10
Benzo(a)pyrene	RES	1.1E-09	1.1E-09	2.0E-09	1.7E-12	8.7E-10
Benzo(b)fluoranthene	RES	1.1E-10	1.1E-10	1.9E-10	8.8E-14	7.7E-11
Benzo(g,h,i)perylene	RES	1.3E-09	1.3E-09	2.3E-09	2.3E-12	1.0E-09
Benzo(k)fluoranthene	RES	2.1E-09	2.1E-09	3.8E-09	5.2E-12	1.6E-09
Chrysene	RES	3.7E-09	3.7E-09	6.7E-09	3.2E-12	2.9E-09
Dibenz(a,h)anthracene	RES	4.4E-10	4.4E-10	3.7E-10	5.1E-12	2.4E-11
Fluoranthene	RES	2.8E-10	2.8E-10	4.9E-10	2.7E-13	2.1E-10
Fluorene	RES	3.0E-08	3.0E-08	3.0E-08	7.6E-15	5.1E-12
Indeno(1,2,3-cd)pyrene	RES	2.9E-10	2.9E-10	2.4E-10	4.1E-12	1.9E-11
Phenanthrene	RES	8.4E-08	8.4E-08	8.4E-08	2.3E-13	9.4E-11
Pyrene	RES	3.6E-10	3.6E-10	6.4E-10	1.5E-13	2.8E-10
C9-C18 Aromatics	RES	6.9E-10	6.9E-10	1.4E-09	2.2E-14	7.2E-10
Formaldehyde	RES	9.7E-14	9.7E-14	1.3E-13	6.3E-16	4.4E-14
2-methylnaphthalene	WORK	1.0E-05	1.0E-05	1.0E-05	6.2E-13	9.4E-12
3-methylcholanthrene	WORK	1.8E-09	2.2E-09	2.3E-09	8.3E-10	5.2E-10
7,12-Dimethylbenz(a)anthracene	WORK	2.2E-08	2.7E-08	2.9E-08	1.0E-08	6.4E-09
Acenaphthene	WORK	3.0E-11	3.0E-11	2.9E-11	2.1E-12	-5.1E-13
Acenaphthylene	WORK	1.9E-10	1.9E-10	2.0E-10	2.1E-12	1.2E-11
Anthracene	WORK	2.1E-10	2.2E-10	2.6E-10	3.1E-11	4.3E-11
Benzo(a)anthracene	WORK	1.0E-08	1.1E-08	1.4E-08	1.1E-07	4.0E-09
Benzo(a)pyrene	WORK	1.2E-08	1.4E-08	1.7E-08	4.8E-09	5.1E-09
Benzo(b)fluoranthene	WORK	2.1E-09	2.2E-09	2.5E-09	2.8E-10	3.8E-10
Benzo(g,h,i)perylene	WORK	2.1E-08	2.3E-08	2.6E-08	5.2E-09	4.9E-09
Benzo(k)fluoranthene	WORK	3.9E-08	4.5E-08	5.2E-08	1.7E-08	1.3E-08
Chrysene	WORK	4.4E-08	4.7E-08	5.6E-08	8.7E-09	1.2E-08
Dibenz(a,h)anthracene	WORK	2.7E-08	3.2E-08	2.9E-08	1.3E-08	2.2E-09
Fluoranthene	WORK	7.1E-09	7.4E-09	7.6E-09	7.2E-10	4.6E-10
Fluorene	WORK	1.0E-05	1.0E-05	1.0E-05	2.0E-11	-3.4E-11
Indeno(1,2,3-cd)pyrene	WORK	1.8E-08	2.2E-08	2.0E-08	1.1E-08	1.9E-09
Phenanthrene	WORK	2.8E-05	2.8E-05	2.8E-05	5.8E-10	-2.3E-10
Pyrene	WORK	7.2E-09	7.4E-09	8.0E-09	5.2E-10	8.0E-10
C9-C18 Aromatics	WORK	3.4E-08	3.4E-08	8.1E-08	3.2E-10	4.7E-08
Formaldehyde	WORK	7.1E-12	8.3E-12	1.2E-11	1.1E-10	4.8E-12

Table D-15 Summary of Air Concentrations Used to Estimate Human Exposures [ug/m3]

Chemical	Receptor	Baseline	Application	PDC	Project Incremental	Future Incremental
2-methylnaphthalene	RES	1.0E-03	1.0E-03	1.8E-03	1.0E-07	7.9E-04
3-methylcholanthrene	RES	1.8E-06	1.8E-06	2.0E-06	7.3E-09	1.2E-07
7,12-Dimethylbenz(a)anthracene	RES	1.6E-05	1.7E-05	1.8E-05	6.5E-08	1.0E-06
Acenaphthene	RES	9.3E-05	9.3E-05	1.6E-04	7.2E-08	7.1E-05
Acenaphthylene	RES	1.8E-03	1.8E-03	3.2E-03	5.1E-08	1.4E-03
Anthracene	RES	1.2E-04	1.2E-04	2.1E-04	9.1E-08	9.3E-05
Benzo(a)anthracene	RES	1.7E-04	1.7E-04	2.9E-04	7.9E-08	1.2E-04
Benzo(a)pyrene	RES	3.4E-05	3.4E-05	6.1E-05	5.4E-08	2.7E-05
Benzo(b)fluoranthene	RES	5.3E-05	5.3E-05	9.1E-05	4.3E-08	3.8E-05
Benzo(g,h,i)perylene	RES	3.5E-05	3.5E-05	6.2E-05	6.0E-08	2.7E-05
Benzo(k)fluoranthene	RES	1.7E-05	1.7E-05	3.1E-05	4.3E-08	1.4E-05
Chrysene	RES	1.0E-04	1.0E-04	1.8E-04	8.7E-08	8.0E-05
Dibenz(a,h)anthracene	RES	6.6E-06	6.6E-06	5.6E-06	7.7E-08	3.6E-07
Fluoranthene	RES	1.8E-04	1.8E-04	3.2E-04	1.8E-07	1.4E-04
Fluorene	RES	2.5E-04	2.5E-04	4.2E-04	2.6E-07	1.7E-04
Indeno(1,2,3-cd)pyrene	RES	5.6E-06	5.6E-06	4.7E-06	7.9E-08	3.7E-07
Phenanthrene	RES	7.4E-04	7.4E-04	1.3E-03	1.3E-06	5.5E-04
Pyrene	RES	2.1E-04	2.1E-04	3.7E-04	8.6E-08	1.6E-04
C9-C18 Aromatics	RES	7.5E-01	7.5E-01	1.5E+00	2.4E-05	7.9E-01
Formaldehyde	RES	1.0E-01	1.0E-01	1.4E-01	6.8E-04	4.7E-02
2-methylnaphthalene	WORK	3.1E-05	3.2E-05	5.3E-05	1.5E-06	2.2E-05
3-methylcholanthrene	WORK	3.5E-07	4.2E-07	4.5E-07	1.6E-07	1.0E-07
7,12-Dimethylbenz(a)anthracene	WORK	3.1E-06	3.8E-06	4.0E-06	1.4E-06	9.0E-07
Acenaphthene	WORK	8.7E-06	8.9E-06	8.5E-06	6.3E-07	-1.5E-07
Acenaphthylene	WORK	4.1E-05	4.1E-05	4.4E-05	4.7E-07	2.6E-06
Anthracene	WORK	5.4E-06	5.7E-06	6.5E-06	7.9E-07	1.1E-06
Benzo(a)anthracene	WORK	4.5E-06	4.7E-06	6.2E-06	4.7E-05	1.8E-06
Benzo(a)pyrene	WORK	1.2E-06	1.3E-06	1.6E-06	4.5E-07	4.8E-07
Benzo(b)fluoranthene	WORK	3.1E-06	3.3E-06	3.7E-06	4.1E-07	5.7E-07
Benzo(g,h,i)perylene	WORK	1.7E-06	1.8E-06	2.1E-06	4.2E-07	3.9E-07
Benzo(k)fluoranthene	WORK	9.8E-07	1.1E-06	1.3E-06	4.1E-07	3.1E-07
Chrysene	WORK	3.7E-06	3.9E-06	4.7E-06	7.3E-07	9.9E-07
Dibenz(a,h)anthracene	WORK	1.2E-06	1.4E-06	1.3E-06	6.1E-07	1.0E-07
Fluoranthene	WORK	1.4E-05	1.5E-05	1.5E-05	1.4E-06	9.2E-07
Fluorene	WORK	4.1E-05	4.2E-05	3.8E-05	2.0E-06	-3.5E-06
Indeno(1,2,3-cd)pyrene	WORK	1.1E-06	1.3E-06	1.2E-06	6.7E-07	1.1E-07
Phenanthrene	WORK	8.5E-05	8.8E-05	8.1E-05	1.0E-05	-4.1E-06
Pyrene	WORK	1.3E-05	1.3E-05	1.4E-05	9.2E-07	1.4E-06
C9-C18 Aromatics	WORK	1.1E-01	1.1E-01	2.7E-01	1.1E-03	1.6E-01
Formaldehyde	WORK	2.3E-02	2.7E-02	3.9E-02	3.5E-01	1.6E-02

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																	
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
Application	RES	Adolescent	2-methylnaphthalene	8.00E-04	2.46E-03	4.74E-07	1.64E-01	3.46E-02	1.66E-01	1.18E+01	6.28E-03	5.33E-02	2.15E-05	9.72E-10	6.44E-09	8.81E-04	4.80E-04	4.32E-04	0.00E+00	1.22E+01	1.03E-05	5.13E-02	5.13E-02
Application	RES	Adult	2-methylnaphthalene	8.00E-04	3.69E-03	5.05E-07	1.87E-01	4.19E-02	1.66E-01	9.79E+00	6.28E-03	5.33E-02	3.31E-05	1.53E-09	9.88E-09	1.00E-03	5.34E-04	4.93E-04	0.00E+00	1.02E+01	1.30E-05	3.62E-02	3.62E-02
Application	RES	Child	2-methylnaphthalene	8.00E-04	1.97E-03	4.41E-07	1.34E-01	2.00E-02	5.52E-02	8.38E+00	2.09E-03	4.40E-02	1.53E-05	6.94E-10	4.60E-09	5.99E-04	3.54E-04	2.73E-04	0.00E+00	8.64E+00	1.49E-05	6.56E-02	6.56E-02
Application	RES	Infant	2-methylnaphthalene	8.00E-04	7.37E-04	6.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.03E-04	1.92E-04	8.76E-05	9.86E-03	1.19E-02	2.25E-05	3.40E-04	3.62E-04
Application	RES	Toddler	2-methylnaphthalene	3.20E-03	1.47E-03	2.52E-07	9.15E-02	9.10E-03	5.52E-02	5.47E+00	2.09E-03	2.66E-02	1.05E-05	4.86E-10	3.22E-09	3.74E-04	2.58E-04	1.55E-04	0.00E+00	5.66E+00	2.23E-05	8.57E-02	8.57E-02
Baseline	RES	Adolescent	2-methylnaphthalene	8.00E-04	2.46E-03	4.74E-07	1.64E-01	3.46E-02	1.66E-01	1.18E+01	6.28E-03	5.33E-02	2.15E-05	9.72E-10	6.44E-09	8.81E-04	4.80E-04	4.32E-04	0.00E+00	1.22E+01	1.03E-05	5.13E-02	5.13E-02
Baseline	RES	Adult	2-methylnaphthalene	8.00E-04	3.69E-03	5.05E-07	1.87E-01	4.19E-02	1.66E-01	9.79E+00	6.28E-03	5.33E-02	3.31E-05	1.53E-09	9.88E-09	1.00E-03	5.34E-04	4.93E-04	0.00E+00	1.02E+01	1.30E-05	3.62E-02	3.62E-02
Baseline	RES	Child	2-methylnaphthalene	8.00E-04	1.97E-03	4.41E-07	1.34E-01	2.00E-02	5.52E-02	8.38E+00	2.09E-03	4.40E-02	1.53E-05	6.94E-10	4.60E-09	5.99E-04	3.54E-04	2.73E-04	0.00E+00	8.64E+00	1.49E-05	6.56E-02	6.56E-02
Baseline	RES	Infant	2-methylnaphthalene	8.00E-04	7.37E-04	6.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.03E-04	1.92E-04	8.76E-05	9.86E-03	1.19E-02	2.25E-05	3.40E-04	3.62E-04
Baseline	RES	Toddler	2-methylnaphthalene	3.20E-03	1.47E-03	2.52E-07	9.15E-02	9.10E-03	5.52E-02	5.47E+00	2.09E-03	2.66E-02	1.05E-05	4.86E-10	3.22E-09	3.74E-04	2.58E-04	1.55E-04	0.00E+00	5.66E+00	2.23E-05	8.57E-02	8.57E-02
Future	RES	Adolescent	2-methylnaphthalene	2.67E-08	1.94E-03	1.58E-11	1.65E-05	2.64E-06	9.51E-07	3.94E-05	2.10E-08	4.21E-02	1.70E-05	7.68E-10	5.08E-09	6.96E-04	1.60E-08	1.44E-08	0.00E+00	4.48E-02	8.13E-06	1.80E-04	1.88E-04
Future	RES	Adult	2-methylnaphthalene	2.67E-08	2.91E-03	1.68E-11	1.88E-05	3.20E-06	9.51E-07	3.27E-05	2.10E-08	4.21E-02	2.62E-05	1.21E-09	7.81E-09	7.92E-04	1.78E-08	1.65E-08	0.00E+00	4.59E-02	1.03E-05	1.52E-04	1.62E-04
Future	RES	Child	2-methylnaphthalene	2.67E-08	1.55E-03	1.47E-11	1.35E-05	1.53E-06	3.17E-07	2.80E-05	6.98E-09	3.47E-02	1.21E-05	5.48E-10	3.63E-09	4.73E-04	1.18E-08	9.11E-09	0.00E+00	3.68E-02	1.18E-05	2.68E-04	2.80E-04
Future	RES	Infant	2-methylnaphthalene	2.67E-08	5.82E-04	2.23E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.60E-04	6.41E-09	2.92E-09	4.41E-05	7.87E-04	1.78E-05	6.23E-06	2.40E-05
Future	RES	Toddler	2-methylnaphthalene	1.07E-07	1.16E-03	8.42E-12	9.21E-06	6.95E-07	3.17E-07	1.82E-05	6.98E-09	2.10E-02	8.30E-06	3.84E-10	2.54E-09	2.96E-04	8.61E-09	5.17E-09	0.00E+00	2.25E-02	1.76E-05	3.24E-04	3.42E-04
PDC	RES	Adolescent	2-methylnaphthalene	8.00E-04	4.40E-03	4.74E-07	1.64E-01	3.46E-02	1.66E-01	1.18E+01	6.28E-03	9.54E-02	3.85E-05	1.74E-09	1.15E-08	1.58E-03	4.80E-04	4.32E-04	0.00E+00	1.23E+01	1.84E-05	5.14E-02	5.15E-02
PDC	RES	Adult	2-methylnaphthalene	8.00E-04	6.60E-03	5.05E-07	1.87E-01	4.19E-02	1.66E-01	9.79E+00	6.28E-03	9.54E-02	5.93E-05	2.73E-09	1.77E-08	1.79E-03	5.34E-04	4.93E-04	0.00E+00	1.03E+01	2.33E-05	3.64E-02	3.64E-02
PDC	RES	Child	2-methylnaphthalene	8.00E-04	3.52E-03	4.41E-07	1.34E-01	2.00E-02	5.52E-02	8.38E+00	2.09E-03	7.87E-02	2.75E-05	1.24E-09	8.23E-09	1.07E-03	3.54E-04	2.73E-04	0.00E+00	8.68E+00	2.67E-05	6.59E-02	6.59E-02
PDC	RES	Infant	2-methylnaphthalene	8.00E-04	1.32E-03	6.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.63E-04	1.92E-04	8.76E-05	9.90E-03	1.27E-02	4.02E-05	3.46E-04	3.86E-04
PDC	RES	Toddler	2-methylnaphthalene	3.20E-03	2.64E-03	2.52E-07	9.15E-02	9.10E-03	5.52E-02	5.47E+00	2.09E-03	4.77E-02	1.88E-05	8.70E-10	5.76E-09	6.70E-04	2.58E-04	1.55E-04	0.00E+00	5.68E+00	4.00E-05	8.60E-02	8.60E-02
Project	RES	Adolescent	2-methylnaphthalene	3.37E-12	7.98E-06	2.00E-15	2.08E-09	3.33E-10	1.20E-10	4.97E-09	2.64E-12	1.73E-04	6.98E-08	3.16E-12	2.09E-11	2.86E-06	2.02E-12	1.82E-12	0.00E+00	1.84E-04	3.34E-08	7.37E-07	7.71E-07
Project	RES	Adult	2-methylnaphthalene	3.37E-12	1.20E-05	2.12E-15	2.38E-09	4.03E-10	1.20E-10	4.12E-09	2.64E-12	1.73E-04	1.08E-07	4.96E-12	3.21E-11	3.26E-06	2.25E-12	2.08E-12	0.00E+00	1.88E-04	4.23E-08	6.24E-07	6.66E-07
Project	RES	Child	2-methylnaphthalene	3.37E-12	6.39E-06	1.86E-15	1.70E-09	1.93E-10	4.00E-11	3.53E-09	8.81E-13	1.43E-04	4.99E-08	2.25E-12	1.49E-11	1.95E-06	1.49E-12	1.15E-12	0.00E+00	1.51E-04	4.85E-08	1.10E-06	1.15E-06
Project	RES	Infant	2-methylnaphthalene	3.37E-12	2.39E-06	2.82E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.58E-07	8.08E-13	3.69E-13	1.81E-07	3.23E-06	7.30E-08	2.56E-08	9.86E-08
Project	RES	Toddler	2-methylnaphthalene	1.35E-11	4.79E-06	1.06E-15	1.16E-09	8.77E-11	4.00E-11	2.30E-09	8.81E-13	8.66E-05	3.41E-08	1.58E-12	1.05E-11	1.22E-06	1.09E-12	6.52E-13	0.00E+00	9.26E-05	7.26E-08	1.33E-06	1.40E-06
Application	RES	Adolescent	3-methylcholanthrene	7.59E-07	4.51E-06	4.50E-10	1.51E-04	3.16E-05	1.13E-05	3.32E-04	1.97E-08	2.06E-04	3.10E-03	1.21E-06	8.41E-06	1.53E-05	3.03E-07	2.73E-07	0.00E+00	3.86E-03	2.52E-09	2.15E-06	2.16E-06
Application	RES	Adult	3-methylcholanthrene	7.59E-07	6.76E-06	4.78E-10	1.73E-04	3.82E-05	1.13E-05	2.75E-04	1.97E-08	2.06E-04	4.77E-03	1.90E-06	1.29E-05	1.74E-05	3.38E-07	3.12E-07	0.00E+00	5.52E-03	3.19E-09	2.60E-06	2.60E-06
Application	RES	Child	3-methylcholanthrene	7.59E-07	3.61E-06	4.18E-10	1.23E-04	1.83E-05	3.76E-06	2.35E-04	6.58E-09	1.70E-04	2.21E-03	8.64E-07	6.01E-06	1.01E-05	2.24E-07	1.73E-07	0.00E+00	2.78E-03	3.65E-09	2.82E-06	2.82E-06
Application	RES	Infant	3-methylcholanthrene	7.59E-07	1.35E-06	6.34E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.57E-06	1.21E-07	5.54E-08	1.93E-03	1.93E-03	7.85E-06	7.86E-06	7.86E-06
Application	RES	Toddler	3-methylcholanthrene	3.03E-06	2.70E-06	2.39E-10	8.44E-05	8.31E-06	3.76E-06	1.53E-04	6.58E-09	1.03E-04	1.51E-03	6.05E-07	4.20E-06	6.11E-06	1.63E-07	9.79E-08	0.00E+00	1.88E-03	5.46E-09	3.80E-06	3.81E-06
Baseline	RES	Adolescent	3-methylcholanthrene	7.58E-07	4.50E-06	4.49E-10	1.51E-04	3.16E-05	1.13E-05	3.31E-04	1.97E-08	2.06E-04	3.10E-03	1.21E-06	8.40E-06	1.53E-05	3.03E-07	2.73E-07	0.00E+00	3.86E-03	2.52E-09	2.15E-06	2.15E-06
Baseline	RES	Adult	3-methylcholanthrene	7.58E-07	6.76E-06	4.78E-10	1.72E-04	3.82E-05	1.13E-05	2.74E-04	1.97E-08	2.06E-04	4.77E-03	1.90E-06	1.29E-05	1.74E-05	3.37E-07	3.12E-07	0.00E+00	5.51E-03	3.19E-09	2.60E-06	2.60E-06
Baseline	RES	Child	3-methylcholanthrene	7.58E-07	3.60E-06	4.18E-10	1.23E-04	1.83E-05	3.76E-06	2.35E-04	6.57E-09	1.70E-04	2.21E-03	8.64E-07	6.00E-06	1.01E-05	2.24E-07	1.72E-07	0.00E+00	2.78E-03	3.65E-09	2.82E-06	2.82E-06
Baseline	RES	Infant	3-methylcholanthrene	7.58E-07	1.35E-06	6.34E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.57E-06	1.21E-07	5.53E-08	1.93E-03	1.93E-03	5.49E-09	7.85E-06	7.85E-06
Baseline	RES	Toddler	3-methylcholanthrene	3.03E-06	2.70E-06	2.39E-10	8.43E-05	8.31E-06	3.76E-06	1.53E-04	6.57E-09	1.03E-04	1.51E-03	6.05E-07	4.20E-06	6.11E-06	1.63E-07	9.78E-08	0.00E+00	1.88E-03	5.46E-09	3.80E-06	3.80E-06
Future	RES	Adolescent	3-methylcholanthrene	4.81E-08	5.01E-07	2.85E-11	9.59E-06	2.00E-06	7.16E-07	2.10E-05	1.25E-09	2.29E-05	3.44E-04	1.35E-07	9.35E-07	1.70E-06	1.93E-08	1.73E-08	0.00E+00	4.04E-04	2.80E-10	2.25E-07	2.26E-07
Future	RES	Adult	3-methylcholanthrene	4.81E-08	7.52E-07	3.04E-11	1.09E-05	2.43E-06	7.16E-07	1.74E-05	1.25E-09	2.29E-05	5.31E-04	2.11E-07	1.44E-06	1.94E-06	2.14E-08	1.98E-08	0.00E+00	5.90E-04	3.54E-10	2.78E-07	2.78E-07
Future	RES	Child	3-methylcholanthrene	4.81E-08	4.01E-07	2.65E-11	7.83E-06	1.16E-06	2.39E-07	1.49E-05	4.17E-10	1.89E-05	2.46E-04	9.61E-08	6.68E-07	1.12E-06	1.42E-08	1.10E-08	0.00E+00	2.91E-04	4.06E-10	2.95E-07	2.95E-07
Future	RES	Infant	3-methylcholanthrene	4.81E-08	1.50E-07	4.02E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.97E-07	7.70E-09	3.51E-09	2.06E-04	2.07E-04	6.11E-10	8.39E-07	8.40E-07
Future	RES	Toddler	3-methylcholanthrene	1.93E-07	3.01E-07	1.52E-11	5.35E-06	5.28E-07	2.39E-07	9.73E-06	4.17E-10	1.14E-05	1.68E-04	6.73E-08	4.68E-07	6.79E-07	1.03E-08	6.21E-09	0.00E+00	1.97E-04	6.07E-10	3.98E-07	3.99E-07
PDC	RES	Adolescent	3-methylcholanthrene	8.06E-07	4.79E-06	4.78E-10	1.61E-04	3.36E-05	1.20E-05	3.52E-04	2.10E-08	2.19E-04	3.29E-03	1.29E-06	8.94E-06	1.63E-05	3.22E-07	2.90E-07	0.00E+00	4.10E-03	2.67E-09	2.29E-06	2.29E-06
PDC	RES	Adult	3-methylcholanthrene	8.06E-07	7.19E-06	5.09E-10	1.83E-04	4.07E-05	1.20E-05	2.92E-04	2.10E-08	2.19E-04	5.07E-03	2.02E-06	1.37E-05	1.85E-05	3.59E-07	3.31E-07	0.00E+00	5.86E-03	3.39E-09	2.76E-06	2.76E-06
PDC	RES	Child	3-methylcholanthrene	8.06E-07	3.83E-06	4.44E-10	1.31E-04	1.94E-05	4.00E-06	2.50E-04	6.99E-09	1.81E-04	2.35E-03	9.19E-07	6.38E-06	1.07E-05	2.38E-07	1.83E-07	0.00E+00	2.96E-03	3.88E-09	2.99E-06	3.00E-06
PDC	RES	Infant	3-methylcholanthrene	8.06E-07	1.44E-06	6.74E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.80E-06	1.29E-07	5.89E-08	2.05E-03	2.05E-03	5.84E-09	8.35E-06	8.35E-06
PDC	RES	Toddler	3-methylcholanthrene	3.22E-06	2.87E-06	2.54E-10	8.97E-05	8.84E-06	4.00E-06	1.63E-04	6.99E-09	1.09E-04	1.61E-03	6.43E-07	4.47E-06	6.49E-06	1.73E-07	1.04E-07	0.00E+00	2.00E-03	5.81E-09	4.04E-06	4.04E-06
Project	RES	Adolescent	3-methylcholanthrene	3.00E-09	7.87E-07	1.78E-12	5.98E-07	1.25E-07	4.47E-08	1.31E-06	7.81E-11	3.59E-05	5.41E-04	2.11E-07	1.47E-06	2.67E-06	1.20E-09	1.08E-09	0.00E+00	5.84E-04	4.39E-10	3.26E-07	3.26E-07
Project	RES	Adult	3-methylcholanthrene	3.00E-09	1.18E-06	1.89E-12	6.83E-07	1.51E-07	4.47E-08	1.09E-06	7.81E-11	3.59E-05	8.33E-04	3.32E-07	2.25E-06	3.05E-06	1.34E-09	1.23E-09	0.00E+00	8.78E-04	5.56E-10	4.13E-07	4.14E-07
Project	RES	Child	3-methylcholanthrene	3.00E-09	6.29E-07	1.66E-12	4.89E-07	7.24E-08	1.49E-08	9.31E-07	2.60E-11	2.96E-05	3.86E-04	1.51E-07	1.05E-06	1.76E-06	8.86E-10	6.83E-10	0.00E+00	4.21E-04	6.38E-10	4.26E-07	4.27E-07
Project	RES	Infant	3-methylcholanthrene	3.00E-09	2.36E-07	2.51E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.24E-07	4.81E-10	2.19E-10	3.07E-04	3.08E-04	9.59E-10	1.25E-06	1.25E-06
Project	RES	Toddler	3-methylcholanthrene	1.20E-08	4.72E-07	9.47E-13	3.34E-07	3.29E-08	1.49E-08	6.07E-07	2.60E-11	1.80E-05	2.64E-04	1.06E-07	7.34E-07	1.07E-06	6.46E-10	3.88E-10	0.00E+00	2.86E-04	9.54E-10	5.76E-07	5.77E-07
Application	RES	Adolescent	7,12-Dimethylbenz(a)anthracene	9.43E-06	4.05E-05	5.59E-09	1.33E-03	2.80E-04	1.01E-04	9.72E-05	5.60E-07	8.91E-05	4.66E-04	1.85E-07	1.28E-06	6.27E-05	4.91E-06	4.41E-06	0.00E+00	2.49E-03	4.85E-04	2.93E-02	2.98E-02
Application	RES	Adult	7,12-Dimethylbenz(a)anthracene	9.43E-06	6.08E-05	5.95E-09	1.52E-03	3.39E-04	1.01E-04	8.05E-05	5.60E-07	8.91E-05	7.18E-04	2.90E-07	1.96E-06	7.15E-05	5.46E-06	5.04E-06	0.00E+00	3.00E-03	6.14E-04	2.97E-02	3.03E-02
Application	RES	Child	7,12-Dimethylbenz(a)anthracene	9.43E-06	3.24E-05	5.20E-09	1.09E-03	1.62E-04	3.38E-05	6.89E-05	1.87E-07	7.35E-05	3.33E-04	1.32E-07	9.11E-07	4.15E-05	3.62E-06	2.79E-06	0.00E+00	1.85E-03	7.04E-04	3.95E-02	4.02E-02
Application	RES	Infant	7,12-Dimethylbenz(a)anthracene	9.43E-06	1.22E-05	7.89E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-05	1.96E-06	8.95E-07	2.52E-04	2.91E-04	1.06E-03	2.43E-02	2.53E-02
Application	RES	Toddler	7,12-Dimethylbenz(a)anthracene	3.77E-05	2.43E-05	2.98E-09	7.44E-04	7.38E-05	3.38E-05	4.49E-05	1.87E-07	4.46E-05	2.28E-04	9.23E-08	6.38E-07	2.53E-05	2.64E-06	1.58E-06	0.00E+00	1.26E-03	1.05E-03	5.35E-02	5.46E-02
Baseline	RES	Adolescent	7,12-Dimethylbenz(a)anthracene	9.43E-06	4.05E-05	5.59E-09	1.33E-03	2.80E-04	1.01E-04	9.71E-05	5.60E-07	8.91E-05	4.65E-04	1.84E-07	1.27E-06	6.27E-05	4.90E-06	4.41E-06	0.00E+00	2.49E-03	4.84E-04	2.93E-02	2.98E-02
Baseline	RES	Adult	7,12-Dimethylbenz(a)anthracene	9.43E-06	6.07E-05	5.95E-09	1.52E-03	3.39E-04	1.01E-04	8.04E-05	5.60E-07	8.91E-05	7.17E-04	2.90E-07	1.96E-06	7.15E-05	5.45E-06	5.04E-06	0.00E+00	3.00E-03	6.14E-04	2.97E-02	3.03E-02
Baseline	RES	Child	7,12-Dimethylbenz(a)anthracene	9.43E-06	3.24E-05	5.19E-09	1.09E-03	1.62E-04	3.37E-05	6.89E-05	1.87E-07	7.35E-05	3.32E-04	1.32E-07	9.10E-07	4.14E-05	3.62E-06	2.79E-06	0.00E+00	1.85E-03	7.03E-04	3.94E-02	4.01E-02
Baseline	RES	Infant	7,12-Dimethylbenz(a)anthracene	9.43E-06	1.21E-05	7.88E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-05	1.96E-06	8.95E-07	2.51E-04	2.91E-04	1.06E-03	2.42E-02	2.53E-02
Baseline	RES	Toddler	7,12-Dimethylbenz(a)anthracene	3.77E-05	2.43E-05	2.97E-09	7.43E-04	7.37E-05	3.37E-05	4.49E-05	1.87E-07	4.45E-05	2.27E-04	9.22E-08	6.37E-07	2.53E-05	2.63E-06	1.58E-06	0.00E+00	1.26E-03	1.05E-03	5.35E-02	5.45E-02
Future	RES	Adolescent	7,12-Dimethylbenz(a)anthracene	5.92E-07	4.45E-06	3.51E-10	8.36E-05	1.76E-05	6.36E-06	6.10E-06	3.51E-08	9.80E-06	5.12E-05	2.03E-08	1.40E-07	6.90E-06	3.08E-07	2.77E-07	0.00E+00	1.87E-04	5.33E-05	2.19E-03	2.24E-03
Future	RES	Adult	7,12-Dimethylbenz(a)anthracene	5.92E-07	6.68E-06	3.74E-10	9.55E-05	2.13E-05	6.36E-06	5.05E-06	3.51E-08	9.80E-06	7.89E-05	3.19E-08	2.15E-07	7.86E-06	3.43E-07	3.16E-07	0.00E+00	2.33E-04	6.75E-05	2.29E-03	2.35E-03
Future	RES	Child	7,12-Dimethylbenz(a)anthracene	5.92E-07	3.56E-06	3.26E-10	6.83E-05	1.02E-05	2.12E-06	4.33E-06	1.17E-08	8.08E-06	3.66E-05	1.45E-08	1.00E-07	4.56E-06	2.27E-07	1.75E-07	0.00E+00	1.39E-04	7.74E-05	2.94E-03	3.01E-03
Future	RES	Infant	7,12-Dimethylbenz(a)anthracene	5.92E-07	1.34E-06	4.95E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.61E-06	1.23E-07	5.62E-08	1.95E-05	2.32E-05	1.16E-04	1.91E-03	2.02E-03
Future	RES	Toddler	7,12-Dimethylbenz(a)anthracene	2.37E-06	2.67E-06	1.87E-10	4.67E-05	4.63E-06	2.12E-06	2.82E-06	1.17E-08	4.90E-06	2.50E-05	1.01E-08	7.01E-08	2.78E-06	1.66E-07	9.93E-08	0.00E+00	9.43E-05	1.16E-04	3.97E-03	4.08E-03
PDC	RES	Adolescent	7,12-Dimethylbenz(a)anthracene	1.00E-05	4.30E-05	5.94E-09	1.41E-03	2.98E-04	1.08E-04	1.03E-04	5.95E-07	9.47E-05	4.94E-04	1.96E-07	1.35E-06	6.66E-05	5.21E-06	4.69E-06	0.00E+00	2.64E-03	5.15E-04	3.11E-02	3.16E-02
PDC	RES	Adult	7,12-Dimethylbenz(a)anthracene	1.00E-05	6.45E-05	6.32E-09	1.61E-03	3.60E-04	1.08E-04	8.55E-05	5.95E-07	9.47E-05	7.62E-04	3.08E-07	2.08E-06	7.59E-05	5.80E-06	5.35E-06	0.00E+00	3.19E-03	6.52E-04	3.16E-02	3.22E-02

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																		
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
PDC	RES	Child	7,12-Dimethylbenz(a)anthracene	1.00E-05	3.44E-05	5.52E-09	1.16E-03	1.72E-04	3.59E-05	7.32E-05	1.98E-07	7.81E-05	3.53E-04	1.40E-07	9.67E-07	4.40E-05	3.84E-06	2.96E-06	0.00E+00	1.96E-03	7.47E-04	4.19E-02	4.27E-02
PDC	RES	Infant	7,12-Dimethylbenz(a)anthracene	1.00E-05	1.29E-05	8.38E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-05	2.08E-06	9.51E-07	2.67E-04	3.09E-04	1.12E-03	2.58E-02	2.69E-02
PDC	RES	Toddler	7,12-Dimethylbenz(a)anthracene	4.01E-05	2.58E-05	3.16E-09	7.90E-04	7.84E-05	3.59E-05	4.77E-05	1.98E-07	4.73E-05	2.42E-04	9.80E-08	6.77E-07	2.68E-05	2.80E-06	1.68E-06	0.00E+00	1.34E-03	1.12E-03	5.68E-02	5.80E-02
Project	RES	Adolescent	7,12-Dimethylbenz(a)anthracene	3.69E-08	6.99E-06	2.19E-11	5.22E-06	1.10E-06	3.97E-07	3.81E-07	2.19E-09	1.54E-05	8.04E-05	3.19E-08	2.20E-07	1.08E-05	1.92E-08	1.73E-08	0.00E+00	1.21E-04	8.37E-05	1.36E-03	1.45E-03
Project	RES	Adult	7,12-Dimethylbenz(a)anthracene	3.69E-08	1.05E-05	2.33E-11	5.95E-06	1.33E-06	3.97E-07	3.15E-07	2.19E-09	1.54E-05	1.24E-04	5.01E-08	3.38E-07	1.23E-05	2.14E-08	1.97E-08	0.00E+00	1.71E-04	1.06E-04	1.62E-03	1.72E-03
Project	RES	Child	7,12-Dimethylbenz(a)anthracene	3.69E-08	5.59E-06	2.04E-11	4.26E-06	6.36E-07	1.32E-07	2.70E-07	7.31E-10	1.27E-05	5.74E-05	2.28E-08	1.57E-07	7.16E-06	1.42E-08	1.09E-08	0.00E+00	8.84E-05	1.21E-04	1.80E-03	1.92E-03
Project	RES	Infant	7,12-Dimethylbenz(a)anthracene	3.69E-08	2.10E-06	3.09E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E-06	7.68E-09	3.51E-09	1.43E-05	1.90E-05	1.83E-04	1.47E-03	1.65E-03
Project	RES	Toddler	7,12-Dimethylbenz(a)anthracene	1.48E-07	4.20E-06	1.17E-11	2.91E-06	2.89E-07	1.32E-07	1.76E-07	7.31E-10	7.69E-06	3.93E-05	1.59E-08	1.10E-07	4.36E-06	1.03E-08	6.20E-09	0.00E+00	5.93E-05	1.82E-04	2.39E-03	2.57E-03
Application	RES	Adolescent	Acenaphthene	2.54E-08	2.29E-04	1.51E-11	6.62E-06	1.07E-06	1.90E-07	9.23E-07	1.84E-08	1.84E-03	5.69E-04	3.70E-08	9.18E-08	7.71E-05	1.53E-08	1.37E-08	0.00E+00	2.72E-03	9.58E-08	1.04E-06	1.14E-06
Application	RES	Adult	Acenaphthene	2.54E-08	3.43E-04	1.60E-11	7.55E-06	1.30E-06	1.90E-07	7.64E-07	1.84E-08	1.84E-03	8.77E-04	5.82E-08	1.41E-07	8.77E-05	1.70E-08	1.57E-08	0.00E+00	3.16E-03	1.21E-07	9.95E-07	1.12E-06
Application	RES	Child	Acenaphthene	2.54E-08	1.83E-04	1.40E-11	5.40E-06	6.21E-07	6.34E-08	6.54E-07	6.14E-09	1.52E-03	4.06E-04	2.64E-08	6.56E-08	5.25E-05	1.13E-08	8.68E-09	0.00E+00	2.17E-03	1.39E-07	1.51E-06	1.65E-06
Application	RES	Infant	Acenaphthene	2.54E-08	6.87E-05	2.13E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.77E-05	6.11E-09	2.79E-09	3.49E-06	8.99E-05	2.09E-07	6.47E-08	2.74E-07
Application	RES	Toddler	Acenaphthene	1.02E-07	1.37E-04	8.02E-12	3.69E-06	2.82E-07	6.34E-08	4.27E-07	6.14E-09	9.20E-04	2.78E-04	1.85E-08	4.59E-08	3.29E-05	8.20E-09	4.92E-09	0.00E+00	1.37E-03	2.08E-07	1.87E-06	2.08E-06
Baseline	RES	Adolescent	Acenaphthene	2.54E-08	2.29E-04	1.51E-11	6.61E-06	1.07E-06	1.90E-07	9.22E-07	1.84E-08	1.84E-03	5.69E-04	3.70E-08	9.18E-08	7.71E-05	1.53E-08	1.37E-08	0.00E+00	2.72E-03	9.58E-08	1.04E-06	1.14E-06
Baseline	RES	Adult	Acenaphthene	2.54E-08	3.43E-04	1.60E-11	7.55E-06	1.30E-06	1.90E-07	7.64E-07	1.84E-08	1.84E-03	8.76E-04	5.82E-08	1.41E-07	8.77E-05	1.70E-08	1.57E-08	0.00E+00	3.16E-03	1.21E-07	9.95E-07	1.12E-06
Baseline	RES	Child	Acenaphthene	2.54E-08	1.83E-04	1.40E-11	5.40E-06	6.21E-07	6.34E-08	6.54E-07	6.14E-09	1.52E-03	4.06E-04	2.64E-08	6.56E-08	5.25E-05	1.13E-08	8.68E-09	0.00E+00	2.17E-03	1.39E-07	1.51E-06	1.65E-06
Baseline	RES	Infant	Acenaphthene	2.54E-08	6.87E-05	2.13E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.77E-05	6.10E-09	2.79E-09	3.49E-06	8.99E-05	2.09E-07	6.47E-08	2.74E-07
Baseline	RES	Toddler	Acenaphthene	1.02E-07	1.37E-04	8.02E-12	3.69E-06	2.82E-07	6.34E-08	4.27E-07	6.14E-09	9.20E-04	2.78E-04	1.85E-08	4.59E-08	3.29E-05	8.20E-09	4.92E-09	0.00E+00	1.37E-03	2.08E-07	1.87E-06	2.08E-06
Future	RES	Adolescent	Acenaphthene	1.93E-08	1.73E-04	1.14E-11	5.01E-06	8.12E-07	1.44E-07	6.99E-07	1.40E-08	1.39E-03	4.31E-04	2.80E-08	6.95E-08	5.84E-05	1.16E-08	1.04E-08	0.00E+00	2.06E-03	7.26E-08	7.91E-07	8.64E-07
Future	RES	Adult	Acenaphthene	1.93E-08	2.60E-04	1.22E-11	5.72E-06	9.83E-07	1.44E-07	5.78E-07	1.40E-08	1.39E-03	6.64E-04	4.40E-08	1.07E-07	6.64E-05	1.29E-08	1.19E-08	0.00E+00	2.39E-03	9.19E-08	7.54E-07	8.46E-07
Future	RES	Child	Acenaphthene	1.93E-08	1.39E-04	1.06E-11	4.09E-06	4.70E-07	4.80E-08	4.95E-07	4.65E-09	1.15E-03	3.08E-04	2.00E-08	4.97E-08	3.98E-05	8.52E-09	6.57E-09	0.00E+00	1.64E-03	1.05E-07	1.14E-06	1.25E-06
Future	RES	Infant	Acenaphthene	1.93E-08	5.20E-05	1.61E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-05	4.62E-09	2.11E-09	2.64E-06	6.81E-05	1.59E-07	4.90E-08	2.08E-07
Future	RES	Toddler	Acenaphthene	7.70E-08	1.04E-04	6.08E-12	2.80E-06	2.14E-07	4.80E-08	3.23E-07	4.65E-09	6.97E-04	2.10E-04	1.40E-08	3.48E-08	2.49E-05	6.21E-09	3.73E-09	0.00E+00	1.04E-03	1.58E-07	1.42E-06	1.58E-06
PDC	RES	Adolescent	Acenaphthene	4.47E-08	4.02E-04	2.65E-11	1.16E-05	1.89E-06	3.34E-07	1.62E-06	3.24E-08	3.23E-03	9.99E-04	6.50E-08	1.61E-07	1.36E-04	2.68E-08	2.41E-08	0.00E+00	4.79E-03	1.68E-07	1.84E-06	2.00E-06
PDC	RES	Adult	Acenaphthene	4.47E-08	6.03E-04	2.82E-11	1.33E-05	2.28E-06	3.34E-07	1.34E-06	3.24E-08	3.23E-03	1.54E-03	1.02E-07	2.48E-07	1.54E-04	2.98E-08	2.76E-08	0.00E+00	5.55E-03	2.13E-07	1.75E-06	1.96E-06
PDC	RES	Child	Acenaphthene	4.47E-08	3.22E-04	2.46E-11	9.49E-06	1.09E-06	1.11E-07	1.15E-06	1.08E-08	2.67E-03	7.14E-04	4.65E-08	1.15E-07	9.23E-05	1.98E-08	1.53E-08	0.00E+00	3.81E-03	2.44E-07	2.65E-06	2.89E-06
PDC	RES	Infant	Acenaphthene	4.47E-08	1.21E-04	3.74E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.11E-05	1.07E-08	4.89E-09	6.13E-06	1.58E-04	3.68E-07	1.14E-07	4.82E-07
PDC	RES	Toddler	Acenaphthene	1.79E-07	2.41E-04	1.41E-11	6.49E-06	4.96E-07	1.11E-07	7.50E-07	1.08E-08	1.62E-03	4.88E-04	3.25E-08	8.07E-08	5.78E-05	1.44E-08	8.65E-09	0.00E+00	2.41E-03	3.66E-07	3.29E-06	3.66E-06
Project	RES	Adolescent	Acenaphthene	1.97E-11	6.28E-06	1.17E-14	5.13E-09	8.32E-10	1.48E-10	7.15E-10	1.43E-11	5.05E-05	1.56E-05	1.02E-09	2.52E-09	2.12E-06	1.18E-11	1.07E-11	0.00E+00	7.45E-05	2.63E-09	2.86E-08	3.12E-08
Project	RES	Adult	Acenaphthene	1.97E-11	9.42E-06	1.24E-14	5.86E-09	1.01E-09	1.48E-10	5.93E-10	1.43E-11	5.05E-05	2.41E-05	1.60E-09	3.87E-09	2.41E-06	1.32E-11	1.22E-11	0.00E+00	8.64E-05	3.33E-09	2.72E-08	3.05E-08
Project	RES	Child	Acenaphthene	1.97E-11	5.02E-06	1.09E-14	4.19E-09	4.82E-10	4.92E-11	5.07E-10	4.77E-12	4.17E-05	1.11E-05	7.25E-10	1.80E-09	1.44E-06	8.73E-12	6.73E-12	0.00E+00	5.93E-05	3.82E-09	4.12E-08	4.50E-08
Project	RES	Infant	Acenaphthene	1.97E-11	1.88E-06	1.65E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.86E-07	4.74E-12	2.16E-12	9.54E-08	2.47E-06	5.74E-09	1.77E-09	7.52E-09
Project	RES	Toddler	Acenaphthene	7.89E-11	3.77E-06	6.22E-15	2.86E-09	2.19E-10	4.92E-11	3.31E-10	4.77E-12	2.52E-05	7.63E-06	5.08E-10	1.26E-09	9.03E-07	6.36E-12	3.82E-12	0.00E+00	3.75E-05	5.71E-09	5.12E-08	5.69E-08
Application	RES	Adolescent	Acenaphthylene	6.39E-07	4.33E-03	3.79E-10	2.09E-04	3.37E-05	5.82E-06	2.32E-05	4.51E-07	3.48E-02	1.08E-02	8.77E-07	1.96E-06	1.54E-03	3.83E-07	3.45E-07	0.00E+00	5.18E-02	1.81E-06	1.99E-05	2.17E-05
Application	RES	Adult	Acenaphthylene	6.39E-07	6.50E-03	4.03E-10	2.38E-04	4.07E-05	5.82E-06	1.92E-05	4.51E-07	3.48E-02	1.67E-02	1.38E-06	3.00E-06	1.76E-03	4.27E-07	3.94E-07	0.00E+00	6.01E-02	2.30E-06	1.90E-05	2.13E-05
Application	RES	Child	Acenaphthylene	6.39E-07	3.47E-03	3.52E-10	1.70E-04	1.95E-05	1.94E-06	1.64E-05	1.50E-07	2.87E-02	7.74E-03	6.26E-07	1.40E-06	1.05E-03	2.83E-07	2.18E-07	0.00E+00	4.12E-02	2.63E-06	2.87E-05	3.13E-05
Application	RES	Infant	Acenaphthylene	6.39E-07	1.30E-03	5.34E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.55E-04	1.53E-07	7.00E-08	6.95E-05	1.72E-03	3.96E-06	1.30E-06	5.26E-06
Application	RES	Toddler	Acenaphthylene	2.56E-06	2.60E-03	2.02E-10	1.16E-04	8.86E-06	1.94E-06	1.07E-05	1.50E-07	1.74E-02	5.29E-03	4.38E-07	9.78E-07	6.56E-04	2.06E-07	1.24E-07	0.00E+00	2.61E-02	3.94E-06	3.56E-05	3.96E-05
Baseline	RES	Adolescent	Acenaphthylene	6.39E-07	4.33E-03	3.79E-10	2.09E-04	3.37E-05	5.82E-06	2.32E-05	4.51E-07	3.48E-02	1.08E-02	8.77E-07	1.96E-06	1.54E-03	3.83E-07	3.45E-07	0.00E+00	5.18E-02	1.81E-06	1.99E-05	2.17E-05
Baseline	RES	Adult	Acenaphthylene	6.39E-07	6.50E-03	4.03E-10	2.38E-04	4.07E-05	5.82E-06	1.92E-05	4.51E-07	3.48E-02	1.67E-02	1.38E-06	3.00E-06	1.76E-03	4.27E-07	3.94E-07	0.00E+00	6.01E-02	2.30E-06	1.90E-05	2.13E-05
Baseline	RES	Child	Acenaphthylene	6.39E-07	3.47E-03	3.52E-10	1.70E-04	1.95E-05	1.94E-06	1.64E-05	1.50E-07	2.87E-02	7.74E-03	6.26E-07	1.40E-06	1.05E-03	2.83E-07	2.18E-07	0.00E+00	4.12E-02	2.63E-06	2.87E-05	3.13E-05
Baseline	RES	Infant	Acenaphthylene	6.39E-07	1.30E-03	5.34E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.55E-04	1.53E-07	7.00E-08	6.95E-05	1.72E-03	3.96E-06	1.30E-06	5.26E-06
Baseline	RES	Toddler	Acenaphthylene	2.56E-06	2.60E-03	2.02E-10	1.16E-04	8.86E-06	1.94E-06	1.07E-05	1.50E-07	1.74E-02	5.29E-03	4.38E-07	9.78E-07	6.56E-04	2.06E-07	1.24E-07	0.00E+00	2.61E-02	3.94E-06	3.56E-05	3.96E-05
Future	RES	Adolescent	Acenaphthylene	5.09E-07	3.45E-03	3.02E-10	1.66E-04	2.68E-05	4.64E-06	1.85E-05	3.59E-07	2.78E-02	8.63E-03	6.99E-07	1.56E-06	1.23E-03	3.06E-07	2.75E-07	0.00E+00	4.13E-02	1.45E-06	1.59E-05	1.73E-05
Future	RES	Adult	Acenaphthylene	5.09E-07	5.18E-03	3.21E-10	1.90E-04	3.25E-05	4.64E-06	1.53E-05	3.59E-07	2.78E-02	1.33E-02	1.10E-06	2.40E-06	1.40E-03	3.40E-07	3.14E-07	0.00E+00	4.79E-02	1.83E-06	1.51E-05	1.69E-05
Future	RES	Child	Acenaphthylene	5.09E-07	2.76E-03	2.81E-10	1.36E-04	1.55E-05	1.55E-06	1.31E-05	1.20E-07	2.29E-02	6.17E-03	4.99E-07	1.11E-06	8.36E-04	2.25E-07	1.74E-07	0.00E+00	3.28E-02	2.10E-06	2.29E-05	2.50E-05
Future	RES	Infant	Acenaphthylene	5.09E-07	1.04E-03	4.26E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.83E-04	1.22E-07	5.58E-08	5.54E-05	1.37E-03	3.16E-06	1.03E-06	4.19E-06
Future	RES	Toddler	Acenaphthylene	2.04E-06	2.07E-03	1.61E-10	9.29E-05	7.06E-06	1.55E-06	8.55E-06	1.20E-07	1.39E-02	4.22E-03	3.49E-07	7.80E-07	5.23E-04	1.64E-07	9.86E-08	0.00E+00	2.08E-02	3.14E-06	2.84E-05	3.15E-05
PDC	RES	Adolescent	Acenaphthylene	1.15E-06	7.79E-03	6.81E-10	3.75E-04	6.05E-05	1.05E-05	4.17E-05	8.10E-07	6.26E-02	1.95E-02	1.58E-06	3.52E-06	2.77E-03	6.89E-07	6.20E-07	0.00E+00	9.31E-02	3.26E-06	3.57E-05	3.90E-05
PDC	RES	Adult	Acenaphthylene	1.15E-06	1.17E-02	7.25E-10	4.28E-04	7.32E-05	1.05E-05	3.45E-05	8.10E-07	6.26E-02	3.00E-02	2.48E-06	5.40E-06	3.16E-03	7.67E-07	7.08E-07	0.00E+00	1.08E-01	4.13E-06	3.41E-05	3.82E-05
PDC	RES	Child	Acenaphthylene	1.15E-06	6.23E-03	6.33E-10	3.06E-04	3.50E-05	3.49E-06	2.95E-05	2.70E-07	5.17E-02	1.39E-02	1.13E-06	2.51E-06	1.88E-03	5.08E-07	3.92E-07	0.00E+00	7.40E-02	4.73E-06	5.15E-05	5.63E-05
PDC	RES	Infant	Acenaphthylene	1.15E-06	2.34E-03	9.60E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.37E-04	2.76E-07	1.26E-07	1.25E-04	3.10E-03	7.12E-06	2.33E-06	9.45E-06
PDC	RES	Toddler	Acenaphthylene	4.59E-06	4.67E-03	3.62E-10	2.09E-04	1.59E-05	3.49E-06	1.93E-05	2.70E-07	3.13E-02	9.51E-03	7.88E-07	1.76E-06	1.18E-03	3.70E-07	2.22E-07	0.00E+00	4.69E-02	7.08E-06	6.40E-05	7.11E-05
Project	RES	Adolescent	Acenaphthylene	1.84E-11	4.42E-06	1.09E-14	6.01E-09	9.69E-10	1.68E-10	6.68E-10	1.30E-11	3.56E-05	1.11E-05	8.95E-10	2.00E-09	1.58E-06	1.10E-11	9.94E-12	0.00E+00	5.26E-05	1.85E-09	2.02E-08	2.20E-08
Project	RES	Adult	Acenaphthylene	1.84E-11	6.64E-06	1.16E-14	6.86E-09	1.17E-09	1.68E-10	5.53E-10	1.30E-11	3.56E-05	1.70E-05	1.41E-09	3.07E-09	1.79E-06	1.23E-11	1.13E-11	0.00E+00	6.11E-05	2.35E-09	1.92E-08	2.16E-08
Project	RES	Child	Acenaphthylene	1.84E-11	3.54E-06	1.01E-14	4.91E-09	5.61E-10	5.59E-11	4.73E-10	4.33E-12	2.93E-05	7.90E-06	6.39E-10	1.43E-09	1.07E-06	8.15E-12	6.28E-12	0.00E+00	4.19E-05	2.69E-09	2.91E-08	3.18E-08
Project	RES	Infant	Acenaphthylene	1.84E-11	1.33E-06	1.54E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.62E-07	4.42E-12	2.02E-12	7.06E-08	1.76E-06	4.05E-09	1.32E-09	5.37E-09
Project	RES	Toddler	Acenaphthylene	7.36E-11	2.65E-06	5.81E-15	3.36E-09	2.55E-10	5.59E-11	3.09E-10	4.33E-12	1.78E-05	5.40E-06	4.47E-10	9.99E-10	6.69E-07	5.94E-12	3.56E-12	0.00E+00	2.65E-05	4.02E-09	3.62E-08	4.02E-08
Application	RES	Adolescent	Anthracene	3.78E-07	2.86E-04	2.24E-10	4.48E-06	8.96E-07	2.94E-07	9.71E-06	1.35E-07	6.29E-04	2.52E-04	9.23E-10	5.42E-09	1.57E-04	2.27E-07	2.04E-07	0.00E+00	1.34E-03	1.20E-07	4.42E-07	5.62E-07
Application	RES	Adult	Anthracene	3.78E-07	4.29E-04	2.38E-10	5.12E-06	1.08E-06	2.94E-07	8.04E-06	1.35E-07	6.29E-04	3.89E-04	1.45E-09	8.32E-09	1.79E-04	2.52E-07	2.33E-07	0.00E+00	1.64E-03	1.52E-07	4.29E-07	5.81E-07
Application	RES	Child	Anthracene	3.78E-07	2.29E-04	2.08E-10	3.66E-06	5.19E-07	9.81E-08	6.89E-06	4.51E-08	5.19E-04	1.80E-04	6.59E-10	3.87E-09	1.05E-04	1.67E-07	1.29E-07	0.00E+00	1.05E-03	1.74E-07	6.21E-07	7.95E-07
Application	RES	Infant	Anthracene	3.78E-07	8.58E-05	3.16E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.63E-05	9.07E-08	4.14E-08	6.14E-06	1.29E-04	2.62E-07	1.31E-07	3.93E-07
Application	RES	Toddler	Anthracene	1.51E-06	1.72E-04	1.19E-10	2.50E-06	2.36E-07	9.81E-08	4.49E-06	4.51E-08	3.15E-04	1.23E-04	4.61E-10	2.71E-09	6.52E-05	1.22E-07	7.31E-08	0.00E+00	6.84E-04	2.60E-07	7.76E-07	1.04E-06
Baseline	RES	Adolescent	Anthracene	3.78E-07	2.86E-04	2.24E-10	4.48E-06	8.96E-07	2.94E-07	9.71E-06	1.35E-07	6.29E-04	2.52E-04	9.23E-10	5.42E-09	1.57E-04	2.27E-07	2.04E-07	0.00E+00	1.34E-03	1.20E-07	4.42E-07	5.62E-07
Baseline	RES	Adult	Anthracene	3.78E-07	4.29E-04	2.38E-10	5.12E-06	1.08E-06	2.94E-07	8.04E-06	1.35E-07	6.29E-04	3.89E-04	1.45E-09	8.32E-09	1.79E-04	2.52E-07	2.33E-07	0.00E+00	1.64E-03	1.52E-07	4.29E-07	5.80E-07
Baseline	RES	Child	Anthracene	3.78E-07	2.29E-04	2.08E-10	3.66E-06	5.19E-07	9.81E-08	6.89E-06	4.51E-08	5.19E-04	1.80E-04	6.59E-10	3.87E-09	1.05E-04	1.67E-07	1.29E-07	0.00E+00	1.05E-03	1.74E-07	6.21E-07	7.94E-07
Baseline	RES	Infant	Anthracene	3.78E-07	8.58E-05	3.16E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.63E-05	9.07E-08	4.14E-08	6.14E-06	1.29E-04	2.62E-07	1.31E-07	3.93E-07

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																		
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
Baseline	RES	Toddler	Anthracene	1.51E-06	1.72E-04	1.19E-10	2.50E-06	2.36E-07	9.81E-08	4.49E-06	4.51E-08	3.15E-04	1.23E-04	4.61E-10	2.71E-09	6.52E-05	1.22E-07	7.31E-08	0.00E+00	6.84E-04	2.60E-07	7.76E-07	1.04E-06
Future	RES	Adolescent	Anthracene	2.95E-07	2.23E-04	1.75E-10	3.50E-06	6.99E-07	2.29E-07	7.57E-06	1.05E-07	4.91E-04	1.97E-04	7.20E-10	4.22E-09	1.22E-04	1.77E-07	1.59E-07	0.00E+00	1.05E-03	9.34E-08	3.44E-07	4.38E-07
Future	RES	Adult	Anthracene	2.95E-07	3.35E-04	1.86E-10	3.99E-06	8.46E-07	2.29E-07	6.27E-06	1.05E-07	4.91E-04	3.03E-04	1.13E-09	6.48E-09	1.39E-04	1.97E-07	1.82E-07	0.00E+00	1.28E-03	1.18E-07	3.34E-07	4.53E-07
Future	RES	Child	Anthracene	2.95E-07	1.78E-04	1.62E-10	2.85E-06	4.04E-07	7.65E-08	5.37E-06	3.51E-08	4.05E-04	1.40E-04	5.14E-10	3.02E-09	8.22E-05	1.30E-07	1.01E-07	0.00E+00	8.15E-04	1.36E-07	4.84E-07	6.19E-07
Future	RES	Infant	Anthracene	2.95E-07	6.69E-05	2.46E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.83E-05	7.07E-08	3.23E-08	4.79E-06	1.00E-04	2.04E-07	1.02E-07	3.06E-07
Future	RES	Toddler	Anthracene	1.18E-06	1.34E-04	9.29E-11	1.95E-06	1.84E-07	7.65E-08	3.50E-06	3.51E-08	2.45E-04	9.61E-05	3.60E-10	2.11E-09	5.08E-05	9.50E-08	5.70E-08	0.00E+00	5.33E-04	2.03E-07	6.05E-07	8.08E-07
PDC	RES	Adolescent	Anthracene	6.72E-07	5.09E-04	3.99E-10	7.98E-06	1.59E-06	5.24E-07	1.73E-05	2.41E-07	1.12E-03	4.49E-04	1.64E-09	9.64E-09	2.80E-04	4.03E-07	3.63E-07	0.00E+00	2.39E-03	2.13E-07	7.86E-07	9.99E-07
PDC	RES	Adult	Anthracene	6.72E-07	7.64E-04	4.24E-10	9.11E-06	1.93E-06	5.24E-07	1.43E-05	2.41E-07	1.12E-03	6.92E-04	2.58E-09	1.48E-08	3.18E-04	4.49E-07	4.14E-07	0.00E+00	2.92E-03	2.70E-07	7.63E-07	1.03E-06
PDC	RES	Child	Anthracene	6.72E-07	4.07E-04	3.70E-10	6.52E-06	9.23E-07	1.75E-07	1.23E-05	8.02E-08	9.24E-04	3.21E-04	1.17E-09	6.88E-09	1.88E-04	2.98E-07	2.29E-07	0.00E+00	1.86E-03	3.09E-07	1.10E-06	1.41E-06
PDC	RES	Infant	Anthracene	6.72E-07	1.53E-04	5.62E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.46E-05	1.61E-07	7.36E-08	1.09E-05	2.29E-04	4.66E-07	2.33E-07	6.99E-07
PDC	RES	Toddler	Anthracene	2.69E-06	3.05E-04	2.12E-10	4.46E-06	4.20E-07	1.75E-07	7.99E-06	8.02E-08	5.60E-04	2.19E-04	8.21E-10	4.82E-09	1.16E-04	2.17E-07	1.30E-07	0.00E+00	1.22E-03	4.63E-07	1.38E-06	1.84E-06
Project	RES	Adolescent	Anthracene	2.87E-10	7.69E-06	1.70E-13	3.41E-09	6.81E-10	2.24E-10	7.38E-09	1.03E-10	1.69E-05	6.78E-06	2.48E-11	1.46E-10	4.22E-06	1.72E-10	1.55E-10	0.00E+00	3.56E-05	3.22E-09	1.17E-08	1.49E-08
Project	RES	Adult	Anthracene	2.87E-10	1.15E-05	1.81E-13	3.89E-09	8.25E-10	2.24E-10	6.12E-09	1.03E-10	1.69E-05	1.05E-05	3.90E-11	2.24E-10	4.81E-06	1.92E-10	1.77E-10	0.00E+00	4.37E-05	4.08E-09	1.14E-08	1.55E-08
Project	RES	Child	Anthracene	2.87E-10	6.15E-06	1.58E-13	2.78E-09	3.94E-10	7.46E-11	5.24E-09	3.43E-11	1.40E-05	4.84E-06	1.77E-11	1.04E-10	2.83E-06	1.27E-10	9.80E-11	0.00E+00	2.78E-05	4.67E-09	1.64E-08	2.11E-08
Project	RES	Infant	Anthracene	2.87E-10	2.31E-06	2.40E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.77E-07	6.89E-11	3.15E-11	1.64E-07	3.45E-06	7.03E-09	3.48E-09	1.05E-08
Project	RES	Toddler	Anthracene	1.15E-09	4.61E-06	9.06E-14	1.90E-09	1.79E-10	7.46E-11	3.42E-09	3.43E-11	8.46E-06	3.31E-06	1.24E-11	7.28E-11	1.75E-06	9.26E-11	5.56E-11	0.00E+00	1.81E-05	6.99E-09	2.05E-08	2.75E-08
Application	RES	Adolescent	Benzo(a)anthracene	3.07E-05	4.11E-04	1.82E-08	9.55E-03	2.01E-03	7.28E-04	4.95E-04	1.92E-06	9.04E-04	3.45E-03	1.28E-06	9.00E-06	8.59E-04	1.84E-05	1.66E-05	0.00E+00	1.85E-02	4.92E-03	2.16E-01	2.21E-01
Application	RES	Adult	Benzo(a)anthracene	3.07E-05	6.16E-04	1.93E-08	1.09E-02	2.44E-03	7.28E-04	4.10E-04	1.92E-06	9.04E-04	5.32E-03	2.02E-06	1.38E-05	9.79E-04	2.05E-05	1.89E-05	0.00E+00	2.24E-02	6.23E-03	2.20E-01	2.26E-01
Application	RES	Child	Benzo(a)anthracene	3.07E-05	3.29E-04	1.69E-08	7.80E-03	1.17E-03	2.43E-04	3.51E-04	6.40E-07	7.46E-04	2.47E-03	9.18E-07	6.43E-06	5.66E-04	1.36E-05	1.05E-05	0.00E+00	1.37E-02	7.14E-03	2.91E-01	2.98E-01
Application	RES	Infant	Benzo(a)anthracene	3.07E-05	1.23E-04	2.56E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-04	7.36E-06	3.36E-06	1.71E-03	2.08E-03	1.07E-02	1.70E-01	1.81E-01
Application	RES	Toddler	Benzo(a)anthracene	1.23E-04	2.47E-04	9.67E-09	5.33E-03	5.30E-04	2.43E-04	2.29E-04	6.40E-07	4.52E-04	1.69E-03	6.42E-07	4.50E-06	3.44E-04	9.89E-06	5.93E-06	0.00E+00	9.21E-03	1.07E-02	3.88E-01	3.99E-01
Baseline	RES	Adolescent	Benzo(a)anthracene	3.07E-05	4.11E-04	1.82E-08	9.55E-03	2.01E-03	7.28E-04	4.95E-04	1.92E-06	9.04E-04	3.45E-03	1.28E-06	9.00E-06	8.59E-04	1.84E-05	1.66E-05	0.00E+00	1.85E-02	4.92E-03	2.16E-01	2.21E-01
Baseline	RES	Adult	Benzo(a)anthracene	3.07E-05	6.16E-04	1.93E-08	1.09E-02	2.44E-03	7.28E-04	4.10E-04	1.92E-06	9.04E-04	5.32E-03	2.02E-06	1.38E-05	9.79E-04	2.05E-05	1.89E-05	0.00E+00	2.24E-02	6.23E-03	2.20E-01	2.26E-01
Baseline	RES	Child	Benzo(a)anthracene	3.07E-05	3.29E-04	1.69E-08	7.80E-03	1.17E-03	2.43E-04	3.51E-04	6.40E-07	7.46E-04	2.47E-03	9.18E-07	6.43E-06	5.66E-04	1.36E-05	1.05E-05	0.00E+00	1.37E-02	7.14E-03	2.91E-01	2.98E-01
Baseline	RES	Infant	Benzo(a)anthracene	3.07E-05	1.23E-04	2.56E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-04	7.36E-06	3.36E-06	1.71E-03	2.08E-03	1.07E-02	1.70E-01	1.81E-01
Baseline	RES	Toddler	Benzo(a)anthracene	1.23E-04	2.46E-04	9.67E-09	5.33E-03	5.30E-04	2.43E-04	2.29E-04	6.40E-07	4.52E-04	1.69E-03	6.42E-07	4.50E-06	3.44E-04	9.89E-06	5.93E-06	0.00E+00	9.21E-03	1.07E-02	3.88E-01	3.99E-01
Future	RES	Adolescent	Benzo(a)anthracene	2.21E-05	2.96E-04	1.31E-08	6.89E-03	1.45E-03	5.25E-04	3.57E-04	1.38E-06	6.52E-04	2.49E-03	9.27E-07	6.49E-06	6.19E-04	1.33E-05	1.19E-05	0.00E+00	1.33E-02	3.55E-03	1.56E-01	1.60E-01
Future	RES	Adult	Benzo(a)anthracene	2.21E-05	4.45E-04	1.40E-08	7.87E-03	1.76E-03	5.25E-04	2.96E-04	1.38E-06	6.52E-04	3.84E-03	1.46E-06	9.97E-06	7.06E-04	1.48E-05	1.36E-05	0.00E+00	1.62E-02	4.49E-03	1.59E-01	1.63E-01
Future	RES	Child	Benzo(a)anthracene	2.21E-05	2.37E-04	1.22E-08	5.63E-03	8.41E-04	1.75E-04	2.53E-04	4.61E-07	5.38E-04	1.78E-03	6.62E-07	4.64E-06	4.09E-04	9.79E-06	7.55E-06	0.00E+00	9.90E-03	5.15E-03	2.10E-01	2.15E-01
Future	RES	Infant	Benzo(a)anthracene	2.21E-05	8.89E-05	1.85E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-04	5.31E-06	2.42E-06	1.23E-03	1.50E-03	7.75E-03	1.23E-01	1.30E-01
Future	RES	Toddler	Benzo(a)anthracene	8.85E-05	1.78E-04	6.98E-09	3.85E-03	3.82E-04	1.75E-04	1.65E-04	4.61E-07	3.26E-04	1.22E-03	4.63E-07	3.24E-06	2.48E-04	7.13E-06	4.28E-06	0.00E+00	6.64E-03	7.70E-03	2.80E-01	2.88E-01
PDC	RES	Adolescent	Benzo(a)anthracene	5.28E-05	7.07E-04	3.13E-08	1.64E-02	3.46E-03	1.25E-03	8.52E-04	3.30E-06	1.56E-03	5.94E-03	2.21E-06	1.55E-05	1.48E-03	3.17E-05	2.85E-05	0.00E+00	3.18E-02	8.46E-03	3.72E-01	3.81E-01
PDC	RES	Adult	Benzo(a)anthracene	5.28E-05	1.06E-03	3.33E-08	1.88E-02	4.19E-03	1.25E-03	7.05E-04	3.30E-06	1.56E-03	9.16E-03	3.47E-06	2.38E-05	1.68E-03	3.52E-05	3.25E-05	0.00E+00	3.85E-02	1.07E-02	3.79E-01	3.89E-01
PDC	RES	Child	Benzo(a)anthracene	5.28E-05	5.66E-04	2.91E-08	1.34E-02	2.01E-03	4.18E-04	6.04E-04	1.10E-06	1.28E-03	4.25E-03	1.58E-06	1.11E-05	9.75E-04	2.34E-05	1.80E-05	0.00E+00	2.36E-02	1.23E-02	5.01E-01	5.13E-01
PDC	RES	Infant	Benzo(a)anthracene	5.28E-05	2.12E-04	4.41E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.45E-04	1.27E-05	5.78E-06	2.95E-03	3.57E-03	1.85E-02	2.93E-01	3.11E-01
PDC	RES	Toddler	Benzo(a)anthracene	2.11E-04	4.24E-04	1.66E-08	9.18E-03	9.12E-04	4.18E-04	3.94E-04	1.10E-06	7.78E-04	2.90E-03	1.11E-06	7.74E-06	5.93E-04	1.70E-05	1.02E-05	0.00E+00	1.59E-02	1.84E-02	6.68E-01	6.86E-01
Project	RES	Adolescent	Benzo(a)anthracene	1.44E-08	1.17E-04	8.55E-12	4.49E-06	9.47E-07	3.43E-07	2.33E-07	9.03E-10	2.56E-04	9.79E-04	3.64E-07	2.55E-06	2.44E-04	8.65E-09	7.79E-09	0.00E+00	1.60E-03	1.39E-03	1.78E-02	1.92E-02
Project	RES	Adult	Benzo(a)anthracene	1.44E-08	1.75E-04	9.10E-12	5.13E-06	1.15E-06	3.43E-07	1.93E-07	9.03E-10	2.56E-04	1.51E-03	5.73E-07	3.92E-06	2.78E-04	9.63E-09	8.89E-09	0.00E+00	2.23E-03	1.77E-03	2.08E-02	2.25E-02
Project	RES	Child	Benzo(a)anthracene	1.44E-08	9.32E-05	7.95E-12	3.67E-06	5.48E-07	1.14E-07	1.65E-07	3.01E-10	2.11E-04	6.99E-04	2.60E-07	1.82E-06	1.61E-04	6.38E-09	4.92E-09	0.00E+00	1.17E-03	2.02E-03	2.34E-02	2.54E-02
Project	RES	Infant	Benzo(a)anthracene	1.44E-08	3.50E-05	1.21E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.68E-05	3.46E-09	1.58E-09	1.70E-04	2.62E-04	3.05E-03	1.98E-02	2.28E-02
Project	RES	Toddler	Benzo(a)anthracene	5.77E-08	6.99E-05	4.55E-12	2.51E-06	2.49E-07	1.14E-07	1.08E-07	3.01E-10	1.28E-04	4.79E-04	1.82E-07	1.28E-06	9.77E-05	4.65E-09	2.79E-09	0.00E+00	7.79E-04	3.03E-03	3.07E-02	3.37E-02
Application	RES	Adolescent	Benzo(a)pyrene	2.87E-05	8.30E-05	1.70E-08	3.30E-03	6.65E-04	2.22E-04	2.96E-04	1.10E-06	1.83E-04	1.45E-03	5.94E-07	4.12E-06	2.23E-04	1.72E-05	1.55E-05	0.00E+00	6.49E-03	9.93E-04	7.66E-02	7.76E-02
Application	RES	Adult	Benzo(a)pyrene	2.87E-05	1.24E-04	1.81E-08	3.77E-03	8.04E-04	2.22E-04	2.45E-04	1.10E-06	1.83E-04	2.24E-03	9.34E-07	6.33E-06	2.54E-04	1.92E-05	1.77E-05	0.00E+00	7.91E-03	1.26E-03	7.87E-02	7.99E-02
Application	RES	Child	Benzo(a)pyrene	2.87E-05	6.64E-05	1.58E-08	2.69E-03	3.85E-04	7.39E-05	2.10E-04	3.66E-07	1.51E-04	1.04E-03	4.25E-07	2.94E-06	1.47E-04	1.27E-05	9.80E-06	0.00E+00	4.82E-03	1.44E-03	1.03E-01	1.05E-01
Application	RES	Infant	Benzo(a)pyrene	2.87E-05	2.49E-05	2.40E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.21E-05	6.90E-06	3.15E-06	1.42E-03	1.53E-03	2.17E-03	1.31E-01	1.34E-01
Application	RES	Toddler	Benzo(a)pyrene	1.15E-04	4.98E-05	9.06E-09	1.84E-03	1.75E-04	7.39E-05	1.37E-04	3.66E-07	9.13E-05	7.09E-04	2.97E-07	2.06E-06	8.92E-05	9.27E-06	5.56E-06	0.00E+00	3.30E-03	2.15E-03	1.41E-01	1.43E-01
Baseline	RES	Adolescent	Benzo(a)pyrene	2.87E-05	8.29E-05	1.70E-08	3.30E-03	6.64E-04	2.22E-04	2.96E-04	1.10E-06	1.82E-04	1.45E-03	5.94E-07	4.12E-06	2.23E-04	1.72E-05	1.55E-05	0.00E+00	6.49E-03	9.92E-04	7.66E-02	7.76E-02
Baseline	RES	Adult	Benzo(a)pyrene	2.87E-05	1.24E-04	1.81E-08	3.77E-03	8.04E-04	2.22E-04	2.45E-04	1.10E-06	1.82E-04	2.24E-03	9.34E-07	6.33E-06	2.54E-04	1.92E-05	1.77E-05	0.00E+00	7.91E-03	1.26E-03	7.86E-02	7.99E-02
Baseline	RES	Child	Benzo(a)pyrene	2.87E-05	6.64E-05	1.58E-08	2.69E-03	3.85E-04	7.39E-05	2.10E-04	3.66E-07	1.51E-04	1.04E-03	4.25E-07	2.94E-06	1.47E-04	1.27E-05	9.80E-06	0.00E+00	4.82E-03	1.44E-03	1.03E-01	1.05E-01
Baseline	RES	Infant	Benzo(a)pyrene	2.87E-05	2.49E-05	2.40E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.21E-05	6.89E-06	3.15E-06	1.42E-03	1.53E-03	2.17E-03	1.31E-01	1.33E-01
Baseline	RES	Toddler	Benzo(a)pyrene	1.15E-04	4.98E-05	9.06E-09	1.84E-03	1.75E-04	7.39E-05	1.37E-04	3.66E-07	9.12E-05	7.09E-04	2.97E-07	2.06E-06	8.92E-05	9.26E-06	5.56E-06	0.00E+00	3.30E-03	2.15E-03	1.41E-01	1.43E-01
Future	RES	Adolescent	Benzo(a)pyrene	2.28E-05	6.58E-05	1.35E-08	2.62E-03	5.27E-04	1.76E-04	2.35E-04	8.71E-07	1.45E-04	1.15E-03	4.71E-07	3.27E-06	1.77E-04	1.37E-05	1.23E-05	0.00E+00	5.14E-03	7.87E-04	6.08E-02	6.16E-02
Future	RES	Adult	Benzo(a)pyrene	2.28E-05	9.87E-05	1.44E-08	2.99E-03	6.38E-04	1.76E-04	1.94E-04	8.71E-07	1.45E-04	1.77E-03	7.41E-07	5.02E-06	2.02E-04	1.52E-05	1.40E-05	0.00E+00	6.27E-03	9.97E-04	6.24E-02	6.34E-02
Future	RES	Child	Benzo(a)pyrene	2.28E-05	5.26E-05	1.26E-08	2.14E-03	3.05E-04	5.86E-05	1.66E-04	2.90E-07	1.19E-04	8.22E-04	3.37E-07	2.33E-06	1.16E-04	1.01E-05	7.77E-06	0.00E+00	3.82E-03	1.14E-03	8.18E-02	8.29E-02
Future	RES	Infant	Benzo(a)pyrene	2.28E-05	1.97E-05	1.90E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.13E-05	5.47E-06	2.49E-06	1.12E-03	1.22E-03	1.72E-03	1.04E-01	1.06E-01
Future	RES	Toddler	Benzo(a)pyrene	9.11E-05	3.95E-05	7.19E-09	1.46E-03	1.39E-04	5.86E-05	1.09E-04	2.90E-07	7.24E-05	5.62E-04	2.36E-07	1.63E-06	7.07E-05	7.35E-06	4.41E-06	0.00E+00	2.62E-03	1.71E-03	1.12E-01	1.13E-01
PDC	RES	Adolescent	Benzo(a)pyrene	5.15E-05	1.49E-04	3.05E-08	5.91E-03	1.19E-03	3.97E-04	5.31E-04	1.97E-06	3.27E-04	2.60E-03	1.07E-06	7.39E-06	4.00E-04	3.09E-05	2.78E-05	0.00E+00	1.16E-02	1.78E-03	1.37E-01	1.39E-01
PDC	RES	Adult	Benzo(a)pyrene	5.15E-05	2.23E-04	3.25E-08	6.75E-03	1.44E-03	3.97E-04	4.39E-04	1.97E-06	3.27E-04	4.01E-03	1.67E-06	1.13E-05	4.56E-04	3.44E-05	3.18E-05	0.00E+00	1.42E-02	2.25E-03	1.41E-01	1.43E-01
PDC	RES	Child	Benzo(a)pyrene	5.15E-05	1.19E-04	2.84E-08	4.83E-03	6.90E-04	1.32E-04	3.76E-04	6.57E-07	2.70E-04	1.86E-03	7.61E-07	5.28E-06	2.63E-04	2.28E-05	1.76E-05	0.00E+00	8.64E-03	2.58E-03	1.85E-01	1.88E-01
PDC	RES	Infant	Benzo(a)pyrene	5.15E-05	4.46E-05	4.31E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.33E-05	1.24E-05	5.64E-06	2.54E-03	2.75E-03	3.89E-03	2.35E-01	2.39E-01
PDC	RES	Toddler	Benzo(a)pyrene	2.06E-04	8.92E-05	1.62E-08	3.30E-03	3.13E-04	1.32E-04	2.45E-04	6.57E-07	1.64E-04	1.27E-03	5.33E-07	3.69E-06	1.60E-04	1.66E-05	9.97E-06	0.00E+00	5.92E-03	3.86E-03	2.52E-01	2.56E-01
Project	RES	Adolescent	Benzo(a)pyrene	4.57E-08	4.66E-06	2.71E-11	5.24E-06	1.06E-06	3.52E-07	4.70E-07	1.75E-09	1.02E-05	8.15E-05	3.34E-08	2.31E-07	1.25E-05	2.74E-08	2.47E-08	0.00E+00	1.16E-04	5.57E-05	1.34E-03	1.39E-03
Project	RES	Adult	Benzo(a)pyrene	4.57E-08	6.98E-06	2.88E-11	5.99E-06	1.28E-06	3.52E-07	3.90E-07	1.75E-09	1.02E-05	1.26E-04	5.24E-08	3.55E-07	1.43E-05	3.05E-08	2.82E-08	0.00E+00	1.66E-04	7.06E-05	1.60E-03	1.67E-03
Project	RES	Child	Benzo(a)pyrene	4.57E-08	3.72E-06	2.52E-11	4.28E-06	6.11E-07	1.17E-07	3.34E-07	5.82E-10	8.45E-06	5.82E-05	2.38E-08	1.65E-07	8.24E-06	2.02E-08	1.56E-08	0.00E+00	8.42E-05	8.09E-05	1.75E-03	1.83E-03
Project	RES	Infant	Benzo(a)pyrene	4.57E-08	1.40E-06	3.82E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.92E-06	1.10E-08	5.00E-09	2.97E-05	3.40E-05	1.22E-04	2.84E-03	2.97E-03
Project	RES	Toddler	Benzo(a)pyrene	1.83E-07	2.79E-06	1.44E-11	2.93E-06	2.78E-07	1.17E-07	2.18E-07	5.82E-10	5.12E-06	3.98E-05	1.67E-08	1.16E-07	5.01E-06	1.47E-08	8.84E-09	0.00E+00	5.66E-05	1.21E-04	2.33E-03	2.45E-03
Application	RES	Adolescent	Benzo(b)fluoranthene	2.89E-06	1.31E-04	1.71E-09	9.43E-04	1.49E-04	2.38E-05	5.65E-04	1.76E-07	2.87E-04	1.16E-03	4.28E-07	3.02E-06	2.07E-04	1.73E-06	1.56E-06	0.00E+00	3.47E-03	1.56E-03	4.00E-02	4.16E-02

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																		
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
Application	RES	Adult	Benzo(b)fluoranthene	2.89E-06	1.96E-04	1.82E-09	1.08E-03	1.81E-04	2.38E-05	4.68E-04	1.76E-07	2.87E-04	1.78E-03	6.72E-07	4.63E-06	2.35E-04	1.93E-06	1.78E-06	0.00E+00	4.26E-03	1.98E-03	4.11E-02	4.31E-02
Application	RES	Child	Benzo(b)fluoranthene	2.89E-06	1.04E-04	1.59E-09	7.70E-04	8.66E-05	7.93E-06	4.01E-04	5.86E-08	2.37E-04	8.27E-04	3.06E-07	2.16E-06	1.37E-04	1.28E-06	9.85E-07	0.00E+00	2.58E-03	2.27E-03	5.37E-02	5.60E-02
Application	RES	Infant	Benzo(b)fluoranthene	2.89E-06	3.92E-05	2.41E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.82E-05	6.93E-07	3.16E-07	3.41E-04	4.32E-04	3.41E-03	3.43E-02	3.77E-02
Application	RES	Toddler	Benzo(b)fluoranthene	1.15E-05	7.84E-05	9.10E-10	5.26E-04	3.93E-05	7.93E-06	2.61E-04	5.86E-08	1.44E-04	5.66E-04	2.14E-07	1.51E-06	8.32E-05	9.31E-07	5.58E-07	0.00E+00	1.72E-03	3.39E-03	7.11E-02	7.45E-02
Baseline	RES	Adolescent	Benzo(b)fluoranthene	2.89E-06	1.31E-04	1.71E-09	9.43E-04	1.49E-04	2.38E-05	5.65E-04	1.76E-07	2.87E-04	1.16E-03	4.28E-07	3.02E-06	2.07E-04	1.73E-06	1.56E-06	0.00E+00	3.47E-03	1.56E-03	4.00E-02	4.15E-02
Baseline	RES	Adult	Benzo(b)fluoranthene	2.89E-06	1.96E-04	1.82E-09	1.08E-03	1.81E-04	2.38E-05	4.68E-04	1.76E-07	2.87E-04	1.78E-03	6.72E-07	4.63E-06	2.35E-04	1.93E-06	1.78E-06	0.00E+00	4.26E-03	1.98E-03	4.11E-02	4.31E-02
Baseline	RES	Child	Benzo(b)fluoranthene	2.89E-06	1.04E-04	1.59E-09	7.70E-04	8.65E-05	7.93E-06	4.01E-04	5.86E-08	2.37E-04	8.27E-04	3.05E-07	2.15E-06	1.37E-04	1.28E-06	9.85E-07	0.00E+00	2.58E-03	2.27E-03	5.37E-02	5.60E-02
Baseline	RES	Infant	Benzo(b)fluoranthene	2.89E-06	3.92E-05	2.41E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.81E-05	6.93E-07	3.16E-07	3.41E-04	4.32E-04	3.41E-03	3.42E-02	3.77E-02
Baseline	RES	Toddler	Benzo(b)fluoranthene	1.15E-05	7.83E-05	9.10E-10	5.26E-04	3.93E-05	7.93E-06	2.61E-04	5.86E-08	1.44E-04	5.66E-04	2.14E-07	1.51E-06	8.32E-05	9.31E-07	5.58E-07	0.00E+00	1.72E-03	3.39E-03	7.11E-02	7.45E-02
Future	RES	Adolescent	Benzo(b)fluoranthene	2.04E-06	9.22E-05	1.21E-09	6.66E-04	1.06E-04	1.68E-05	3.99E-04	1.24E-07	2.03E-04	8.17E-04	3.02E-07	2.13E-06	1.46E-04	1.22E-06	1.10E-06	0.00E+00	2.45E-03	1.10E-03	2.82E-02	2.93E-02
Future	RES	Adult	Benzo(b)fluoranthene	2.04E-06	1.38E-04	1.29E-09	7.60E-04	1.28E-04	1.68E-05	3.30E-04	1.24E-07	2.03E-04	1.26E-03	4.75E-07	3.27E-06	1.66E-04	1.36E-06	1.26E-06	0.00E+00	3.01E-03	1.40E-03	2.90E-02	3.04E-02
Future	RES	Child	Benzo(b)fluoranthene	2.04E-06	7.38E-05	1.12E-09	5.44E-04	6.11E-05	5.60E-06	2.83E-04	4.14E-08	1.67E-04	5.84E-04	2.16E-07	1.52E-06	9.64E-05	9.02E-07	6.95E-07	0.00E+00	1.82E-03	1.60E-03	3.79E-02	3.95E-02
Future	RES	Infant	Benzo(b)fluoranthene	2.04E-06	2.77E-05	1.70E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.40E-05	4.89E-07	2.23E-07	2.41E-04	3.05E-04	2.41E-03	2.42E-02	2.66E-02
Future	RES	Toddler	Benzo(b)fluoranthene	8.15E-06	5.53E-05	6.43E-10	3.72E-04	2.78E-05	5.60E-06	1.85E-04	4.14E-08	1.01E-04	3.99E-04	1.51E-07	1.07E-06	5.87E-05	6.57E-07	3.94E-07	0.00E+00	1.21E-03	2.39E-03	5.02E-02	5.26E-02
PDC	RES	Adolescent	Benzo(b)fluoranthene	4.92E-06	2.23E-04	2.92E-09	1.61E-03	2.55E-04	4.06E-05	9.64E-04	3.00E-07	4.90E-04	1.97E-03	7.30E-07	5.15E-06	3.52E-04	2.95E-06	2.66E-06	0.00E+00	5.92E-03	2.67E-03	6.82E-02	7.09E-02
PDC	RES	Adult	Benzo(b)fluoranthene	4.92E-06	3.34E-04	3.11E-09	1.84E-03	3.09E-04	4.06E-05	7.98E-04	3.00E-07	4.90E-04	3.04E-03	1.15E-06	7.90E-06	4.02E-04	3.29E-06	3.04E-06	0.00E+00	7.27E-03	3.38E-03	7.01E-02	7.35E-02
PDC	RES	Child	Benzo(b)fluoranthene	4.92E-06	1.78E-04	2.71E-09	1.31E-03	1.48E-04	1.35E-05	6.84E-04	1.00E-07	4.04E-04	1.41E-03	5.21E-07	3.68E-06	2.33E-04	2.18E-06	1.68E-06	0.00E+00	4.40E-03	3.87E-03	9.16E-02	9.55E-02
PDC	RES	Infant	Benzo(b)fluoranthene	4.92E-06	6.68E-05	4.12E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.21E-05	1.18E-06	5.39E-07	5.82E-04	7.38E-04	5.82E-03	5.84E-02	6.43E-02
PDC	RES	Toddler	Benzo(b)fluoranthene	1.97E-05	1.34E-04	1.55E-09	8.98E-04	6.71E-05	1.35E-05	4.46E-04	1.00E-07	2.45E-04	9.65E-04	3.65E-07	2.57E-06	1.42E-04	1.59E-06	9.53E-07	0.00E+00	2.94E-03	5.79E-03	1.21E-01	1.27E-01
Project	RES	Adolescent	Benzo(b)fluoranthene	2.31E-09	3.71E-06	1.37E-12	7.54E-07	1.20E-07	1.90E-08	4.52E-07	1.41E-10	8.16E-06	3.29E-05	1.22E-08	8.57E-08	5.87E-06	1.39E-09	1.25E-09	0.00E+00	5.21E-05	4.44E-05	5.79E-04	6.23E-04
Project	RES	Adult	Benzo(b)fluoranthene	2.31E-09	5.57E-06	1.46E-12	8.61E-07	1.45E-07	1.90E-08	3.74E-07	1.41E-10	8.16E-06	5.07E-05	1.91E-08	1.32E-07	6.69E-06	1.54E-09	1.42E-09	0.00E+00	7.27E-05	5.62E-05	6.78E-04	7.34E-04
Project	RES	Child	Benzo(b)fluoranthene	2.31E-09	2.97E-06	1.27E-12	6.16E-07	6.92E-08	6.35E-09	3.21E-07	4.69E-11	6.73E-06	2.35E-05	8.68E-09	6.12E-08	3.88E-06	1.02E-09	7.88E-10	0.00E+00	3.82E-05	6.44E-05	7.64E-04	8.28E-04
Project	RES	Infant	Benzo(b)fluoranthene	2.31E-09	1.11E-06	1.93E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-06	5.54E-10	2.53E-10	5.81E-06	8.30E-06	9.70E-05	6.26E-04	7.23E-04
Project	RES	Toddler	Benzo(b)fluoranthene	9.24E-09	2.23E-06	7.28E-13	4.21E-07	3.15E-08	6.35E-09	2.09E-07	4.69E-11	4.08E-06	1.61E-05	6.08E-09	4.29E-08	2.36E-06	7.45E-10	4.47E-10	0.00E+00	2.55E-05	9.64E-05	1.01E-03	1.10E-03
Application	RES	Adolescent	Benzo(g,h,i)perylene	3.45E-05	8.51E-05	2.05E-08	5.67E-03	1.04E-03	2.84E-04	3.55E-04	6.79E-07	1.87E-04	3.03E-03	1.26E-06	8.80E-06	3.58E-04	2.07E-05	1.86E-05	0.00E+00	1.11E-02	1.02E-03	1.32E-01	1.33E-01
Application	RES	Adult	Benzo(g,h,i)perylene	3.45E-05	1.28E-04	2.18E-08	6.48E-03	1.26E-03	2.84E-04	2.94E-04	6.79E-07	1.87E-04	4.67E-03	1.97E-06	1.35E-05	4.09E-04	2.30E-05	2.13E-05	0.00E+00	1.38E-02	1.29E-03	1.38E-01	1.39E-01
Application	RES	Child	Benzo(g,h,i)perylene	3.45E-05	6.80E-05	1.90E-08	4.63E-03	6.04E-04	9.46E-05	2.52E-04	2.26E-07	1.54E-04	2.16E-03	8.97E-07	6.29E-06	2.36E-04	1.53E-05	1.18E-05	0.00E+00	8.27E-03	1.48E-03	1.78E-01	1.80E-01
Application	RES	Infant	Benzo(g,h,i)perylene	3.45E-05	2.55E-05	2.88E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.37E-05	8.28E-06	3.78E-06	7.82E-03	7.98E-03	2.22E-03	6.93E-01	6.95E-01
Application	RES	Toddler	Benzo(g,h,i)perylene	1.38E-04	5.10E-05	1.09E-08	3.17E-03	2.75E-04	9.46E-05	1.64E-04	2.26E-07	9.36E-05	1.48E-03	6.28E-07	4.40E-06	1.43E-04	1.11E-05	6.68E-06	0.00E+00	5.63E-03	2.21E-03	2.42E-01	2.44E-01
Baseline	RES	Adolescent	Benzo(g,h,i)perylene	3.45E-05	8.50E-05	2.05E-08	5.67E-03	1.04E-03	2.84E-04	3.55E-04	6.78E-07	1.87E-04	3.03E-03	1.26E-06	8.80E-06	3.58E-04	2.07E-05	1.86E-05	0.00E+00	1.11E-02	1.02E-03	1.32E-01	1.33E-01
Baseline	RES	Adult	Benzo(g,h,i)perylene	3.45E-05	1.28E-04	2.18E-08	6.48E-03	1.26E-03	2.84E-04	2.94E-04	6.78E-07	1.87E-04	4.67E-03	1.97E-06	1.35E-05	4.08E-04	2.30E-05	2.13E-05	0.00E+00	1.38E-02	1.29E-03	1.38E-01	1.39E-01
Baseline	RES	Child	Benzo(g,h,i)perylene	3.45E-05	6.80E-05	1.90E-08	4.63E-03	6.04E-04	9.46E-05	2.52E-04	2.26E-07	1.54E-04	2.16E-03	8.97E-07	6.29E-06	2.36E-04	1.53E-05	1.18E-05	0.00E+00	8.27E-03	1.48E-03	1.78E-01	1.80E-01
Baseline	RES	Infant	Benzo(g,h,i)perylene	3.45E-05	2.55E-05	2.88E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.37E-05	8.28E-06	3.78E-06	7.82E-03	7.97E-03	2.22E-03	6.92E-01	6.95E-01
Baseline	RES	Toddler	Benzo(g,h,i)perylene	1.38E-04	5.10E-05	1.09E-08	3.17E-03	2.75E-04	9.46E-05	1.64E-04	2.26E-07	9.35E-05	1.48E-03	6.28E-07	4.40E-06	1.43E-04	1.11E-05	6.68E-06	0.00E+00	5.63E-03	2.21E-03	2.41E-01	2.44E-01
Future	RES	Adolescent	Benzo(g,h,i)perylene	2.70E-05	6.65E-05	1.60E-08	4.44E-03	8.16E-04	2.22E-04	2.78E-04	5.30E-07	1.46E-04	2.37E-03	9.82E-07	6.88E-06	2.80E-04	1.62E-05	1.46E-05	0.00E+00	8.68E-03	7.95E-04	1.03E-01	1.04E-01
Future	RES	Adult	Benzo(g,h,i)perylene	2.70E-05	9.97E-05	1.70E-08	5.06E-03	9.87E-04	2.22E-04	2.30E-04	5.30E-07	1.46E-04	3.65E-03	1.54E-06	1.06E-05	3.19E-04	1.80E-05	1.66E-05	0.00E+00	1.08E-02	1.01E-03	1.08E-01	1.09E-01
Future	RES	Child	Benzo(g,h,i)perylene	2.70E-05	5.32E-05	1.49E-08	3.62E-03	4.72E-04	7.40E-05	1.97E-04	1.77E-07	1.21E-04	1.69E-03	7.01E-07	4.92E-06	1.84E-04	1.19E-05	9.21E-06	0.00E+00	6.47E-03	1.15E-03	1.39E-01	1.40E-01
Future	RES	Infant	Benzo(g,h,i)perylene	2.70E-05	1.99E-05	2.26E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.54E-05	6.47E-06	2.95E-06	6.11E-03	6.23E-03	1.74E-03	5.41E-01	5.43E-01
Future	RES	Toddler	Benzo(g,h,i)perylene	1.08E-04	3.99E-05	8.51E-09	2.48E-03	2.15E-04	7.40E-05	1.29E-04	1.77E-07	7.31E-05	1.16E-03	4.91E-07	3.44E-06	1.12E-04	8.70E-06	5.22E-06	0.00E+00	4.40E-03	1.73E-03	1.89E-01	1.91E-01
PDC	RES	Adolescent	Benzo(g,h,i)perylene	6.15E-05	1.52E-04	3.64E-08	1.01E-02	1.86E-03	5.06E-04	6.33E-04	1.21E-06	3.33E-04	5.39E-03	2.24E-06	1.57E-05	6.38E-04	3.69E-05	3.32E-05	0.00E+00	1.98E-02	1.81E-03	2.35E-01	2.37E-01
PDC	RES	Adult	Benzo(g,h,i)perylene	6.15E-05	2.27E-04	3.88E-08	1.15E-02	2.25E-03	5.06E-04	5.24E-04	1.21E-06	3.33E-04	8.31E-03	3.52E-06	2.41E-05	7.28E-04	4.10E-05	3.79E-05	0.00E+00	2.46E-02	2.30E-03	2.46E-01	2.48E-01
PDC	RES	Child	Benzo(g,h,i)perylene	6.15E-05	1.21E-04	3.39E-08	8.26E-03	1.08E-03	1.69E-04	4.49E-04	4.03E-07	2.75E-04	3.85E-03	1.60E-06	1.12E-05	4.20E-04	2.72E-05	2.10E-05	0.00E+00	1.47E-02	2.63E-03	3.17E-01	3.20E-01
PDC	RES	Infant	Benzo(g,h,i)perylene	6.15E-05	4.55E-05	5.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E-04	1.48E-05	6.73E-06	1.39E-02	1.42E-02	3.96E-03	1.23E+00	**1.24E+00**
PDC	RES	Toddler	Benzo(g,h,i)perylene	2.46E-04	9.09E-05	1.94E-08	5.64E-03	4.89E-04	1.69E-04	2.93E-04	4.03E-07	1.67E-04	2.64E-03	1.12E-06	7.84E-06	2.55E-04	1.98E-05	1.19E-05	0.00E+00	1.00E-02	3.94E-03	4.30E-01	4.34E-01
Project	RES	Adolescent	Benzo(g,h,i)perylene	5.94E-08	4.88E-06	3.52E-11	9.76E-06	1.80E-06	4.89E-07	6.12E-07	1.17E-09	1.07E-05	1.74E-04	7.20E-08	5.05E-07	2.06E-05	3.56E-08	3.21E-08	0.00E+00	2.23E-04	5.84E-05	2.61E-03	2.67E-03
Project	RES	Adult	Benzo(g,h,i)perylene	5.94E-08	7.32E-06	3.75E-11	1.11E-05	2.17E-06	4.89E-07	5.07E-07	1.17E-09	1.07E-05	2.68E-04	1.13E-07	7.75E-07	2.34E-05	3.96E-08	3.66E-08	0.00E+00	3.24E-04	7.39E-05	3.20E-03	3.28E-03
Project	RES	Child	Benzo(g,h,i)perylene	5.94E-08	3.90E-06	3.27E-11	7.97E-06	1.04E-06	1.63E-07	4.34E-07	3.89E-10	8.85E-06	1.24E-04	5.14E-08	3.61E-07	1.35E-05	2.63E-08	2.03E-08	0.00E+00	1.60E-04	8.47E-05	3.40E-03	3.48E-03
Project	RES	Infant	Benzo(g,h,i)perylene	5.94E-08	1.46E-06	4.96E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-06	1.43E-08	6.50E-09	1.84E-04	1.90E-04	1.27E-04	1.64E-02	1.66E-02
Project	RES	Toddler	Benzo(g,h,i)perylene	2.38E-07	2.93E-06	1.87E-11	5.45E-06	4.73E-07	1.63E-07	2.83E-07	3.89E-10	5.37E-06	8.49E-05	3.60E-08	2.52E-07	8.19E-06	1.92E-08	1.15E-08	0.00E+00	1.08E-04	1.27E-04	4.56E-03	4.69E-03
Application	RES	Adolescent	Benzo(k)fluoranthene	5.59E-05	4.16E-05	3.31E-08	1.67E-03	3.40E-04	1.16E-04	5.80E-04	2.20E-06	9.16E-05	6.97E-04	3.19E-07	2.09E-06	1.09E-04	3.35E-05	3.02E-05	0.00E+00	3.77E-03	4.98E-04	4.46E-02	4.51E-02
Application	RES	Adult	Benzo(k)fluoranthene	5.59E-05	6.25E-05	3.53E-08	1.91E-03	4.12E-04	1.16E-04	4.80E-04	2.20E-06	9.16E-05	1.08E-03	5.02E-07	3.21E-06	1.24E-04	3.73E-05	3.45E-05	0.00E+00	4.40E-03	6.31E-04	4.38E-02	4.45E-02
Application	RES	Child	Benzo(k)fluoranthene	5.59E-05	3.33E-05	3.08E-08	1.36E-03	1.97E-04	3.87E-05	4.11E-04	7.32E-07	7.56E-05	4.98E-04	2.28E-07	1.49E-06	7.15E-05	2.47E-05	1.91E-05	0.00E+00	2.79E-03	7.23E-04	5.99E-02	6.06E-02
Application	RES	Infant	Benzo(k)fluoranthene	5.59E-05	1.25E-05	4.67E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-05	1.34E-05	6.12E-06	7.53E-04	8.66E-04	1.09E-03	7.44E-02	7.55E-02
Application	RES	Toddler	Benzo(k)fluoranthene	2.24E-04	2.50E-05	1.76E-08	9.33E-04	8.96E-05	3.87E-05	2.68E-04	7.32E-07	4.58E-05	3.41E-04	1.60E-07	1.04E-06	4.35E-05	1.80E-05	1.08E-05	0.00E+00	2.04E-03	1.08E-03	8.72E-02	8.83E-02
Baseline	RES	Adolescent	Benzo(k)fluoranthene	5.59E-05	4.16E-05	3.31E-08	1.67E-03	3.40E-04	1.16E-04	5.79E-04	2.20E-06	9.16E-05	6.97E-04	3.19E-07	2.09E-06	1.09E-04	3.35E-05	3.02E-05	0.00E+00	3.77E-03	4.98E-04	4.46E-02	4.51E-02
Baseline	RES	Adult	Benzo(k)fluoranthene	5.59E-05	6.24E-05	3.53E-08	1.91E-03	4.12E-04	1.16E-04	4.80E-04	2.20E-06	9.16E-05	1.07E-03	5.02E-07	3.21E-06	1.24E-04	3.73E-05	3.45E-05	0.00E+00	4.40E-03	6.31E-04	4.38E-02	4.45E-02
Baseline	RES	Child	Benzo(k)fluoranthene	5.59E-05	3.33E-05	3.08E-08	1.36E-03	1.97E-04	3.87E-05	4.11E-04	7.32E-07	7.55E-05	4.98E-04	2.28E-07	1.49E-06	7.15E-05	2.47E-05	1.91E-05	0.00E+00	2.79E-03	7.23E-04	5.99E-02	6.06E-02
Baseline	RES	Infant	Benzo(k)fluoranthene	5.59E-05	1.25E-05	4.67E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-05	1.34E-05	6.12E-06	7.53E-04	8.66E-04	1.09E-03	7.44E-02	7.54E-02
Baseline	RES	Toddler	Benzo(k)fluoranthene	2.24E-04	2.50E-05	1.76E-08	9.33E-04	8.95E-05	3.87E-05	2.68E-04	7.32E-07	4.58E-05	3.41E-04	1.60E-07	1.04E-06	4.34E-05	1.80E-05	1.08E-05	0.00E+00	2.04E-03	1.08E-03	8.72E-02	8.82E-02
Future	RES	Adolescent	Benzo(k)fluoranthene	4.33E-05	3.23E-05	2.57E-08	1.30E-03	2.64E-04	8.99E-05	4.49E-04	1.70E-06	7.10E-05	5.41E-04	2.48E-07	1.62E-06	8.42E-05	2.60E-05	2.34E-05	0.00E+00	2.92E-03	3.86E-04	3.46E-02	3.50E-02
Future	RES	Adult	Benzo(k)fluoranthene	4.33E-05	4.84E-05	2.73E-08	1.48E-03	3.19E-04	8.99E-05	3.72E-04	1.70E-06	7.10E-05	8.33E-04	3.89E-07	2.49E-06	9.59E-05	2.89E-05	2.67E-05	0.00E+00	3.41E-03	4.89E-04	3.40E-02	3.45E-02
Future	RES	Child	Benzo(k)fluoranthene	4.33E-05	2.58E-05	2.39E-08	1.06E-03	1.53E-04	3.00E-05	3.19E-04	5.68E-07	5.86E-05	3.86E-04	1.77E-07	1.16E-06	5.54E-05	1.92E-05	1.48E-05	0.00E+00	2.16E-03	5.60E-04	4.64E-02	4.70E-02
Future	RES	Infant	Benzo(k)fluoranthene	4.33E-05	9.68E-06	3.62E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.96E-05	1.04E-05	4.75E-06	5.84E-04	6.72E-04	8.43E-04	5.77E-02	5.85E-02
Future	RES	Toddler	Benzo(k)fluoranthene	1.73E-04	1.94E-05	1.37E-08	7.23E-04	6.94E-05	3.00E-05	2.08E-04	5.68E-07	3.55E-05	2.64E-04	1.24E-07	8.09E-07	3.37E-05	1.40E-05	8.39E-06	0.00E+00	1.58E-03	8.38E-04	6.76E-02	6.84E-02
PDC	RES	Adolescent	Benzo(k)fluoranthene	9.92E-05	7.39E-05	5.88E-08	2.97E-03	6.04E-04	2.06E-04	1.03E-03	3.90E-06	1.63E-04	1.24E-03	5.67E-07	3.71E-06	1.93E-04	5.95E-05	5.36E-05	0.00E+00	6.69E-03	8.84E-04	7.92E-02	8.01E-02
PDC	RES	Adult	Benzo(k)fluoranthene	9.92E-05	1.11E-04	6.26E-08	3.39E-03	7.31E-04	2.06E-04	8.52E-04	3.90E-06	1.63E-04	1.91E-03	8.91E-07	5.69E-06	2.20E-04	6.62E-05	6.12E-05	0.00E+00	7.81E-03	1.12E-03	7.78E-02	7.89E-02
PDC	RES	Child	Benzo(k)fluoranthene	9.92E-05	5.91E-05	5.47E-08	2.42E-03	3.50E-04	6.86E-05	7.30E-04	1.30E-06	1.34E-04	8.84E-04	4.05E-07	2.65E-06	1.27E-04	4.39E-05	3.39E-05	0.00E+00	4.96E-03	1.28E-03	1.06E-01	1.08E-01

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																		
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
PDC	RES	Infant	Benzo(k)fluoranthene	9.92E-05	2.22E-05	8.30E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E-05	2.38E-05	1.09E-05	1.34E-03	1.54E-03	1.93E-03	1.32E-01	1.34E-01
PDC	RES	Toddler	Benzo(k)fluoranthene	3.97E-04	4.43E-05	3.13E-08	1.66E-03	1.59E-04	6.86E-05	4.76E-04	1.30E-06	8.13E-05	6.05E-04	2.83E-07	1.85E-06	7.71E-05	3.20E-05	1.92E-05	0.00E+00	3.62E-03	1.92E-03	1.55E-01	1.57E-01
Project	RES	Adolescent	Benzo(k)fluoranthene	1.36E-07	3.60E-06	8.06E-11	4.06E-06	8.28E-07	2.82E-07	1.41E-06	5.34E-09	7.91E-06	6.02E-05	2.76E-08	1.80E-07	9.38E-06	8.16E-08	7.34E-08	0.00E+00	8.82E-05	4.30E-05	1.01E-03	1.06E-03
Project	RES	Adult	Benzo(k)fluoranthene	1.36E-07	5.39E-06	8.58E-11	4.64E-06	1.00E-06	2.82E-07	1.17E-06	5.34E-09	7.91E-06	9.29E-05	4.33E-08	2.77E-07	1.07E-05	9.08E-08	8.38E-08	0.00E+00	1.25E-04	5.45E-05	1.20E-03	1.26E-03
Project	RES	Child	Benzo(k)fluoranthene	1.36E-07	2.88E-06	7.49E-11	3.32E-06	4.79E-07	9.40E-08	1.00E-06	1.78E-09	6.53E-06	4.30E-05	1.97E-08	1.29E-07	6.18E-06	6.02E-08	4.64E-08	0.00E+00	6.39E-05	6.25E-05	1.32E-03	1.39E-03
Project	RES	Infant	Benzo(k)fluoranthene	1.36E-07	1.08E-06	1.14E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.19E-06	3.26E-08	1.49E-08	2.13E-05	2.48E-05	9.40E-05	2.06E-03	2.16E-03
Project	RES	Toddler	Benzo(k)fluoranthene	5.44E-07	2.16E-06	4.29E-11	2.27E-06	2.18E-07	9.40E-08	6.52E-07	1.78E-09	3.96E-06	2.94E-05	1.38E-08	9.02E-08	3.75E-06	4.39E-08	2.63E-08	0.00E+00	4.33E-05	9.34E-05	1.78E-03	1.87E-03
Application	RES	Adolescent	C9-C18 Aromatics	1.80E-05	5.15E+00	1.07E-08	3.72E-03	6.17E-04	1.20E-04	8.26E-04	2.00E-05	1.13E+01	4.24E-02	1.84E-06	1.22E-05	1.14E+00	1.44E-05	1.30E-05	0.00E+00	1.77E+01	2.16E-03	5.24E-03	7.40E-03
Application	RES	Adult	C9-C18 Aromatics	1.80E-05	7.73E+00	1.14E-08	4.25E-03	7.47E-04	1.20E-04	6.84E-04	2.00E-05	1.13E+01	6.53E-02	2.90E-06	1.87E-05	1.29E+00	1.61E-05	1.48E-05	0.00E+00	2.04E+01	2.73E-03	4.49E-03	7.22E-03
Application	RES	Child	C9-C18 Aromatics	1.80E-05	4.12E+00	9.94E-09	3.04E-03	3.57E-04	4.00E-05	5.86E-04	6.67E-06	9.35E+00	3.03E-02	1.32E-06	8.72E-06	7.90E-01	1.06E-05	8.21E-06	0.00E+00	1.43E+01	3.13E-03	7.73E-03	1.09E-02
Application	RES	Infant	C9-C18 Aromatics	1.80E-05	1.55E+00	1.51E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-01	5.77E-06	2.63E-06	1.08E-02	1.82E+00	4.71E-03	8.22E-04	5.53E-03
Application	RES	Toddler	C9-C18 Aromatics	7.22E-05	3.09E+00	5.69E-09	2.08E-03	1.62E-04	4.00E-05	3.82E-04	6.67E-06	5.67E+00	2.07E-02	9.21E-07	6.10E-06	5.04E-01	7.76E-06	4.66E-06	0.00E+00	9.29E+00	4.68E-03	9.39E-03	1.41E-02
Baseline	RES	Adolescent	C9-C18 Aromatics	1.80E-05	5.15E+00	1.07E-08	3.72E-03	6.17E-04	1.20E-04	8.26E-04	2.00E-05	1.13E+01	4.24E-02	1.84E-06	1.22E-05	1.14E+00	1.44E-05	1.30E-05	0.00E+00	1.77E+01	2.16E-03	5.24E-03	7.40E-03
Baseline	RES	Adult	C9-C18 Aromatics	1.80E-05	7.73E+00	1.14E-08	4.25E-03	7.47E-04	1.20E-04	6.84E-04	2.00E-05	1.13E+01	6.53E-02	2.90E-06	1.87E-05	1.29E+00	1.61E-05	1.48E-05	0.00E+00	2.04E+01	2.73E-03	4.49E-03	7.22E-03
Baseline	RES	Child	C9-C18 Aromatics	1.80E-05	4.12E+00	9.94E-09	3.04E-03	3.57E-04	4.00E-05	5.86E-04	6.67E-06	9.35E+00	3.03E-02	1.32E-06	8.72E-06	7.90E-01	1.06E-05	8.21E-06	0.00E+00	1.43E+01	3.13E-03	7.73E-03	1.09E-02
Baseline	RES	Infant	C9-C18 Aromatics	1.80E-05	1.55E+00	1.51E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-01	5.77E-06	2.63E-06	1.08E-02	1.82E+00	4.71E-03	8.22E-04	5.53E-03
Baseline	RES	Toddler	C9-C18 Aromatics	7.22E-05	3.09E+00	5.69E-09	2.08E-03	1.62E-04	4.00E-05	3.82E-04	6.67E-06	5.67E+00	2.07E-02	9.21E-07	6.10E-06	5.04E-01	7.76E-06	4.66E-06	0.00E+00	9.29E+00	4.68E-03	9.39E-03	1.41E-02
Future	RES	Adolescent	C9-C18 Aromatics	1.90E-05	4.57E+00	1.12E-08	3.91E-03	6.49E-04	1.26E-04	8.69E-04	2.10E-05	1.01E+01	3.76E-02	1.63E-06	1.08E-05	1.01E+00	1.52E-05	1.37E-05	0.00E+00	1.57E+01	1.91E-03	4.65E-03	6.56E-03
Future	RES	Adult	C9-C18 Aromatics	1.90E-05	6.85E+00	1.20E-08	4.47E-03	7.85E-04	1.26E-04	7.20E-04	2.10E-05	1.01E+01	5.80E-02	2.57E-06	1.66E-05	1.15E+00	1.69E-05	1.56E-05	0.00E+00	1.81E+01	2.42E-03	3.98E-03	6.41E-03
Future	RES	Child	C9-C18 Aromatics	1.90E-05	3.66E+00	1.05E-08	3.20E-03	3.76E-04	4.21E-05	6.16E-04	7.01E-06	8.29E+00	2.69E-02	1.17E-06	7.73E-06	7.01E-01	1.12E-05	8.63E-06	0.00E+00	1.27E+01	2.78E-03	6.86E-03	9.64E-03
Future	RES	Infant	C9-C18 Aromatics	1.90E-05	1.37E+00	1.59E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.29E-01	6.07E-06	2.77E-06	9.58E-03	1.61E+00	4.18E-03	7.29E-04	4.91E-03
Future	RES	Toddler	C9-C18 Aromatics	7.59E-05	2.74E+00	5.98E-09	2.19E-03	1.71E-04	4.21E-05	4.02E-04	7.01E-06	5.03E+00	1.84E-02	8.17E-07	5.41E-06	4.47E-01	8.16E-06	4.89E-06	0.00E+00	8.24E+00	4.15E-03	8.32E-03	1.25E-02
PDC	RES	Adolescent	C9-C18 Aromatics	3.70E-05	9.72E+00	2.19E-08	7.64E-03	1.27E-03	2.46E-04	1.70E-03	4.11E-05	2.14E+01	8.00E-02	3.48E-06	2.30E-05	2.15E+00	2.96E-05	2.67E-05	0.00E+00	3.33E+01	4.07E-03	9.89E-03	1.40E-02
PDC	RES	Adult	C9-C18 Aromatics	3.70E-05	1.46E+01	2.34E-08	8.72E-03	1.53E-03	2.46E-04	1.40E-03	4.11E-05	2.14E+01	1.23E-01	5.46E-06	3.54E-05	2.44E+00	3.29E-05	3.04E-05	0.00E+00	3.85E+01	5.16E-03	8.47E-03	1.36E-02
PDC	RES	Child	C9-C18 Aromatics	3.70E-05	7.78E+00	2.04E-08	6.24E-03	7.33E-04	8.21E-05	1.20E-03	1.37E-05	1.76E+01	5.71E-02	2.48E-06	1.64E-05	1.49E+00	2.18E-05	1.68E-05	0.00E+00	2.70E+01	5.91E-03	1.46E-02	2.05E-02
PDC	RES	Infant	C9-C18 Aromatics	3.70E-05	2.92E+00	3.09E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.88E-01	1.18E-05	5.40E-06	2.04E-02	3.42E+00	8.89E-03	1.55E-03	1.04E-02
PDC	RES	Toddler	C9-C18 Aromatics	1.48E-04	5.83E+00	1.17E-08	4.27E-03	3.33E-04	8.21E-05	7.84E-04	1.37E-05	1.07E+01	3.91E-02	1.74E-06	1.15E-05	9.51E-01	1.59E-05	9.55E-06	0.00E+00	1.75E+01	8.84E-03	1.77E-02	2.65E-02
Project	RES	Adolescent	C9-C18 Aromatics	5.70E-10	1.12E-02	3.38E-13	1.18E-07	1.95E-08	3.79E-09	2.61E-08	6.33E-10	2.47E-02	9.23E-05	4.01E-09	2.66E-08	2.48E-03	4.56E-10	4.11E-10	0.00E+00	3.85E-02	4.70E-06	1.14E-05	1.61E-05
Project	RES	Adult	C9-C18 Aromatics	5.70E-10	1.68E-02	3.60E-13	1.34E-07	2.36E-08	3.79E-09	2.16E-08	6.33E-10	2.47E-02	1.42E-04	6.30E-09	4.08E-08	2.82E-03	5.08E-10	4.69E-10	0.00E+00	4.44E-02	5.95E-06	9.77E-06	1.57E-05
Project	RES	Child	C9-C18 Aromatics	5.70E-10	8.97E-03	3.14E-13	9.61E-08	1.13E-08	1.26E-09	1.85E-08	2.11E-10	2.04E-02	6.59E-05	2.87E-09	1.90E-08	1.72E-03	3.36E-10	2.59E-10	0.00E+00	3.11E-02	6.82E-06	1.68E-05	2.36E-05
Project	RES	Infant	C9-C18 Aromatics	5.70E-10	3.36E-03	4.77E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.63E-04	1.82E-10	8.33E-11	2.35E-05	3.95E-03	1.03E-05	1.79E-06	1.20E-05
Project	RES	Toddler	C9-C18 Aromatics	2.28E-09	6.73E-03	1.80E-13	6.57E-08	5.13E-09	1.26E-09	1.21E-08	2.11E-10	1.23E-02	4.51E-05	2.01E-09	1.33E-08	1.10E-03	2.45E-10	1.47E-10	0.00E+00	2.02E-02	1.02E-05	2.04E-05	3.06E-05
Application	RES	Adolescent	Chrysene	9.83E-05	2.51E-04	5.83E-08	3.32E-03	6.92E-04	2.45E-04	1.59E-03	5.76E-06	5.52E-04	1.43E-03	5.72E-07	3.74E-06	5.65E-04	5.90E-05	5.31E-05	0.00E+00	8.87E-03	3.00E-03	1.03E-01	1.06E-01
Application	RES	Adult	Chrysene	9.83E-05	3.76E-04	6.20E-08	3.79E-03	8.37E-04	2.45E-04	1.31E-03	5.76E-06	5.52E-04	2.21E-03	8.99E-07	5.75E-06	6.44E-04	6.56E-05	6.06E-05	0.00E+00	1.02E-02	3.80E-03	9.93E-02	1.03E-01
Application	RES	Child	Chrysene	9.83E-05	2.01E-04	5.42E-08	2.71E-03	4.00E-04	8.18E-05	1.13E-03	1.92E-06	4.55E-04	1.02E-03	4.09E-07	2.67E-06	3.73E-04	4.35E-05	3.35E-05	0.00E+00	6.55E-03	4.35E-03	1.38E-01	1.42E-01
Application	RES	Infant	Chrysene	9.83E-05	7.52E-05	8.22E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-04	2.36E-05	1.08E-05	8.75E-04	1.21E-03	6.55E-03	9.93E-02	1.06E-01
Application	RES	Toddler	Chrysene	3.93E-04	1.50E-04	3.10E-08	1.85E-03	1.82E-04	8.18E-05	7.34E-04	1.92E-06	2.76E-04	7.00E-04	2.86E-07	1.87E-06	2.27E-04	3.17E-05	1.90E-05	0.00E+00	4.65E-03	6.51E-03	1.95E-01	2.01E-01
Baseline	RES	Adolescent	Chrysene	9.83E-05	2.51E-04	5.83E-08	3.32E-03	6.92E-04	2.45E-04	1.59E-03	5.76E-06	5.52E-04	1.43E-03	5.72E-07	3.74E-06	5.65E-04	5.90E-05	5.31E-05	0.00E+00	8.87E-03	3.00E-03	1.03E-01	1.06E-01
Baseline	RES	Adult	Chrysene	9.83E-05	3.76E-04	6.20E-08	3.79E-03	8.37E-04	2.45E-04	1.31E-03	5.76E-06	5.52E-04	2.21E-03	8.99E-07	5.75E-06	6.44E-04	6.56E-05	6.06E-05	0.00E+00	1.02E-02	3.80E-03	9.93E-02	1.03E-01
Baseline	RES	Child	Chrysene	9.83E-05	2.01E-04	5.42E-08	2.71E-03	4.00E-04	8.18E-05	1.13E-03	1.92E-06	4.55E-04	1.02E-03	4.09E-07	2.67E-06	3.73E-04	4.35E-05	3.35E-05	0.00E+00	6.55E-03	4.35E-03	1.38E-01	1.42E-01
Baseline	RES	Infant	Chrysene	9.83E-05	7.52E-05	8.22E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-04	2.36E-05	1.08E-05	8.75E-04	1.21E-03	6.55E-03	9.93E-02	1.06E-01
Baseline	RES	Toddler	Chrysene	3.93E-04	1.50E-04	3.10E-08	1.85E-03	1.82E-04	8.18E-05	7.34E-04	1.92E-06	2.76E-04	7.00E-04	2.86E-07	1.87E-06	2.27E-04	3.17E-05	1.90E-05	0.00E+00	4.65E-03	6.51E-03	1.95E-01	2.01E-01
Future	RES	Adolescent	Chrysene	7.72E-05	1.97E-04	4.58E-08	2.61E-03	5.43E-04	1.93E-04	1.25E-03	4.52E-06	4.33E-04	1.13E-03	4.49E-07	2.94E-06	4.44E-04	4.63E-05	4.17E-05	0.00E+00	6.96E-03	2.36E-03	8.10E-02	8.33E-02
Future	RES	Adult	Chrysene	7.72E-05	2.95E-04	4.87E-08	2.98E-03	6.58E-04	1.93E-04	1.03E-03	4.52E-06	4.33E-04	1.74E-03	7.06E-07	4.51E-06	5.06E-04	5.15E-05	4.76E-05	0.00E+00	8.02E-03	2.98E-03	7.80E-02	8.10E-02
Future	RES	Child	Chrysene	7.72E-05	1.58E-04	4.25E-08	2.13E-03	3.15E-04	6.42E-05	8.84E-04	1.51E-06	3.57E-04	8.04E-04	3.21E-07	2.10E-06	2.93E-04	3.42E-05	2.64E-05	0.00E+00	5.15E-03	3.42E-03	1.08E-01	1.12E-01
Future	RES	Infant	Chrysene	7.72E-05	5.91E-05	6.46E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-04	1.85E-05	8.46E-06	6.87E-04	9.54E-04	5.15E-03	7.80E-02	8.31E-02
Future	RES	Toddler	Chrysene	3.09E-04	1.18E-04	2.44E-08	1.46E-03	1.43E-04	6.42E-05	5.76E-04	1.51E-06	2.17E-04	5.50E-04	2.25E-07	1.47E-06	1.78E-04	2.49E-05	1.49E-05	0.00E+00	3.66E-03	5.12E-03	1.53E-01	1.58E-01
PDC	RES	Adolescent	Chrysene	1.76E-04	4.48E-04	1.04E-07	5.93E-03	1.23E-03	4.38E-04	2.83E-03	1.03E-05	9.85E-04	2.56E-03	1.02E-06	6.68E-06	1.01E-03	1.05E-04	9.48E-05	0.00E+00	1.58E-02	5.36E-03	1.84E-01	1.89E-01
PDC	RES	Adult	Chrysene	1.76E-04	6.71E-04	1.11E-07	6.77E-03	1.49E-03	4.38E-04	2.35E-03	1.03E-05	9.85E-04	3.94E-03	1.61E-06	1.03E-05	1.15E-03	1.17E-04	1.08E-04	0.00E+00	1.82E-02	6.78E-03	1.77E-01	1.84E-01
PDC	RES	Child	Chrysene	1.76E-04	3.58E-04	9.67E-08	4.84E-03	7.15E-04	1.46E-04	2.01E-03	3.43E-06	8.12E-04	1.83E-03	7.30E-07	4.77E-06	6.65E-04	7.77E-05	5.99E-05	0.00E+00	1.17E-02	7.78E-03	2.46E-01	2.54E-01
PDC	RES	Infant	Chrysene	1.76E-04	1.34E-04	1.47E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-04	4.21E-05	1.92E-05	1.56E-03	2.17E-03	1.17E-02	1.77E-01	1.89E-01
PDC	RES	Toddler	Chrysene	7.02E-04	2.69E-04	5.54E-08	3.31E-03	3.25E-04	1.46E-04	1.31E-03	3.43E-06	4.92E-04	1.25E-03	5.11E-07	3.34E-06	4.04E-04	5.66E-05	3.40E-05	0.00E+00	8.31E-03	1.16E-02	3.48E-01	3.60E-01
Project	RES	Adolescent	Chrysene	8.41E-08	7.57E-06	4.99E-11	2.84E-06	5.92E-07	2.10E-07	1.36E-06	4.93E-09	1.67E-05	4.33E-05	1.73E-08	1.13E-07	1.71E-05	5.05E-08	4.54E-08	0.00E+00	8.99E-05	9.06E-05	9.85E-04	1.08E-03
Project	RES	Adult	Chrysene	8.41E-08	1.14E-05	5.31E-11	3.24E-06	7.16E-07	2.10E-07	1.12E-06	4.93E-09	1.67E-05	6.67E-05	2.72E-08	1.74E-07	1.95E-05	5.61E-08	5.19E-08	0.00E+00	1.20E-04	1.15E-04	1.10E-03	1.21E-03
Project	RES	Child	Chrysene	8.41E-08	6.06E-06	4.63E-11	2.32E-06	3.43E-07	7.00E-08	9.63E-07	1.64E-09	1.37E-05	3.09E-05	1.23E-08	8.07E-08	1.13E-05	3.72E-08	2.87E-08	0.00E+00	6.59E-05	1.32E-04	1.30E-03	1.43E-03
Project	RES	Infant	Chrysene	8.41E-08	2.27E-06	7.03E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.98E-06	2.02E-08	9.21E-09	1.03E-05	1.66E-05	1.98E-04	1.25E-03	1.45E-03
Project	RES	Toddler	Chrysene	3.36E-07	4.54E-06	2.65E-11	1.59E-06	1.56E-07	7.00E-08	6.28E-07	1.64E-09	8.33E-06	2.12E-05	8.64E-09	5.65E-08	6.84E-06	2.71E-08	1.63E-08	0.00E+00	4.38E-05	1.97E-04	1.70E-03	1.89E-03
Application	RES	Adolescent	Dibenz(a,h)anthracene	1.16E-05	1.87E-05	6.91E-09	1.03E-03	2.01E-04	6.24E-05	8.03E-05	1.95E-07	4.11E-05	4.65E-04	1.96E-07	1.36E-06	9.19E-05	6.99E-06	6.29E-06	0.00E+00	2.02E-03	2.23E-04	2.39E-02	2.41E-02
Application	RES	Adult	Dibenz(a,h)anthracene	1.16E-05	2.80E-05	7.35E-09	1.18E-03	2.43E-04	6.24E-05	6.65E-05	1.95E-07	4.11E-05	7.16E-04	3.08E-07	2.08E-06	1.05E-04	7.78E-06	7.18E-06	0.00E+00	2.47E-03	2.83E-04	2.47E-02	2.49E-02
Application	RES	Child	Dibenz(a,h)anthracene	1.16E-05	1.49E-05	6.42E-09	8.42E-04	1.16E-04	2.08E-05	5.70E-05	6.51E-08	3.39E-05	3.32E-04	1.40E-07	9.69E-07	6.04E-05	5.16E-06	3.98E-06	0.00E+00	1.50E-03	3.24E-04	3.22E-02	3.25E-02
Application	RES	Infant	Dibenz(a,h)anthracene	1.16E-05	5.60E-06	9.74E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E-05	2.80E-06	1.28E-06	1.84E-03	1.89E-03	4.88E-04	1.64E-01	1.64E-01
Application	RES	Toddler	Dibenz(a,h)anthracene	4.66E-05	1.12E-05	3.67E-09	5.76E-04	5.28E-05	2.08E-05	3.72E-05	6.51E-08	2.05E-05	2.27E-04	9.80E-08	6.78E-07	3.66E-05	3.76E-06	2.25E-06	0.00E+00	1.04E-03	4.85E-04	4.43E-02	4.48E-02
Baseline	RES	Adolescent	Dibenz(a,h)anthracene	1.16E-05	1.86E-05	6.89E-09	1.03E-03	2.00E-04	6.23E-05	8.02E-05	1.95E-07	4.09E-05	4.63E-04	1.95E-07	1.35E-06	9.17E-05	6.97E-06	6.28E-06	0.00E+00	2.01E-03	2.23E-04	2.39E-02	2.41E-02
Baseline	RES	Adult	Dibenz(a,h)anthracene	1.16E-05	2.79E-05	7.33E-09	1.17E-03	2.42E-04	6.23E-05	6.64E-05	1.95E-07	4.09E-05	7.14E-04	3.07E-07	2.08E-06	1.04E-04	7.76E-06	7.17E-06	0.00E+00	2.46E-03	2.82E-04	2.46E-02	2.49E-02
Baseline	RES	Child	Dibenz(a,h)anthracene	1.16E-05	1.49E-05	6.41E-09	8.40E-04	1.16E-04	2.08E-05	5.69E-05	6.50E-08	3.38E-05	3.31E-04	1.40E-07	9.66E-07	6.02E-05	5.14E-06	3.97E-06	0.00E+00	1.50E-03	3.23E-04	3.21E-02	3.25E-02
Baseline	RES	Infant	Dibenz(a,h)anthracene	1.16E-05	5.58E-06	9.72E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-05	2.79E-06	1.27E-06	1.84E-03	1.88E-03	4.86E-04	1.63E-01	1.64E-01
Baseline	RES	Toddler	Dibenz(a,h)anthracene	4.65E-05	1.12E-05	3.67E-09	5.74E-04	5.27E-05	2.08E-05	3.71E-05	6.50E-08	2.05E-05	2.26E-04	9.77E-08	6.76E-07	3.65E-05	3.75E-06	2.25E-06	0.00E+00	1.03E-03	4.83E-04	4.42E-02	4.47E-02

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																		
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
Future	RES	Adolescent	Dibenz(a,h)anthracene	6.41E-07	5.67E-06	3.80E-10	5.68E-05	1.10E-05	3.43E-06	4.42E-06	1.08E-08	1.25E-05	1.41E-04	5.95E-08	4.12E-07	2.79E-05	3.85E-07	3.46E-07	0.00E+00	2.65E-04	6.78E-05	3.10E-03	3.17E-03
Future	RES	Adult	Dibenz(a,h)anthracene	6.41E-07	8.50E-06	4.05E-10	6.48E-05	1.34E-05	3.43E-06	3.66E-06	1.08E-08	1.25E-05	2.18E-04	9.35E-08	6.33E-07	3.18E-05	4.28E-07	3.95E-07	0.00E+00	3.58E-04	8.59E-05	3.53E-03	3.61E-03
Future	RES	Child	Dibenz(a,h)anthracene	6.41E-07	4.54E-06	3.53E-10	4.64E-05	6.40E-06	1.14E-06	3.14E-06	3.58E-09	1.03E-05	1.01E-04	4.25E-08	2.94E-07	1.84E-05	2.84E-07	2.19E-07	0.00E+00	1.92E-04	9.85E-05	4.08E-03	4.18E-03
Future	RES	Infant	Dibenz(a,h)anthracene	6.41E-07	1.70E-06	5.36E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.53E-06	1.54E-07	7.02E-08	2.67E-04	2.76E-04	1.48E-04	2.39E-02	2.41E-02
Future	RES	Toddler	Dibenz(a,h)anthracene	2.57E-06	3.40E-06	2.02E-10	3.17E-05	2.91E-06	1.14E-06	2.05E-06	3.58E-09	6.24E-06	6.90E-05	2.98E-08	2.06E-07	1.11E-05	2.07E-07	1.24E-07	0.00E+00	1.31E-04	1.47E-04	5.51E-03	5.66E-03
PDC	RES	Adolescent	Dibenz(a,h)anthracene	9.84E-06	1.37E-05	5.83E-09	8.71E-04	1.69E-04	5.27E-05	6.78E-05	1.65E-07	3.01E-05	3.41E-04	1.44E-07	9.96E-07	6.75E-05	5.90E-06	5.31E-06	0.00E+00	1.64E-03	1.64E-04	1.94E-02	1.96E-02
PDC	RES	Adult	Dibenz(a,h)anthracene	9.84E-06	2.06E-05	6.20E-09	9.94E-04	2.05E-04	5.27E-05	5.62E-05	1.65E-07	3.01E-05	5.26E-04	2.26E-07	1.53E-06	7.69E-05	6.57E-06	6.06E-06	0.00E+00	1.99E-03	2.08E-04	1.99E-02	2.01E-02
PDC	RES	Child	Dibenz(a,h)anthracene	9.84E-06	1.10E-05	5.42E-09	7.11E-04	9.81E-05	1.76E-05	4.81E-05	5.50E-08	2.49E-05	2.44E-04	1.03E-07	7.11E-07	4.44E-05	4.35E-06	3.36E-06	0.00E+00	1.22E-03	2.38E-04	2.62E-02	2.64E-02
PDC	RES	Infant	Dibenz(a,h)anthracene	9.84E-06	4.11E-06	8.22E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-05	2.36E-06	1.08E-06	1.48E-03	1.52E-03	3.58E-04	1.32E-01	1.32E-01
PDC	RES	Toddler	Dibenz(a,h)anthracene	3.93E-05	8.22E-06	3.10E-09	4.86E-04	4.46E-05	1.76E-05	3.14E-05	5.50E-08	1.51E-05	1.67E-04	7.19E-08	4.98E-07	2.69E-05	3.17E-06	1.90E-06	0.00E+00	8.42E-04	3.56E-04	3.61E-02	3.64E-02
Project	RES	Adolescent	Dibenz(a,h)anthracene	1.35E-07	6.63E-06	8.01E-11	1.20E-05	2.33E-06	7.24E-07	9.32E-07	2.26E-09	1.46E-05	1.65E-04	6.96E-08	4.82E-07	3.27E-05	8.11E-08	7.30E-08	0.00E+00	2.36E-04	7.94E-05	2.74E-03	2.82E-03
Project	RES	Adult	Dibenz(a,h)anthracene	1.35E-07	9.95E-06	8.52E-11	1.37E-05	2.82E-06	7.24E-07	7.72E-07	2.26E-09	1.46E-05	2.54E-04	1.09E-07	7.40E-07	3.72E-05	9.02E-08	8.33E-08	0.00E+00	3.35E-04	1.01E-04	3.29E-03	3.39E-03
Project	RES	Child	Dibenz(a,h)anthracene	1.35E-07	5.31E-06	7.44E-11	9.77E-06	1.35E-06	2.41E-07	6.61E-07	7.55E-10	1.20E-05	1.18E-04	4.97E-08	3.44E-07	2.15E-05	5.98E-08	4.61E-08	0.00E+00	1.69E-04	1.15E-04	3.56E-03	3.68E-03
Project	RES	Infant	Dibenz(a,h)anthracene	1.35E-07	1.99E-06	1.13E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.64E-06	3.24E-08	1.48E-08	2.50E-04	2.60E-04	1.73E-04	2.25E-02	2.27E-02
Project	RES	Toddler	Dibenz(a,h)anthracene	5.40E-07	3.98E-06	4.26E-11	6.68E-06	6.12E-07	2.41E-07	4.31E-07	7.55E-10	7.30E-06	8.07E-05	3.48E-08	2.41E-07	1.30E-05	4.36E-08	2.61E-08	0.00E+00	1.14E-04	1.72E-04	4.76E-03	4.93E-03
Application	RES	Adolescent	Fluoranthene	7.30E-06	4.43E-04	4.33E-09	7.81E-05	1.38E-05	3.32E-06	1.86E-04	1.02E-06	9.75E-04	5.34E-04	3.27E-08	2.07E-07	5.22E-04	4.38E-06	3.94E-06	0.00E+00	2.77E-03	5.30E-03	2.79E-02	3.32E-02
Application	RES	Adult	Fluoranthene	7.30E-06	6.64E-04	4.60E-09	8.91E-05	1.67E-05	3.32E-06	1.54E-04	1.02E-06	9.75E-04	8.23E-04	5.14E-08	3.17E-07	5.94E-04	4.87E-06	4.50E-06	0.00E+00	3.34E-03	6.71E-03	2.70E-02	3.37E-02
Application	RES	Child	Fluoranthene	7.30E-06	3.54E-04	4.02E-09	6.38E-05	7.97E-06	1.11E-06	1.32E-04	3.38E-07	8.04E-04	3.81E-04	2.33E-08	1.48E-07	3.46E-04	3.23E-06	2.49E-06	0.00E+00	2.10E-03	7.69E-03	3.80E-02	4.57E-02
Application	RES	Infant	Fluoranthene	7.30E-06	1.33E-04	6.10E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-04	1.75E-06	7.99E-07	6.41E-05	3.28E-04	1.16E-02	1.70E-02	2.86E-02
Application	RES	Toddler	Fluoranthene	2.92E-05	2.66E-04	2.30E-09	4.36E-05	3.62E-06	1.11E-06	8.62E-05	3.38E-07	4.87E-04	2.61E-04	1.63E-08	1.03E-07	2.11E-04	2.35E-06	1.41E-06	0.00E+00	1.39E-03	1.15E-02	4.88E-02	6.03E-02
Baseline	RES	Adolescent	Fluoranthene	7.30E-06	4.43E-04	4.33E-09	7.81E-05	1.38E-05	3.32E-06	1.86E-04	1.01E-06	9.74E-04	5.34E-04	3.27E-08	2.07E-07	5.22E-04	4.38E-06	3.94E-06	0.00E+00	2.77E-03	5.30E-03	2.79E-02	3.32E-02
Baseline	RES	Adult	Fluoranthene	7.30E-06	6.64E-04	4.60E-09	8.91E-05	1.67E-05	3.32E-06	1.54E-04	1.01E-06	9.74E-04	8.23E-04	5.13E-08	3.17E-07	5.94E-04	4.87E-06	4.50E-06	0.00E+00	3.34E-03	6.71E-03	2.70E-02	3.37E-02
Baseline	RES	Child	Fluoranthene	7.30E-06	3.54E-04	4.02E-09	6.37E-05	7.96E-06	1.11E-06	1.32E-04	3.38E-07	8.04E-04	3.81E-04	2.33E-08	1.48E-07	3.46E-04	3.23E-06	2.49E-06	0.00E+00	2.10E-03	7.69E-03	3.80E-02	4.57E-02
Baseline	RES	Infant	Fluoranthene	7.30E-06	1.33E-04	6.10E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-04	1.75E-06	7.99E-07	6.41E-05	3.28E-04	1.16E-02	1.70E-02	2.86E-02
Baseline	RES	Toddler	Fluoranthene	2.92E-05	2.66E-04	2.30E-09	4.36E-05	3.62E-06	1.11E-06	8.62E-05	3.38E-07	4.87E-04	2.61E-04	1.63E-08	1.03E-07	2.11E-04	2.35E-06	1.41E-06	0.00E+00	1.39E-03	1.15E-02	4.88E-02	6.03E-02
Future	RES	Adolescent	Fluoranthene	5.49E-06	3.33E-04	3.26E-09	5.88E-05	1.04E-05	2.50E-06	1.40E-04	7.64E-07	7.34E-04	4.02E-04	2.46E-08	1.56E-07	3.93E-04	3.30E-06	2.97E-06	0.00E+00	2.09E-03	3.99E-03	2.10E-02	2.50E-02
Future	RES	Adult	Fluoranthene	5.49E-06	5.00E-04	3.47E-09	6.71E-05	1.25E-05	2.50E-06	1.16E-04	7.64E-07	7.34E-04	6.20E-04	3.87E-08	2.39E-07	4.47E-04	3.67E-06	3.39E-06	0.00E+00	2.51E-03	5.05E-03	2.03E-02	2.54E-02
Future	RES	Child	Fluoranthene	5.49E-06	2.67E-04	3.03E-09	4.80E-05	6.00E-06	8.33E-07	9.95E-05	2.55E-07	6.05E-04	2.87E-04	1.76E-08	1.11E-07	2.60E-04	2.43E-06	1.87E-06	0.00E+00	1.58E-03	5.79E-03	2.86E-02	3.44E-02
Future	RES	Infant	Fluoranthene	5.49E-06	1.00E-04	4.59E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.14E-05	1.32E-06	6.02E-07	4.82E-05	2.47E-04	8.71E-03	1.28E-02	2.15E-02
Future	RES	Toddler	Fluoranthene	2.20E-05	2.00E-04	1.73E-09	3.28E-05	2.73E-06	8.33E-07	6.49E-05	2.55E-07	3.67E-04	1.96E-04	1.23E-08	7.78E-08	1.59E-04	1.77E-06	1.06E-06	0.00E+00	1.05E-03	8.66E-03	3.67E-02	4.54E-02
PDC	RES	Adolescent	Fluoranthene	1.28E-05	7.76E-04	7.58E-09	1.37E-04	2.41E-05	5.82E-06	3.27E-04	1.78E-06	1.71E-03	9.36E-04	5.73E-08	3.62E-07	9.14E-04	7.67E-06	6.91E-06	0.00E+00	4.86E-03	9.29E-03	4.88E-02	5.81E-02
PDC	RES	Adult	Fluoranthene	1.28E-05	1.16E-03	8.07E-09	1.56E-04	2.92E-05	5.82E-06	2.71E-04	1.78E-06	1.71E-03	1.44E-03	9.00E-08	5.56E-07	1.04E-03	8.54E-06	7.88E-06	0.00E+00	5.85E-03	1.18E-02	4.73E-02	5.91E-02
PDC	RES	Child	Fluoranthene	1.28E-05	6.21E-04	7.05E-09	1.12E-04	1.40E-05	1.94E-06	2.32E-04	5.93E-07	1.41E-03	6.69E-04	4.09E-08	2.59E-07	6.06E-04	5.66E-06	4.36E-06	0.00E+00	3.69E-03	1.35E-02	6.66E-02	8.01E-02
PDC	RES	Infant	Fluoranthene	1.28E-05	2.33E-04	1.07E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E-04	3.07E-06	1.40E-06	1.12E-04	5.75E-04	2.03E-02	2.98E-02	5.01E-02
PDC	RES	Toddler	Fluoranthene	5.12E-05	4.66E-04	4.03E-09	7.64E-05	6.35E-06	1.94E-06	1.51E-04	5.93E-07	8.54E-04	4.57E-04	2.86E-08	1.81E-07	3.70E-04	4.12E-06	2.47E-06	0.00E+00	2.44E-03	2.02E-02	8.55E-02	1.06E-01
Project	RES	Adolescent	Fluoranthene	7.09E-09	1.52E-05	4.21E-12	7.59E-08	1.34E-08	3.23E-09	1.81E-07	9.87E-10	3.34E-05	1.83E-05	1.12E-09	7.09E-09	1.79E-05	4.26E-09	3.83E-09	0.00E+00	8.51E-05	1.82E-04	8.36E-04	1.02E-03
Project	RES	Adult	Fluoranthene	7.09E-09	2.28E-05	4.47E-12	8.66E-08	1.62E-08	3.23E-09	1.50E-07	9.87E-10	3.34E-05	2.82E-05	1.76E-09	1.09E-08	2.04E-05	4.73E-09	4.37E-09	0.00E+00	1.05E-04	2.30E-04	8.31E-04	1.06E-03
Project	RES	Child	Fluoranthene	7.09E-09	1.21E-05	3.91E-12	6.20E-08	7.74E-09	1.08E-09	1.28E-07	3.29E-10	2.76E-05	1.31E-05	8.00E-10	5.06E-09	1.18E-05	3.14E-09	2.42E-09	0.00E+00	6.48E-05	2.64E-04	1.14E-03	1.41E-03
Project	RES	Infant	Fluoranthene	7.09E-09	4.56E-06	5.93E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.16E-06	1.70E-09	7.77E-10	2.02E-06	1.07E-05	3.97E-04	5.39E-04	9.36E-04
Project	RES	Toddler	Fluoranthene	2.84E-08	9.11E-06	2.24E-12	4.24E-08	3.52E-09	1.08E-09	8.38E-08	3.29E-10	1.67E-05	8.95E-06	5.60E-10	3.54E-09	7.24E-06	2.29E-09	1.37E-09	0.00E+00	4.22E-05	3.94E-04	1.43E-03	1.83E-03
Application	RES	Adolescent	Fluorene	8.00E-04	7.04E-04	4.74E-07	1.07E-01	2.26E-02	8.20E-03	2.59E-01	4.10E-03	1.55E-03	5.41E-04	7.97E-10	4.95E-09	3.01E-04	4.80E-04	4.32E-04	0.00E+00	4.05E-01	2.95E-07	1.69E-04	1.70E-04
Application	RES	Adult	Fluorene	8.00E-04	1.06E-03	5.05E-07	1.22E-01	2.73E-02	8.20E-03	2.14E-01	4.10E-03	1.55E-03	8.34E-04	1.25E-09	7.61E-09	3.42E-04	5.34E-04	4.93E-04	0.00E+00	3.82E-01	3.74E-07	1.35E-04	1.35E-04
Application	RES	Child	Fluorene	8.00E-04	5.63E-04	4.41E-07	8.74E-02	1.31E-02	2.73E-03	1.84E-01	1.37E-03	1.28E-03	3.87E-04	5.69E-10	3.54E-09	2.03E-04	3.54E-04	2.73E-04	0.00E+00	2.92E-01	4.28E-07	2.21E-04	2.22E-04
Application	RES	Infant	Fluorene	8.00E-04	2.11E-04	6.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.93E-05	1.92E-04	8.76E-05	0.00E+00	1.36E-03	6.44E-07	3.50E-06	4.15E-06
Application	RES	Toddler	Fluorene	3.20E-03	4.23E-04	2.52E-07	5.97E-02	5.94E-03	2.73E-03	1.20E-01	1.37E-03	7.75E-04	2.65E-04	3.98E-10	2.48E-09	1.26E-04	2.58E-04	1.55E-04	0.00E+00	1.95E-01	6.40E-07	2.94E-04	2.95E-04
Baseline	RES	Adolescent	Fluorene	8.00E-04	7.04E-04	4.74E-07	1.07E-01	2.26E-02	8.20E-03	2.59E-01	4.10E-03	1.55E-03	5.41E-04	7.97E-10	4.95E-09	3.00E-04	4.80E-04	4.32E-04	0.00E+00	4.05E-01	2.95E-07	1.69E-04	1.70E-04
Baseline	RES	Adult	Fluorene	8.00E-04	1.06E-03	5.05E-07	1.22E-01	2.73E-02	8.20E-03	2.14E-01	4.10E-03	1.55E-03	8.34E-04	1.25E-09	7.60E-09	3.42E-04	5.34E-04	4.93E-04	0.00E+00	3.82E-01	3.73E-07	1.35E-04	1.35E-04
Baseline	RES	Child	Fluorene	8.00E-04	5.63E-04	4.41E-07	8.74E-02	1.31E-02	2.73E-03	1.84E-01	1.37E-03	1.28E-03	3.87E-04	5.69E-10	3.54E-09	2.03E-04	3.54E-04	2.73E-04	0.00E+00	2.92E-01	4.28E-07	2.21E-04	2.22E-04
Baseline	RES	Infant	Fluorene	8.00E-04	2.11E-04	6.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.93E-05	1.92E-04	8.76E-05	0.00E+00	1.36E-03	6.44E-07	3.50E-06	4.15E-06
Baseline	RES	Toddler	Fluorene	3.20E-03	4.22E-04	2.52E-07	5.97E-02	5.94E-03	2.73E-03	1.20E-01	1.37E-03	7.74E-04	2.64E-04	3.98E-10	2.48E-09	1.26E-04	2.58E-04	1.55E-04	0.00E+00	1.95E-01	6.40E-07	2.94E-04	2.95E-04
Future	RES	Adolescent	Fluorene	1.33E-07	4.25E-04	7.91E-11	2.20E-06	4.42E-07	1.47E-07	4.32E-06	6.84E-08	9.35E-04	3.27E-04	4.81E-10	2.99E-09	1.81E-04	8.01E-08	7.21E-08	0.00E+00	1.88E-03	1.78E-07	6.08E-07	7.86E-07
Future	RES	Adult	Fluorene	1.33E-07	6.38E-04	8.42E-11	2.51E-06	5.35E-07	1.47E-07	3.57E-06	6.84E-08	9.35E-04	5.04E-04	7.56E-10	4.59E-09	2.07E-04	8.91E-08	8.23E-08	0.00E+00	2.29E-03	2.26E-07	5.84E-07	8.10E-07
Future	RES	Child	Fluorene	1.33E-07	3.40E-04	7.35E-11	1.79E-06	2.56E-07	4.90E-08	3.06E-06	2.28E-08	7.72E-04	2.33E-04	3.44E-10	2.14E-09	1.23E-04	5.90E-08	4.55E-08	0.00E+00	1.47E-03	2.58E-07	8.61E-07	1.12E-06
Future	RES	Infant	Fluorene	1.33E-07	1.28E-04	1.12E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.18E-05	3.20E-08	1.46E-08	0.00E+00	1.70E-04	3.89E-07	1.28E-07	5.17E-07
Future	RES	Toddler	Fluorene	5.34E-07	2.55E-04	4.21E-11	1.23E-06	1.16E-07	4.90E-08	2.00E-06	2.28E-08	4.68E-04	1.60E-04	2.41E-10	1.50E-09	7.62E-05	4.30E-08	2.58E-08	0.00E+00	9.63E-04	3.87E-07	1.07E-06	1.46E-06
PDC	RES	Adolescent	Fluorene	8.00E-04	1.02E-03	4.74E-07	1.07E-01	2.26E-02	8.20E-03	2.59E-01	4.10E-03	2.24E-03	7.84E-04	1.15E-09	7.17E-09	4.35E-04	4.80E-04	4.32E-04	0.00E+00	4.07E-01	4.27E-07	1.70E-04	1.70E-04
PDC	RES	Adult	Fluorene	8.00E-04	1.53E-03	5.05E-07	1.22E-01	2.73E-02	8.20E-03	2.14E-01	4.10E-03	2.24E-03	1.21E-03	1.81E-09	1.10E-08	4.95E-04	5.34E-04	4.93E-04	0.00E+00	3.83E-01	5.41E-07	1.35E-04	1.36E-04
PDC	RES	Child	Fluorene	8.00E-04	8.16E-04	4.41E-07	8.74E-02	1.31E-02	2.73E-03	1.84E-01	1.37E-03	1.85E-03	5.60E-04	8.24E-10	5.12E-09	2.94E-04	3.54E-04	2.73E-04	0.00E+00	2.93E-01	6.20E-07	2.22E-04	2.23E-04
PDC	RES	Infant	Fluorene	8.00E-04	3.06E-04	6.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-04	1.92E-04	8.76E-05	0.00E+00	1.49E-03	9.33E-07	3.60E-06	4.53E-06
PDC	RES	Toddler	Fluorene	3.20E-03	6.12E-04	2.52E-07	5.97E-02	5.94E-03	2.73E-03	1.20E-01	1.37E-03	1.12E-03	3.83E-04	5.77E-10	3.59E-09	1.83E-04	2.58E-04	1.55E-04	0.00E+00	1.95E-01	9.27E-07	2.95E-04	2.96E-04
Project	RES	Adolescent	Fluorene	1.99E-10	2.24E-05	1.18E-13	3.28E-09	6.59E-10	2.19E-10	6.44E-09	1.02E-10	4.92E-05	1.72E-05	2.53E-11	1.57E-10	9.55E-06	1.19E-10	1.07E-10	0.00E+00	9.84E-05	9.37E-09	3.18E-08	4.12E-08
Project	RES	Adult	Fluorene	1.99E-10	3.36E-05	1.26E-13	3.74E-09	7.98E-10	2.19E-10	5.33E-09	1.02E-10	4.92E-05	2.65E-05	3.98E-11	2.42E-10	1.09E-05	1.33E-10	1.23E-10	0.00E+00	1.20E-04	1.19E-08	3.06E-08	4.25E-08
Project	RES	Child	Fluorene	1.99E-10	1.79E-05	1.10E-13	2.68E-09	3.82E-10	7.31E-11	4.56E-09	3.40E-11	4.06E-05	1.23E-05	1.81E-11	1.12E-10	6.45E-06	8.80E-11	6.79E-11	0.00E+00	7.72E-05	1.36E-08	4.51E-08	5.87E-08
Project	RES	Infant	Fluorene	1.99E-10	6.71E-06	1.66E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.20E-06	4.78E-11	2.18E-11	0.00E+00	8.91E-06	2.05E-08	6.71E-09	2.72E-08
Project	RES	Toddler	Fluorene	7.96E-10	1.34E-05	6.28E-14	1.83E-09	1.73E-10	7.31E-11	2.98E-09	3.40E-11	2.46E-05	8.40E-06	1.27E-11	7.87E-11	4.01E-06	6.42E-11	3.85E-11	0.00E+00	5.05E-05	2.03E-08	5.61E-08	7.65E-08
Application	RES	Adolescent	Formaldehyde	2.55E-09	2.08E-01	1.51E-12	5.90E-04	9.35E-05	1.48E-05	1.32E-04	7.40E-08	2.63E-02	2.05E-04	5.30E-08	3.50E-07	2.83E-03	1.02E-09	9.16E-10	0.00E+00	2.38E-01	2.32E-05	3.37E-06	2.66E-05
Application	RES	Adult	Formaldehyde	2.55E-09	3.12E-01	1.61E-12	6.73E-04	1.13E-04	1.48E-05	1.09E-04	7.40E-08	2.63E-02	3.16E-04	8.33E-08	5.37E-07	3.04E-03	1.13E-09	1.05E-09	0.00E+00	3.43E-01	2.94E-05	2.88E-06	3.23E-05

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																		
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
Application	RES	Child	Formaldehyde	2.55E-09	1.66E-01	1.40E-12	4.82E-04	5.41E-05	4.95E-06	9.38E-05	2.47E-08	2.17E-02	1.46E-04	3.79E-08	2.50E-07	3.64E-03	7.51E-10	5.79E-10	0.00E+00	1.93E-01	3.37E-05	5.30E-06	3.90E-05
Application	RES	Infant	Formaldehyde	2.55E-09	6.24E-02	2.13E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.52E-04	4.07E-10	1.86E-10	1.02E-07	6.28E-02	5.08E-05	2.86E-07	5.10E-05
Application	RES	Toddler	Formaldehyde	1.02E-08	1.25E-01	8.03E-13	3.29E-04	2.46E-05	4.95E-06	6.11E-05	2.47E-08	1.32E-02	1.00E-04	2.65E-08	1.75E-07	3.25E-03	5.47E-10	3.28E-10	0.00E+00	1.42E-01	5.04E-05	6.84E-06	5.73E-05
Baseline	RES	Adolescent	Formaldehyde	2.54E-09	2.08E-01	1.51E-12	5.89E-04	9.33E-05	1.48E-05	1.32E-04	7.39E-08	2.63E-02	2.04E-04	5.30E-08	3.50E-07	2.82E-03	1.02E-09	9.15E-10	0.00E+00	2.38E-01	2.32E-05	3.37E-06	2.66E-05
Baseline	RES	Adult	Formaldehyde	2.54E-09	3.12E-01	1.60E-12	6.72E-04	1.13E-04	1.48E-05	1.09E-04	7.39E-08	2.63E-02	3.15E-04	8.32E-08	5.37E-07	3.03E-03	1.13E-09	1.05E-09	0.00E+00	3.42E-01	2.94E-05	2.88E-06	3.23E-05
Baseline	RES	Child	Formaldehyde	2.54E-09	1.66E-01	1.40E-12	4.81E-04	5.40E-05	4.94E-06	9.36E-05	2.46E-08	2.17E-02	1.46E-04	3.78E-08	2.50E-07	3.63E-03	7.50E-10	5.78E-10	0.00E+00	1.92E-01	3.37E-05	5.29E-06	3.90E-05
Baseline	RES	Infant	Formaldehyde	2.54E-09	6.24E-02	2.13E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-04	4.07E-10	1.86E-10	1.02E-07	6.27E-02	5.07E-05	2.86E-07	5.10E-05
Baseline	RES	Toddler	Formaldehyde	1.02E-08	1.25E-01	8.02E-13	3.29E-04	2.46E-05	4.94E-06	6.11E-05	2.46E-08	1.31E-02	9.99E-05	2.65E-08	1.75E-07	3.24E-03	5.47E-10	3.28E-10	0.00E+00	1.42E-01	5.04E-05	6.83E-06	5.72E-05
Future	RES	Adolescent	Formaldehyde	1.16E-09	2.06E-01	6.88E-13	2.69E-04	4.26E-05	6.76E-06	6.02E-05	3.37E-08	2.60E-02	2.02E-04	5.24E-08	3.46E-07	2.80E-03	4.64E-10	4.18E-10	0.00E+00	2.35E-01	2.30E-05	3.28E-06	2.63E-05
Future	RES	Adult	Formaldehyde	1.16E-09	3.09E-01	7.32E-13	3.07E-04	5.15E-05	6.76E-06	4.99E-05	3.37E-08	2.60E-02	3.12E-04	8.24E-08	5.32E-07	3.01E-03	5.16E-10	4.77E-10	0.00E+00	3.38E-01	2.91E-05	2.81E-06	3.19E-05
Future	RES	Child	Formaldehyde	1.16E-09	1.65E-01	6.39E-13	2.19E-04	2.47E-05	2.25E-06	4.27E-05	1.12E-08	2.15E-02	1.45E-04	3.75E-08	2.47E-07	3.60E-03	3.42E-10	2.64E-10	0.00E+00	1.90E-01	3.34E-05	5.17E-06	3.85E-05
Future	RES	Infant	Formaldehyde	1.16E-09	6.17E-02	9.70E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E-04	1.86E-10	8.47E-11	1.01E-07	6.21E-02	5.02E-05	2.83E-07	5.05E-05
Future	RES	Toddler	Formaldehyde	4.64E-09	1.23E-01	3.66E-13	1.50E-04	1.12E-05	2.25E-06	2.79E-05	1.12E-08	1.30E-02	9.90E-05	2.62E-08	1.73E-07	3.21E-03	2.49E-10	1.50E-10	0.00E+00	1.40E-01	4.99E-05	6.67E-06	5.66E-05
PDC	RES	Adolescent	Formaldehyde	3.37E-09	3.81E-01	2.00E-12	7.81E-04	1.24E-04	1.97E-05	1.75E-04	9.80E-08	4.82E-02	3.75E-04	9.70E-08	6.40E-07	5.17E-03	1.35E-09	1.21E-09	0.00E+00	4.36E-01	4.25E-05	6.12E-06	4.86E-05
PDC	RES	Adult	Formaldehyde	3.37E-09	5.71E-01	2.13E-12	8.92E-04	1.50E-04	1.97E-05	1.45E-04	9.80E-08	4.82E-02	5.77E-04	1.52E-07	9.83E-07	5.56E-03	1.50E-09	1.39E-09	0.00E+00	6.27E-01	5.39E-05	5.23E-06	5.91E-05
PDC	RES	Child	Formaldehyde	3.37E-09	3.05E-01	1.86E-12	6.38E-04	7.17E-05	6.55E-06	1.24E-04	3.27E-08	3.97E-02	2.68E-04	6.93E-08	4.57E-07	6.65E-03	9.95E-10	7.67E-10	0.00E+00	3.52E-01	6.17E-05	9.63E-06	7.14E-05
PDC	RES	Infant	Formaldehyde	3.37E-09	1.14E-01	2.82E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.43E-04	5.40E-10	2.46E-10	1.86E-07	1.15E-01	9.29E-05	5.23E-07	9.34E-05
PDC	RES	Toddler	Formaldehyde	1.35E-08	2.28E-01	1.06E-12	4.36E-04	3.26E-05	6.55E-06	8.10E-05	3.27E-08	2.41E-02	1.83E-04	4.85E-08	3.20E-07	5.94E-03	7.25E-10	4.35E-10	0.00E+00	2.59E-01	9.23E-05	1.24E-05	1.05E-04
Project	RES	Adolescent	Formaldehyde	1.66E-11	6.98E-01	9.83E-15	3.84E-06	6.09E-07	9.67E-08	8.61E-07	4.82E-10	8.82E-02	6.86E-04	1.78E-07	1.17E-06	9.48E-03	6.64E-12	5.97E-12	0.00E+00	7.96E-01	7.79E-05	1.10E-05	8.89E-05
Project	RES	Adult	Formaldehyde	1.66E-11	1.05E+00	1.05E-14	4.39E-06	7.37E-07	9.67E-08	7.13E-07	4.82E-10	8.82E-02	1.06E-03	2.79E-07	1.80E-06	1.02E-02	7.38E-12	6.82E-12	0.00E+00	1.15E+00	9.87E-05	9.38E-06	1.08E-04
Project	RES	Child	Formaldehyde	1.66E-11	5.58E-01	9.14E-15	3.14E-06	3.53E-07	3.22E-08	6.11E-07	1.61E-10	7.28E-02	4.90E-04	1.27E-07	8.38E-07	1.22E-02	4.89E-12	3.77E-12	0.00E+00	6.44E-01	1.13E-04	1.73E-05	1.30E-04
Project	RES	Infant	Formaldehyde	1.66E-11	2.09E-01	1.39E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-03	2.65E-12	1.21E-12	3.41E-07	2.10E-01	1.70E-04	9.59E-07	1.71E-04
Project	RES	Toddler	Formaldehyde	6.64E-11	4.19E-01	5.23E-15	2.15E-06	1.60E-07	3.22E-08	3.98E-07	1.61E-10	4.41E-02	3.35E-04	8.89E-08	5.87E-07	1.09E-02	3.57E-12	2.14E-12	0.00E+00	4.74E-01	1.69E-04	2.24E-05	1.91E-04
Application	RES	Adolescent	Indeno(1,2,3-cd)pyrene	7.54E-06	1.56E-05	4.47E-09	6.37E-04	1.34E-04	4.83E-05	6.80E-05	1.35E-07	3.43E-05	1.77E-04	7.44E-08	5.07E-07	7.30E-05	4.53E-06	4.07E-06	0.00E+00	1.20E-03	1.87E-04	1.42E-02	1.44E-02
Application	RES	Adult	Indeno(1,2,3-cd)pyrene	7.54E-06	2.34E-05	4.76E-09	7.27E-04	1.62E-04	4.83E-05	5.63E-05	1.35E-07	3.43E-05	2.73E-04	1.17E-07	7.78E-07	8.33E-05	5.04E-06	4.65E-06	0.00E+00	1.43E-03	2.36E-04	1.42E-02	1.44E-02
Application	RES	Child	Indeno(1,2,3-cd)pyrene	7.54E-06	1.25E-05	4.16E-09	5.20E-04	7.75E-05	1.61E-05	4.82E-05	4.51E-08	2.83E-05	1.27E-04	5.31E-08	3.62E-07	4.80E-05	3.34E-06	2.57E-06	0.00E+00	8.91E-04	2.71E-04	1.91E-02	1.93E-02
Application	RES	Infant	Indeno(1,2,3-cd)pyrene	7.54E-06	4.68E-06	6.31E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.71E-05	1.81E-06	8.26E-07	9.49E-04	9.81E-04	4.07E-04	8.51E-02	8.55E-02
Application	RES	Toddler	Indeno(1,2,3-cd)pyrene	3.02E-05	9.35E-06	2.38E-09	3.55E-04	3.52E-05	1.61E-05	3.14E-05	4.51E-08	1.71E-05	8.67E-05	3.72E-08	2.53E-07	2.91E-05	2.43E-06	1.46E-06	0.00E+00	6.15E-04	4.05E-04	2.62E-02	2.66E-02
Baseline	RES	Adolescent	Indeno(1,2,3-cd)pyrene	7.53E-06	1.55E-05	4.46E-09	6.35E-04	1.34E-04	4.82E-05	6.78E-05	1.35E-07	3.42E-05	1.77E-04	7.41E-08	5.05E-07	7.28E-05	4.52E-06	4.06E-06	0.00E+00	1.20E-03	1.86E-04	1.42E-02	1.44E-02
Baseline	RES	Adult	Indeno(1,2,3-cd)pyrene	7.53E-06	2.33E-05	4.75E-09	7.25E-04	1.62E-04	4.82E-05	5.61E-05	1.35E-07	3.42E-05	2.72E-04	1.16E-07	7.75E-07	8.30E-05	5.02E-06	4.64E-06	0.00E+00	1.42E-03	2.35E-04	1.41E-02	1.44E-02
Baseline	RES	Child	Indeno(1,2,3-cd)pyrene	7.53E-06	1.24E-05	4.15E-09	5.19E-04	7.73E-05	1.61E-05	4.81E-05	4.49E-08	2.82E-05	1.26E-04	5.29E-08	3.61E-07	4.78E-05	3.33E-06	2.57E-06	0.00E+00	8.89E-04	2.70E-04	1.90E-02	1.93E-02
Baseline	RES	Infant	Indeno(1,2,3-cd)pyrene	7.53E-06	4.66E-06	6.29E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-05	1.81E-06	8.24E-07	9.46E-04	9.78E-04	4.06E-04	8.48E-02	8.52E-02
Baseline	RES	Toddler	Indeno(1,2,3-cd)pyrene	3.01E-05	9.32E-06	2.37E-09	3.55E-04	3.52E-05	1.61E-05	3.13E-05	4.49E-08	1.71E-05	8.64E-05	3.71E-08	2.52E-07	2.90E-05	2.43E-06	1.46E-06	0.00E+00	6.13E-04	4.03E-04	2.61E-02	2.65E-02
Future	RES	Adolescent	Indeno(1,2,3-cd)pyrene	4.96E-07	5.73E-06	2.94E-10	4.18E-05	8.80E-06	3.18E-06	4.47E-06	8.88E-09	1.26E-05	6.52E-05	2.73E-08	1.86E-07	2.68E-05	2.97E-07	2.68E-07	0.00E+00	1.70E-04	6.85E-05	1.96E-03	2.03E-03
Future	RES	Adult	Indeno(1,2,3-cd)pyrene	4.96E-07	8.59E-06	3.13E-10	4.78E-05	1.07E-05	3.18E-06	3.70E-06	8.88E-09	1.26E-05	1.00E-04	4.30E-08	2.86E-07	3.06E-05	3.31E-07	3.06E-07	0.00E+00	2.19E-04	8.68E-05	2.13E-03	2.21E-03
Future	RES	Child	Indeno(1,2,3-cd)pyrene	4.96E-07	4.58E-06	2.73E-10	3.42E-05	5.10E-06	1.06E-06	3.17E-06	2.96E-09	1.04E-05	4.65E-05	1.95E-08	1.33E-07	1.76E-05	2.19E-07	1.69E-07	0.00E+00	1.24E-04	9.95E-05	2.59E-03	2.69E-03
Future	RES	Infant	Indeno(1,2,3-cd)pyrene	4.96E-07	1.72E-06	4.14E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.27E-06	1.19E-07	5.43E-08	1.46E-04	1.54E-04	1.50E-04	1.33E-02	1.34E-02
Future	RES	Toddler	Indeno(1,2,3-cd)pyrene	1.98E-06	3.44E-06	1.56E-10	2.34E-05	2.32E-06	1.06E-06	2.07E-06	2.96E-09	6.30E-06	3.18E-05	1.37E-08	9.31E-08	1.07E-05	1.60E-07	9.59E-08	0.00E+00	8.34E-05	1.49E-04	3.46E-03	3.61E-03
PDC	RES	Adolescent	Indeno(1,2,3-cd)pyrene	6.40E-06	1.16E-05	3.80E-09	5.40E-04	1.14E-04	4.10E-05	5.77E-05	1.15E-07	2.55E-05	1.32E-04	5.54E-08	3.77E-07	5.44E-05	3.84E-06	3.46E-06	0.00E+00	9.91E-04	1.39E-04	1.17E-02	1.19E-02
PDC	RES	Adult	Indeno(1,2,3-cd)pyrene	6.40E-06	1.74E-05	4.04E-09	6.17E-04	1.38E-04	4.10E-05	4.78E-05	1.15E-07	2.55E-05	2.04E-04	8.71E-08	5.79E-07	6.20E-05	4.27E-06	3.95E-06	0.00E+00	1.17E-03	1.76E-04	1.16E-02	1.18E-02
PDC	RES	Child	Indeno(1,2,3-cd)pyrene	6.40E-06	9.28E-06	3.53E-09	4.41E-04	6.58E-05	1.37E-05	4.09E-05	3.82E-08	2.11E-05	9.43E-05	3.96E-08	2.69E-07	3.57E-05	2.83E-06	2.19E-06	0.00E+00	7.34E-04	2.02E-04	1.57E-02	1.59E-02
PDC	RES	Infant	Indeno(1,2,3-cd)pyrene	6.40E-06	3.48E-06	5.35E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E-05	1.54E-06	7.01E-07	7.77E-04	8.02E-04	3.03E-04	6.95E-02	6.98E-02
PDC	RES	Toddler	Indeno(1,2,3-cd)pyrene	2.56E-05	6.96E-06	2.02E-09	3.02E-04	2.99E-05	1.37E-05	2.67E-05	3.82E-08	1.28E-05	6.45E-05	2.77E-08	1.89E-07	2.17E-05	2.07E-06	1.24E-06	0.00E+00	5.07E-04	3.01E-04	2.17E-02	2.20E-02
Project	RES	Adolescent	Indeno(1,2,3-cd)pyrene	1.07E-07	6.83E-06	6.32E-11	9.00E-06	1.89E-06	6.83E-07	9.60E-07	1.91E-09	1.50E-05	7.77E-05	3.26E-08	2.22E-07	3.20E-05	6.40E-08	5.76E-08	0.00E+00	1.45E-04	8.17E-05	1.65E-03	1.73E-03
Project	RES	Adult	Indeno(1,2,3-cd)pyrene	1.07E-07	1.02E-05	6.73E-11	1.03E-05	2.29E-06	6.83E-07	7.95E-07	1.91E-09	1.50E-05	1.20E-04	5.12E-08	3.41E-07	3.65E-05	7.12E-08	6.57E-08	0.00E+00	1.96E-04	1.03E-04	1.88E-03	1.98E-03
Project	RES	Child	Indeno(1,2,3-cd)pyrene	1.07E-07	5.46E-06	5.88E-11	7.35E-06	1.10E-06	2.28E-07	6.81E-07	6.37E-10	1.24E-05	5.55E-05	2.33E-08	1.58E-07	2.10E-05	4.72E-08	3.64E-08	0.00E+00	1.04E-04	1.19E-04	2.14E-03	2.26E-03
Project	RES	Infant	Indeno(1,2,3-cd)pyrene	1.07E-07	2.05E-06	8.91E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.47E-06	2.56E-08	1.17E-08	1.31E-04	1.40E-04	1.78E-04	1.20E-02	1.22E-02
Project	RES	Toddler	Indeno(1,2,3-cd)pyrene	4.27E-07	4.10E-06	3.36E-11	5.02E-06	4.98E-07	2.28E-07	4.44E-07	6.37E-10	7.51E-06	3.80E-05	1.63E-08	1.11E-07	1.27E-05	3.44E-08	2.06E-08	0.00E+00	6.91E-05	1.77E-04	2.81E-03	2.99E-03
Application	RES	Adolescent	Phenanthrene	2.20E-03	1.82E-03	1.31E-06	2.03E-01	1.14E-01	2.21E-01	6.86E-01	2.07E-02	4.01E-03	1.63E-03	1.14E-08	7.14E-08	1.02E-03	1.32E-03	1.19E-03	0.00E+00	1.26E+00	2.18E-02	1.50E+01	**1.50E+01**
Application	RES	Adult	Phenanthrene	2.20E-03	2.73E-03	1.39E-06	2.31E-01	1.38E-01	2.21E-01	5.68E-01	2.07E-02	4.01E-03	2.51E-03	1.80E-08	1.10E-07	1.16E-03	1.47E-03	1.36E-03	0.00E+00	1.19E+00	2.76E-02	1.20E+01	**1.21E+01**
Application	RES	Child	Phenanthrene	2.20E-03	1.46E-03	1.21E-06	1.66E-01	6.60E-02	7.36E-02	4.86E-01	6.90E-03	3.31E-03	1.16E-03	8.18E-09	5.10E-08	6.82E-04	9.75E-04	7.52E-04	0.00E+00	8.09E-01	3.17E-02	1.75E+01	**1.76E+01**
Application	RES	Infant	Phenanthrene	2.20E-03	5.47E-04	1.84E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-04	5.29E-04	2.41E-04	4.57E-03	8.33E-03	4.76E-02	6.78E-01	7.26E-01
Application	RES	Toddler	Phenanthrene	8.81E-03	1.09E-03	6.95E-07	1.13E-01	3.00E-02	7.36E-02	3.17E-01	6.90E-03	2.01E-03	7.95E-04	5.72E-09	3.57E-08	4.21E-04	7.11E-04	4.26E-04	0.00E+00	5.55E-01	4.73E-02	2.40E+01	**2.40E+01**
Baseline	RES	Adolescent	Phenanthrene	2.20E-03	1.82E-03	1.31E-06	2.03E-01	1.14E-01	2.21E-01	6.86E-01	2.07E-02	4.01E-03	1.63E-03	1.14E-08	7.14E-08	1.02E-03	1.32E-03	1.19E-03	0.00E+00	1.26E+00	2.18E-02	1.50E+01	**1.50E+01**
Baseline	RES	Adult	Phenanthrene	2.20E-03	2.73E-03	1.39E-06	2.31E-01	1.38E-01	2.21E-01	5.68E-01	2.07E-02	4.01E-03	2.51E-03	1.80E-08	1.10E-07	1.16E-03	1.47E-03	1.36E-03	0.00E+00	1.19E+00	2.76E-02	1.20E+01	**1.21E+01**
Baseline	RES	Child	Phenanthrene	2.20E-03	1.46E-03	1.21E-06	1.66E-01	6.60E-02	7.36E-02	4.86E-01	6.90E-03	3.31E-03	1.16E-03	8.18E-09	5.10E-08	6.81E-04	9.75E-04	7.52E-04	0.00E+00	8.09E-01	3.17E-02	1.75E+01	**1.76E+01**
Baseline	RES	Infant	Phenanthrene	2.20E-03	5.47E-04	1.84E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-04	5.29E-04	2.41E-04	4.57E-03	8.33E-03	4.76E-02	6.78E-01	7.26E-01
Baseline	RES	Toddler	Phenanthrene	8.81E-03	1.09E-03	6.95E-07	1.13E-01	3.00E-02	7.36E-02	3.17E-01	6.90E-03	2.00E-03	7.94E-04	5.72E-09	3.57E-08	4.21E-04	7.11E-04	4.26E-04	0.00E+00	5.55E-01	4.73E-02	2.40E+01	**2.40E+01**
Future	RES	Adolescent	Phenanthrene	2.47E-06	1.36E-03	1.46E-09	2.87E-05	1.37E-05	2.49E-05	7.70E-05	2.32E-06	2.98E-03	1.21E-03	8.51E-09	5.31E-08	7.55E-04	1.48E-06	1.33E-06	0.00E+00	6.45E-03	1.62E-02	6.10E-02	7.72E-02
Future	RES	Adult	Phenanthrene	2.47E-06	2.03E-03	1.56E-09	3.28E-05	1.66E-05	2.49E-05	6.37E-05	2.32E-06	2.98E-03	1.86E-03	1.34E-08	8.15E-08	8.60E-04	1.65E-06	1.52E-06	0.00E+00	7.88E-03	2.05E-02	5.91E-02	7.96E-02
Future	RES	Child	Phenanthrene	2.47E-06	1.08E-03	1.36E-09	2.34E-05	7.95E-06	8.31E-06	5.46E-05	7.75E-07	2.46E-03	8.63E-04	6.08E-09	3.79E-08	5.07E-04	1.09E-06	8.43E-07	0.00E+00	5.01E-03	2.35E-02	8.53E-02	1.09E-01
Future	RES	Infant	Phenanthrene	2.47E-06	4.07E-04	2.06E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-04	5.93E-07	2.70E-07	3.02E-05	6.15E-04	3.54E-02	1.81E-02	5.36E-02
Future	RES	Toddler	Phenanthrene	9.88E-06	8.13E-04	7.79E-10	1.60E-05	3.62E-06	8.31E-06	3.56E-05	7.75E-07	1.49E-03	5.91E-04	4.26E-09	2.65E-08	3.13E-04	7.97E-07	4.78E-07	0.00E+00	3.28E-03	3.52E-02	1.07E-01	1.42E-01
PDC	RES	Adolescent	Phenanthrene	2.21E-03	3.18E-03	1.31E-06	2.03E-01	1.14E-01	2.21E-01	6.86E-01	2.07E-02	6.99E-03	2.83E-03	2.00E-08	1.24E-07	1.77E-03	1.32E-03	1.19E-03	0.00E+00	1.26E+00	3.80E-02	1.51E+01	**1.51E+01**
PDC	RES	Adult	Phenanthrene	2.21E-03	4.77E-03	1.39E-06	2.31E-01	1.38E-01	2.21E-01	5.68E-01	2.07E-02	6.99E-03	4.37E-03	3.14E-08	1.91E-07	2.02E-03	1.47E-03	1.36E-03	0.00E+00	1.20E+00	4.82E-02	1.21E+01	**1.21E+01**
PDC	RES	Child	Phenanthrene	2.21E-03	2.54E-03	1.22E-06	1.66E-01	6.60E-02	7.36E-02	4.86E-01	6.90E-03	5.77E-03	2.02E-03	1.43E-08	8.89E-08	1.19E-03	9.76E-04	7.53E-04	0.00E+00	8.14E-01	5.52E-02	1.76E+01	**1.77E+01**
PDC	RES	Infant	Phenanthrene	2.21E-03	9.53E-04	1.84E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.10E-04	5.29E-04	2.42E-04	4.60E-03	8.94E-03	8.30E-02	6.96E-01	7.79E-01

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																		
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
PDC	RES	Toddler	Phenanthrene	8.82E-03	1.91E-03	6.96E-07	1.13E-01	3.00E-02	7.36E-02	3.17E-01	6.90E-03	3.50E-03	1.39E-03	9.98E-09	6.22E-08	7.34E-04	7.11E-04	4.27E-04	0.00E+00	5.58E-01	8.25E-02	2.41E+01	**2.42E+01**
Project	RES	Adolescent	Phenanthrene	5.95E-09	1.15E-04	3.53E-12	6.92E-08	3.31E-08	6.01E-08	1.85E-07	5.60E-09	2.53E-04	1.03E-04	7.23E-10	4.50E-09	6.41E-05	3.57E-09	3.21E-09	0.00E+00	5.35E-04	1.38E-03	5.03E-03	6.40E-03
Project	RES	Adult	Phenanthrene	5.95E-09	1.73E-04	3.76E-12	7.90E-08	4.01E-08	6.01E-08	1.54E-07	5.60E-09	2.53E-04	1.58E-04	1.14E-09	6.92E-09	7.30E-05	3.97E-09	3.67E-09	0.00E+00	6.57E-04	1.74E-03	4.90E-03	6.64E-03
Project	RES	Child	Phenanthrene	5.95E-09	9.20E-05	3.28E-12	5.65E-08	1.92E-08	2.00E-08	1.32E-07	1.87E-09	2.09E-04	7.33E-05	5.16E-10	3.22E-09	4.30E-05	2.63E-09	2.03E-09	0.00E+00	4.17E-04	2.00E-03	7.06E-03	9.06E-03
Project	RES	Infant	Phenanthrene	5.95E-09	3.45E-05	4.98E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.48E-05	1.43E-09	6.52E-10	2.52E-06	5.19E-05	3.01E-03	1.51E-03	4.52E-03
Project	RES	Toddler	Phenanthrene	2.38E-08	6.90E-05	1.88E-12	3.86E-08	8.72E-09	2.00E-08	8.58E-08	1.87E-09	1.27E-04	5.02E-05	3.61E-10	2.25E-09	2.66E-05	1.92E-09	1.15E-09	0.00E+00	2.73E-04	2.99E-03	8.81E-03	1.18E-02
Application	RES	Adolescent	Pyrene	9.47E-06	5.21E-04	5.62E-09	7.26E-05	1.41E-05	4.39E-06	2.34E-04	1.91E-06	1.15E-03	5.59E-04	2.11E-08	1.19E-07	4.02E-04	5.68E-06	5.12E-06	0.00E+00	2.97E-03	2.91E-07	1.37E-06	1.66E-06
Application	RES	Adult	Pyrene	9.47E-06	7.81E-04	5.98E-09	8.29E-05	1.71E-05	4.39E-06	1.94E-04	1.91E-06	1.15E-03	8.62E-04	3.32E-08	1.83E-07	4.58E-04	6.32E-06	5.84E-06	0.00E+00	3.57E-03	3.68E-07	1.31E-06	1.68E-06
Application	RES	Child	Pyrene	9.47E-06	4.17E-04	5.22E-09	5.93E-05	8.18E-06	1.46E-06	1.66E-04	6.38E-07	9.45E-04	3.99E-04	1.51E-08	8.51E-08	2.68E-04	4.19E-06	3.23E-06	0.00E+00	2.28E-03	4.22E-07	1.89E-06	2.31E-06
Application	RES	Infant	Pyrene	9.47E-06	1.56E-04	7.92E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.33E-05	2.27E-06	1.04E-06	3.59E-05	2.98E-04	6.35E-07	5.77E-07	1.21E-06
Application	RES	Toddler	Pyrene	3.79E-05	3.13E-04	2.99E-09	4.05E-05	3.72E-06	1.46E-06	1.08E-04	6.38E-07	5.73E-04	2.73E-04	1.06E-08	5.96E-08	1.65E-04	3.05E-06	1.83E-06	0.00E+00	1.52E-03	6.31E-07	2.44E-06	3.07E-06
Baseline	RES	Adolescent	Pyrene	9.47E-06	5.21E-04	5.61E-09	7.26E-05	1.41E-05	4.39E-06	2.34E-04	1.91E-06	1.15E-03	5.59E-04	2.11E-08	1.19E-07	4.02E-04	5.68E-06	5.11E-06	0.00E+00	2.97E-03	2.91E-07	1.37E-06	1.66E-06
Baseline	RES	Adult	Pyrene	9.47E-06	7.81E-04	5.97E-09	8.29E-05	1.71E-05	4.39E-06	1.94E-04	1.91E-06	1.15E-03	8.62E-04	3.32E-08	1.83E-07	4.58E-04	6.32E-06	5.84E-06	0.00E+00	3.57E-03	3.68E-07	1.31E-06	1.68E-06
Baseline	RES	Child	Pyrene	9.47E-06	4.17E-04	5.22E-09	5.93E-05	8.18E-06	1.46E-06	1.66E-04	6.38E-07	9.45E-04	3.99E-04	1.51E-08	8.51E-08	2.68E-04	4.19E-06	3.23E-06	0.00E+00	2.28E-03	4.22E-07	1.89E-06	2.31E-06
Baseline	RES	Infant	Pyrene	9.47E-06	1.56E-04	7.92E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.33E-05	2.27E-06	1.04E-06	3.59E-05	2.98E-04	6.35E-07	5.77E-07	1.21E-06
Baseline	RES	Toddler	Pyrene	3.79E-05	3.13E-04	2.99E-09	4.05E-05	3.72E-06	1.46E-06	1.08E-04	6.38E-07	5.73E-04	2.73E-04	1.06E-08	5.96E-08	1.65E-04	3.05E-06	1.83E-06	0.00E+00	1.52E-03	6.31E-07	2.44E-06	3.07E-06
Future	RES	Adolescent	Pyrene	7.26E-06	3.99E-04	4.30E-09	5.56E-05	1.08E-05	3.37E-06	1.79E-04	1.47E-06	8.78E-04	4.28E-04	1.62E-08	9.13E-08	3.08E-04	4.35E-06	3.92E-06	0.00E+00	2.28E-03	2.23E-07	1.05E-06	1.27E-06
Future	RES	Adult	Pyrene	7.26E-06	5.99E-04	4.58E-09	6.35E-05	1.31E-05	3.37E-06	1.48E-04	1.47E-06	8.78E-04	6.60E-04	2.54E-08	1.40E-07	3.51E-04	4.84E-06	4.47E-06	0.00E+00	2.73E-03	2.82E-07	1.01E-06	1.29E-06
Future	RES	Child	Pyrene	7.26E-06	3.19E-04	4.00E-09	4.54E-05	6.27E-06	1.12E-06	1.27E-04	4.88E-07	7.24E-04	3.06E-04	1.16E-08	6.52E-08	2.05E-04	3.21E-06	2.48E-06	0.00E+00	1.75E-03	3.23E-07	1.45E-06	1.77E-06
Future	RES	Infant	Pyrene	7.26E-06	1.20E-04	6.07E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.15E-05	1.74E-06	7.95E-07	2.75E-05	2.29E-04	4.87E-07	4.42E-07	9.29E-07
Future	RES	Toddler	Pyrene	2.90E-05	2.39E-04	2.29E-09	3.11E-05	2.85E-06	1.12E-06	8.29E-05	4.88E-07	4.39E-04	2.09E-04	8.09E-09	4.56E-08	1.26E-04	2.34E-06	1.40E-06	0.00E+00	1.17E-03	4.84E-07	1.87E-06	2.35E-06
PDC	RES	Adolescent	Pyrene	1.67E-05	9.20E-04	9.92E-09	1.28E-04	2.50E-05	7.76E-06	4.13E-04	3.38E-06	2.02E-03	9.87E-04	3.73E-08	2.10E-07	7.10E-04	1.00E-05	9.03E-06	0.00E+00	5.25E-03	5.14E-07	2.42E-06	2.93E-06
PDC	RES	Adult	Pyrene	1.67E-05	1.38E-03	1.06E-08	1.46E-04	3.02E-05	7.76E-06	3.42E-04	3.38E-06	2.02E-03	1.52E-03	5.86E-08	3.23E-07	8.09E-04	1.12E-05	1.03E-05	0.00E+00	6.30E-03	6.51E-07	2.32E-06	2.97E-06
PDC	RES	Child	Pyrene	1.67E-05	7.36E-04	9.22E-09	1.05E-04	1.44E-05	2.59E-06	2.93E-04	1.13E-06	1.67E-03	7.05E-04	2.66E-08	1.50E-07	4.73E-04	7.40E-06	5.71E-06	0.00E+00	4.03E-03	7.46E-07	3.34E-06	4.08E-06
PDC	RES	Infant	Pyrene	1.67E-05	2.76E-04	1.40E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-04	4.01E-06	1.83E-06	6.35E-05	5.27E-04	1.12E-06	1.02E-06	2.14E-06
PDC	RES	Toddler	Pyrene	6.69E-05	5.52E-04	5.28E-09	7.16E-05	6.57E-06	2.59E-06	1.91E-04	1.13E-06	1.01E-03	4.82E-04	1.86E-08	1.05E-07	2.91E-04	5.40E-06	3.24E-06	0.00E+00	2.69E-03	1.12E-06	4.31E-06	5.43E-06
Project	RES	Adolescent	Pyrene	3.84E-09	7.52E-06	2.27E-12	2.94E-08	5.72E-09	1.78E-09	9.47E-08	7.74E-10	1.66E-05	8.07E-06	3.05E-10	1.72E-09	5.81E-06	2.30E-09	2.07E-09	0.00E+00	3.81E-05	4.20E-09	1.71E-08	2.13E-08
Project	RES	Adult	Pyrene	3.84E-09	1.13E-05	2.42E-12	3.36E-08	6.93E-09	1.78E-09	7.84E-08	7.74E-10	1.66E-05	1.24E-05	4.79E-10	2.64E-09	6.61E-06	2.56E-09	2.36E-09	0.00E+00	4.70E-05	5.32E-09	1.69E-08	2.22E-08
Project	RES	Child	Pyrene	3.84E-09	6.02E-06	2.11E-12	2.40E-08	3.31E-09	5.93E-10	6.72E-08	2.58E-10	1.37E-05	5.77E-06	2.18E-10	1.23E-09	3.87E-06	1.70E-09	1.31E-09	0.00E+00	2.94E-05	6.10E-09	2.37E-08	2.98E-08
Project	RES	Infant	Pyrene	3.84E-09	2.26E-06	3.21E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E-06	9.20E-10	4.20E-10	4.74E-07	4.08E-06	9.18E-09	7.42E-09	1.66E-08
Project	RES	Toddler	Pyrene	1.53E-08	4.51E-06	1.21E-12	1.64E-08	1.51E-09	5.93E-10	4.38E-08	2.58E-10	8.28E-06	3.95E-06	1.53E-10	8.60E-10	2.38E-06	1.24E-09	7.42E-10	0.00E+00	1.92E-05	9.12E-09	2.97E-08	3.88E-08
Application	WORK	Adult	2-methylnaphthalene	4.00E-03	3.69E-03	3.36E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E-03	4.93E-03	0.00E+00	1.83E-02	1.30E-05	5.17E-05	6.47E-05
Baseline	WORK	Adult	2-methylnaphthalene	4.00E-03	3.69E-03	3.36E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E-03	4.93E-03	0.00E+00	1.83E-02	1.30E-05	5.17E-05	6.47E-05
Future	WORK	Adult	2-methylnaphthalene	3.75E-09	2.91E-03	3.15E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.01E-09	4.63E-09	0.00E+00	2.91E-03	1.03E-05	4.84E-11	1.03E-05
PDC	WORK	Adult	2-methylnaphthalene	4.00E-03	6.60E-03	3.36E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E-03	4.93E-03	0.00E+00	2.12E-02	2.33E-05	5.17E-05	7.50E-05
Project	WORK	Adult	2-methylnaphthalene	2.48E-10	1.20E-05	2.08E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.31E-10	3.05E-10	0.00E+00	1.20E-05	4.23E-08	3.20E-12	4.23E-08
Application	WORK	Adult	3-methylcholanthrene	8.67E-07	6.76E-06	7.28E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.71E-07	7.12E-07	0.00E+00	9.18E-06	3.19E-09	1.14E-09	4.33E-09
Baseline	WORK	Adult	3-methylcholanthrene	7.16E-07	6.76E-06	6.01E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.37E-07	5.88E-07	0.00E+00	8.76E-06	3.19E-09	9.44E-10	4.13E-09
Future	WORK	Adult	3-methylcholanthrene	2.09E-07	7.52E-07	1.76E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.86E-07	1.72E-07	0.00E+00	1.34E-06	3.54E-10	2.76E-10	6.30E-10
PDC	WORK	Adult	3-methylcholanthrene	9.25E-07	7.19E-06	7.77E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.23E-07	7.60E-07	0.00E+00	9.77E-06	3.39E-09	1.22E-09	4.61E-09
Project	WORK	Adult	3-methylcholanthrene	3.31E-07	1.18E-06	2.78E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.94E-07	2.72E-07	0.00E+00	2.10E-06	5.56E-10	4.36E-10	9.92E-10
Application	WORK	Adult	7,12-Dimethylbenz(a)anthracene	1.07E-05	6.08E-05	9.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-05	1.15E-05	0.00E+00	9.63E-05	6.14E-04	3.59E-04	9.73E-04
Baseline	WORK	Adult	7,12-Dimethylbenz(a)anthracene	8.89E-06	6.07E-05	7.47E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-05	9.50E-06	0.00E+00	9.02E-05	6.14E-04	2.97E-04	9.11E-04
Future	WORK	Adult	7,12-Dimethylbenz(a)anthracene	2.57E-06	6.68E-06	2.16E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E-06	2.75E-06	0.00E+00	1.52E-05	6.75E-05	8.60E-05	1.53E-04
PDC	WORK	Adult	7,12-Dimethylbenz(a)anthracene	1.15E-05	6.45E-05	9.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.33E-05	1.22E-05	0.00E+00	1.02E-04	6.52E-04	3.83E-04	1.04E-03
Project	WORK	Adult	7,12-Dimethylbenz(a)anthracene	4.07E-06	1.05E-05	3.41E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.70E-06	4.34E-06	0.00E+00	2.39E-05	1.06E-04	1.36E-04	2.42E-04
Application	WORK	Adult	Acenaphthene	1.21E-08	3.43E-04	1.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-08	1.49E-08	0.00E+00	3.43E-04	1.21E-07	1.56E-11	1.21E-07
Baseline	WORK	Adult	Acenaphthene	1.18E-08	3.43E-04	9.91E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-08	1.46E-08	0.00E+00	3.43E-04	1.21E-07	1.52E-11	1.21E-07
Future	WORK	Adult	Acenaphthene	-2.05E-10	2.60E-04	-1.72E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.74E-10	-2.53E-10	0.00E+00	2.60E-04	9.19E-08	-2.65E-13	9.19E-08
PDC	WORK	Adult	Acenaphthene	1.16E-08	6.03E-04	9.74E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-08	1.43E-08	0.00E+00	6.03E-04	2.13E-07	1.50E-11	2.13E-07
Project	WORK	Adult	Acenaphthene	8.58E-10	9.42E-06	7.21E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-09	1.06E-09	0.00E+00	9.42E-06	3.33E-09	1.11E-12	3.33E-09
Application	WORK	Adult	Acenaphthylene	7.49E-08	6.50E-03	6.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-07	9.24E-08	0.00E+00	6.50E-03	2.30E-06	9.67E-11	2.30E-06
Baseline	WORK	Adult	Acenaphthylene	7.46E-08	6.50E-03	6.27E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.96E-08	9.20E-08	0.00E+00	6.50E-03	2.30E-06	9.63E-11	2.30E-06
Future	WORK	Adult	Acenaphthylene	4.69E-09	5.18E-03	3.94E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E-09	5.78E-09	0.00E+00	5.18E-03	1.83E-06	6.05E-12	1.83E-06
PDC	WORK	Adult	Acenaphthylene	7.93E-08	1.17E-02	6.66E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-07	9.78E-08	0.00E+00	1.17E-02	4.13E-06	1.02E-10	4.13E-06
Project	WORK	Adult	Acenaphthylene	8.53E-10	6.64E-06	7.17E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E-09	1.05E-09	0.00E+00	6.64E-06	2.35E-09	1.10E-12	2.35E-09
Application	WORK	Adult	Anthracene	8.94E-08	4.29E-04	7.51E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-07	1.10E-07	0.00E+00	4.29E-04	1.52E-07	1.15E-10	1.52E-07
Baseline	WORK	Adult	Anthracene	8.50E-08	4.29E-04	7.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-07	1.05E-07	0.00E+00	4.29E-04	1.52E-07	1.10E-10	1.52E-07
Future	WORK	Adult	Anthracene	1.74E-08	3.35E-04	1.46E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.32E-08	2.14E-08	0.00E+00	3.35E-04	1.18E-07	2.24E-11	1.18E-07
PDC	WORK	Adult	Anthracene	1.02E-07	7.64E-04	8.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-07	1.26E-07	0.00E+00	7.64E-04	2.70E-07	1.32E-10	2.70E-07
Project	WORK	Adult	Anthracene	1.25E-08	1.15E-05	1.05E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-08	1.54E-08	0.00E+00	1.16E-05	4.08E-09	1.61E-11	4.09E-09
Application	WORK	Adult	Benzo(a)anthracene	4.31E-06	6.16E-04	3.62E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.76E-06	5.32E-06	0.00E+00	6.32E-04	6.23E-03	1.59E-04	6.39E-03
Baseline	WORK	Adult	Benzo(a)anthracene	4.10E-06	6.16E-04	3.45E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.48E-06	5.06E-06	0.00E+00	6.31E-04	6.23E-03	1.51E-04	6.38E-03
Future	WORK	Adult	Benzo(a)anthracene	1.61E-06	4.45E-04	1.35E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-06	1.98E-06	0.00E+00	4.50E-04	4.49E-03	5.93E-05	4.55E-03
PDC	WORK	Adult	Benzo(a)anthracene	5.71E-06	1.06E-03	4.80E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.62E-06	7.04E-06	0.00E+00	1.08E-03	1.07E-02	2.11E-04	1.09E-02
Project	WORK	Adult	Benzo(a)anthracene	4.35E-05	1.75E-04	3.65E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.80E-05	5.36E-05	0.00E+00	3.34E-04	1.77E-03	1.60E-03	3.37E-03
Application	WORK	Adult	Benzo(a)pyrene	5.58E-06	1.24E-04	4.69E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.45E-06	6.88E-06	0.00E+00	1.45E-04	1.26E-03	2.06E-04	1.46E-03

Table D-16 Summary of Predicted Human Exposures for Each Lifestyle Category, Scenario and Chemical

				Estimated Daily Intake																		
				Soil	Surface Water	Dust	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Swim: Derm+Ing	Dermal	Dermal	Breast Milk	Total	RQ	RQ	RQ
				SIR	WIR	AIR	Plant	Berries	Lab_tea	Root	Cattail	Fish	Moose	Ruffed_Grouse	Snowshoe_ Hare	Surface Water	Hands	Other	Breast Milk	EDI	Water	Oral	Total
Scenario	Site	Receptor	Chemical	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	ug/day	Unitless	Unitless	Unitless
Baseline	WORK	Adult	Benzo(a)pyrene	4.92E-06	1.24E-04	4.13E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.56E-06	6.06E-06	0.00E+00	1.42E-04	1.26E-03	1.81E-04	1.44E-03
Future	WORK	Adult	Benzo(a)pyrene	2.04E-06	9.87E-05	1.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-06	2.52E-06	0.00E+00	1.06E-04	9.97E-04	7.54E-05	1.07E-03
PDC	WORK	Adult	Benzo(a)pyrene	6.96E-06	2.23E-04	5.85E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.29E-06	8.58E-06	0.00E+00	2.48E-04	2.25E-03	2.57E-04	2.51E-03
Project	WORK	Adult	Benzo(a)pyrene	1.92E-06	6.98E-06	1.61E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-06	2.37E-06	0.00E+00	1.40E-05	7.06E-05	7.09E-05	1.41E-04
Application	WORK	Adult	Benzo(b)fluoranthene	8.88E-07	1.96E-04	7.46E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-06	1.09E-06	0.00E+00	1.99E-04	1.98E-03	3.28E-05	2.01E-03
Baseline	WORK	Adult	Benzo(b)fluoranthene	8.47E-07	1.96E-04	7.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-06	1.04E-06	0.00E+00	1.99E-04	1.98E-03	3.12E-05	2.01E-03
Future	WORK	Adult	Benzo(b)fluoranthene	1.54E-07	1.38E-04	1.29E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-07	1.89E-07	0.00E+00	1.39E-04	1.40E-03	5.67E-06	1.40E-03
PDC	WORK	Adult	Benzo(b)fluoranthene	1.00E-06	3.34E-04	8.40E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-06	1.23E-06	0.00E+00	3.38E-04	3.38E-03	3.69E-05	3.41E-03
Project	WORK	Adult	Benzo(b)fluoranthene	1.12E-07	5.57E-06	9.42E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-07	1.38E-07	0.00E+00	5.98E-06	5.62E-05	4.14E-06	6.04E-05
Application	WORK	Adult	Benzo(g,h,i)perylene	9.15E-06	1.28E-04	7.68E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-05	1.13E-05	0.00E+00	1.61E-04	1.29E-03	3.38E-04	1.63E-03
Baseline	WORK	Adult	Benzo(g,h,i)perylene	8.42E-06	1.28E-04	7.07E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-05	1.04E-05	0.00E+00	1.58E-04	1.29E-03	3.11E-04	1.60E-03
Future	WORK	Adult	Benzo(g,h,i)perylene	1.95E-06	9.97E-05	1.64E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-06	2.40E-06	0.00E+00	1.07E-04	1.01E-03	7.18E-05	1.08E-03
PDC	WORK	Adult	Benzo(g,h,i)perylene	1.04E-05	2.27E-04	8.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-05	1.28E-05	0.00E+00	2.65E-04	2.30E-03	3.83E-04	2.68E-03
Project	WORK	Adult	Benzo(g,h,i)perylene	2.08E-06	7.32E-06	1.75E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E-06	2.57E-06	0.00E+00	1.49E-05	7.39E-05	7.68E-05	1.51E-04
Application	WORK	Adult	Benzo(k)fluoranthene	1.82E-05	6.25E-05	1.52E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.42E-05	2.24E-05	0.00E+00	1.29E-04	6.31E-04	6.70E-04	1.30E-03
Baseline	WORK	Adult	Benzo(k)fluoranthene	1.57E-05	6.24E-05	1.32E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.10E-05	1.94E-05	0.00E+00	1.20E-04	6.31E-04	5.80E-04	1.21E-03
Future	WORK	Adult	Benzo(k)fluoranthene	5.00E-06	4.84E-05	4.20E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.68E-06	6.17E-06	0.00E+00	6.67E-05	4.89E-04	1.85E-04	6.74E-04
PDC	WORK	Adult	Benzo(k)fluoranthene	2.07E-05	1.11E-04	1.74E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.77E-05	2.55E-05	0.00E+00	1.86E-04	1.12E-03	7.64E-04	1.88E-03
Project	WORK	Adult	Benzo(k)fluoranthene	6.61E-06	5.39E-06	5.55E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.82E-06	8.15E-06	0.00E+00	2.95E-05	5.45E-05	2.44E-04	2.98E-04
Application	WORK	Adult	C9-C18 Aromatics	1.37E-05	7.73E+00	1.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E-05	2.26E-05	0.00E+00	7.73E+00	2.73E-03	2.19E-08	2.73E-03
Baseline	WORK	Adult	C9-C18 Aromatics	1.36E-05	7.73E+00	1.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.43E-05	2.24E-05	0.00E+00	7.73E+00	2.73E-03	2.17E-08	2.73E-03
Future	WORK	Adult	C9-C18 Aromatics	1.89E-05	6.85E+00	1.59E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.37E-05	3.11E-05	0.00E+00	6.85E+00	2.42E-03	3.02E-08	2.42E-03
PDC	WORK	Adult	C9-C18 Aromatics	3.26E-05	1.46E+01	2.73E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.79E-05	5.35E-05	0.00E+00	1.46E+01	5.16E-03	5.19E-08	5.16E-03
Project	WORK	Adult	C9-C18 Aromatics	1.28E-07	1.68E-02	1.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.28E-07	2.11E-07	0.00E+00	1.68E-02	5.95E-06	2.04E-10	5.95E-06
Application	WORK	Adult	Chrysene	1.89E-05	3.76E-04	1.59E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E-05	2.33E-05	0.00E+00	4.45E-04	3.80E-03	6.97E-04	4.50E-03
Baseline	WORK	Adult	Chrysene	1.77E-05	3.76E-04	1.49E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.36E-05	2.18E-05	0.00E+00	4.41E-04	3.80E-03	6.53E-04	4.45E-03
Future	WORK	Adult	Chrysene	4.78E-06	2.95E-04	4.01E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.38E-06	5.89E-06	0.00E+00	3.13E-04	2.98E-03	1.76E-04	3.16E-03
PDC	WORK	Adult	Chrysene	2.25E-05	6.71E-04	1.89E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-05	2.77E-05	0.00E+00	7.54E-04	6.78E-03	8.29E-04	7.61E-03
Project	WORK	Adult	Chrysene	3.49E-06	1.14E-05	2.93E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.66E-06	4.31E-06	0.00E+00	2.41E-05	1.15E-04	1.29E-04	2.44E-04
Application	WORK	Adult	Dibenz(a,h)anthracene	1.27E-05	2.80E-05	1.07E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.69E-05	1.56E-05	0.00E+00	7.43E-05	2.83E-04	4.68E-04	7.51E-04
Baseline	WORK	Adult	Dibenz(a,h)anthracene	1.09E-05	2.79E-05	9.12E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-05	1.34E-05	0.00E+00	6.76E-05	2.82E-04	4.01E-04	6.83E-04
Future	WORK	Adult	Dibenz(a,h)anthracene	8.80E-07	8.50E-06	7.39E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-06	1.09E-06	0.00E+00	1.17E-05	8.59E-05	3.25E-05	1.18E-04
PDC	WORK	Adult	Dibenz(a,h)anthracene	1.17E-05	2.06E-05	9.86E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E-05	1.45E-05	0.00E+00	6.34E-05	2.08E-04	4.33E-04	6.41E-04
Project	WORK	Adult	Dibenz(a,h)anthracene	5.39E-06	9.95E-06	4.53E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.20E-06	6.65E-06	0.00E+00	2.96E-05	1.01E-04	1.99E-04	3.00E-04
Application	WORK	Adult	Fluoranthene	2.96E-06	6.64E-04	2.48E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.95E-06	3.64E-06	0.00E+00	6.75E-04	6.71E-03	1.09E-04	6.82E-03
Baseline	WORK	Adult	Fluoranthene	2.86E-06	6.64E-04	2.40E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.82E-06	3.52E-06	0.00E+00	6.75E-04	6.71E-03	1.05E-04	6.82E-03
Future	WORK	Adult	Fluoranthene	1.85E-07	5.00E-04	1.56E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.47E-07	2.28E-07	0.00E+00	5.01E-04	5.05E-03	6.83E-06	5.06E-03
PDC	WORK	Adult	Fluoranthene	3.04E-06	1.16E-03	2.56E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.06E-06	3.75E-06	0.00E+00	1.18E-03	1.18E-02	1.12E-04	1.19E-02
Project	WORK	Adult	Fluoranthene	2.87E-07	2.28E-05	2.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.83E-07	3.53E-07	0.00E+00	2.38E-05	2.30E-04	1.06E-05	2.41E-04
Application	WORK	Adult	Fluorene	4.00E-03	1.06E-03	3.36E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E-03	4.93E-03	0.00E+00	1.57E-02	3.74E-07	5.17E-06	5.54E-06
Baseline	WORK	Adult	Fluorene	4.00E-03	1.06E-03	3.36E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E-03	4.93E-03	0.00E+00	1.57E-02	3.73E-07	5.17E-06	5.54E-06
Future	WORK	Adult	Fluorene	-1.36E-08	6.38E-04	-1.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.82E-08	-1.68E-08	0.00E+00	6.38E-04	2.26E-07	-1.76E-11	2.26E-07
PDC	WORK	Adult	Fluorene	4.00E-03	1.53E-03	3.36E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E-03	4.93E-03	0.00E+00	1.61E-02	5.41E-07	5.17E-06	5.71E-06
Project	WORK	Adult	Fluorene	7.88E-09	3.36E-05	6.62E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.05E-08	9.72E-09	0.00E+00	3.36E-05	1.19E-08	1.02E-11	1.19E-08
Application	WORK	Adult	Formaldehyde	3.33E-09	3.12E-01	2.80E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E-09	2.74E-09	0.00E+00	3.12E-01	2.94E-05	8.79E-13	2.94E-05
Baseline	WORK	Adult	Formaldehyde	2.85E-09	3.12E-01	2.39E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-09	2.34E-09	0.00E+00	3.12E-01	2.94E-05	7.51E-13	2.94E-05
Future	WORK	Adult	Formaldehyde	1.94E-09	3.09E-01	1.63E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.72E-09	1.59E-09	0.00E+00	3.09E-01	2.91E-05	5.11E-13	2.91E-05
PDC	WORK	Adult	Formaldehyde	4.78E-09	5.71E-01	4.02E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.26E-09	3.93E-09	0.00E+00	5.71E-01	5.39E-05	1.26E-12	5.39E-05
Project	WORK	Adult	Formaldehyde	4.27E-08	1.05E+00	3.58E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.80E-08	3.51E-08	0.00E+00	1.05E+00	9.87E-05	1.13E-11	9.87E-05
Application	WORK	Adult	Indeno(1,2,3-cd)pyrene	8.74E-06	2.34E-05	7.34E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-05	1.08E-05	0.00E+00	5.53E-05	2.36E-04	3.23E-04	5.59E-04
Baseline	WORK	Adult	Indeno(1,2,3-cd)pyrene	7.18E-06	2.33E-05	6.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.58E-06	8.85E-06	0.00E+00	4.95E-05	2.35E-04	2.65E-04	5.00E-04
Future	WORK	Adult	Indeno(1,2,3-cd)pyrene	7.76E-07	8.59E-06	6.52E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-06	9.57E-07	0.00E+00	1.14E-05	8.68E-05	2.86E-05	1.15E-04
PDC	WORK	Adult	Indeno(1,2,3-cd)pyrene	7.95E-06	1.74E-05	6.68E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E-05	9.80E-06	0.00E+00	4.64E-05	1.76E-04	2.93E-04	4.69E-04
Project	WORK	Adult	Indeno(1,2,3-cd)pyrene	4.51E-06	1.02E-05	3.79E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.02E-06	5.56E-06	0.00E+00	2.67E-05	1.03E-04	1.66E-04	2.70E-04
Application	WORK	Adult	Phenanthrene	1.10E-02	2.73E-03	9.24E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.47E-02	1.36E-02	0.00E+00	4.29E-02	2.76E-02	4.06E-01	4.34E-01
Baseline	WORK	Adult	Phenanthrene	1.10E-02	2.73E-03	9.24E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.47E-02	1.36E-02	0.00E+00	4.29E-02	2.76E-02	4.06E-01	4.34E-01
Future	WORK	Adult	Phenanthrene	-9.24E-08	2.03E-03	-7.76E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.23E-07	-1.14E-07	0.00E+00	2.03E-03	2.05E-02	-3.41E-06	2.05E-02
PDC	WORK	Adult	Phenanthrene	1.10E-02	4.77E-03	9.24E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.47E-02	1.36E-02	0.00E+00	4.49E-02	4.82E-02	4.06E-01	4.54E-01
Project	WORK	Adult	Phenanthrene	2.32E-07	1.73E-04	1.95E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.10E-07	2.86E-07	0.00E+00	1.73E-04	1.74E-03	8.57E-06	1.75E-03
Application	WORK	Adult	Pyrene	2.95E-06	7.81E-04	2.48E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.94E-06	3.64E-06	0.00E+00	7.92E-04	3.68E-07	5.08E-09	3.73E-07
Baseline	WORK	Adult	Pyrene	2.87E-06	7.81E-04	2.41E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.84E-06	3.54E-06	0.00E+00	7.92E-04	3.68E-07	4.95E-09	3.73E-07
Future	WORK	Adult	Pyrene	3.20E-07	5.99E-04	2.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.27E-07	3.94E-07	0.00E+00	6.00E-04	2.82E-07	5.51E-10	2.83E-07
PDC	WORK	Adult	Pyrene	3.19E-06	1.38E-03	2.68E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.26E-06	3.94E-06	0.00E+00	1.39E-03	6.51E-07	5.50E-09	6.56E-07
Project	WORK	Adult	Pyrene	2.06E-07	1.13E-05	1.73E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.75E-07	2.54E-07	0.00E+00	1.20E-05	5.32E-09	3.55E-10	5.68E-09

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Table D-17 Summary of Chemical Concentrations Used to Estimate Exposures

Scenario	Site	Chemical	Soil	Surface Soil	Surface Water	Air	Dust	Deposition Predicted	Environmental Concentrations: Plant Deposition	Plant Air	Plant Soil	Plant SUM	Berries Deposition	Berries Air	Berries Soil	Berries SUM	Lab_tea Deposition	Lab_tea Air	Lab_tea Soil	Lab_tea SUM	Root Soil	Cattail Soil	Moose	Ruffed_grouse	Snowshoe_hare	Fish Water
			mg/kg	mg/kg	mg/L	ug/m3	ug/m3	mg/m2/yr	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww
Application	RES	2-methylnaphthalene	4.00E-02	4.00E-02	2.46E-06	1.00E-03	3.04E-08	7.22E-01	0.00E+00	1.68E-07	1.36E-03	1.36E-03	0.00E+00	1.68E-07	1.82E-03	1.82E-03	0.00E+00	1.68E-07	5.52E-02	5.52E-02	5.20E-02	2.09E-03	1.62E-07	6.94E-11	2.30E-10	1.33E-03
Application	RES	3-methylcholanthrene	3.79E-06	3.79E-05	4.51E-09	1.84E-06	2.88E-11	1.33E-03	1.21E-06	4.88E-08	4.29E-09	1.26E-06	1.61E-06	4.88E-08	5.72E-09	1.66E-06	3.70E-06	4.88E-08	1.32E-08	3.76E-06	1.46E-06	6.58E-09	2.33E-05	8.64E-08	3.00E-07	5.15E-06
Application	RES	7,12-Dimethylbenz(a)anthracene	4.72E-05	4.72E-04	4.05E-08	1.65E-05	3.58E-10	1.19E-02	1.08E-05	1.34E-07	1.22E-07	1.11E-05	1.45E-05	1.34E-07	1.62E-07	1.48E-05	3.33E-05	1.34E-07	3.73E-07	3.38E-05	4.28E-07	1.87E-07	3.50E-06	1.32E-08	4.55E-08	2.23E-06
Application	RES	Acenaphthene	1.27E-07	1.27E-06	2.29E-07	9.32E-05	9.67E-13	6.73E-02	0.00E+00	5.11E-08	4.01E-09	5.51E-08	0.00E+00	5.11E-08	5.34E-09	5.65E-08	0.00E+00	5.11E-08	1.23E-08	6.34E-08	4.06E-09	6.14E-09	4.28E-06	2.64E-09	3.28E-09	4.60E-05
Application	RES	Acenaphthylene	3.20E-06	3.20E-05	4.33E-06	1.77E-03	2.43E-11	1.27E+00	0.00E+00	1.64E-06	9.80E-08	1.74E-06	0.00E+00	1.64E-06	1.31E-07	1.77E-06	0.00E+00	1.64E-06	3.01E-07	1.94E-06	1.02E-07	1.50E-07	8.14E-05	6.26E-08	6.99E-08	8.71E-04
Application	RES	Anthracene	1.89E-06	1.89E-05	2.86E-07	1.20E-04	1.44E-11	8.65E-02	0.00E+00	7.97E-09	2.94E-08	3.74E-08	0.00E+00	7.97E-09	3.92E-08	4.72E-08	0.00E+00	7.97E-09	9.01E-08	9.81E-08	4.28E-08	4.51E-08	1.90E-06	6.59E-11	1.93E-10	1.57E-05
Application	RES	Benzo(a)anthracene	1.53E-04	1.53E-03	4.11E-07	1.67E-04	1.17E-09	1.21E-01	7.85E-05	6.41E-07	4.17E-07	7.96E-05	1.05E-04	6.41E-07	5.56E-07	1.06E-04	2.41E-04	6.41E-07	1.28E-06	2.43E-04	2.18E-06	6.40E-07	2.60E-05	9.18E-08	3.21E-07	2.26E-05
Application	RES	Benzo(a)pyrene	1.44E-04	1.44E-03	8.30E-08	3.38E-05	1.09E-09	2.44E-02	2.22E-05	5.05E-06	2.39E-07	2.75E-05	2.96E-05	5.05E-06	3.19E-07	3.50E-05	6.81E-05	5.05E-06	7.33E-07	7.39E-05	1.30E-06	3.66E-07	1.09E-05	4.25E-08	1.47E-07	4.56E-06
Application	RES	Benzo(b)fluoranthene	1.44E-05	1.44E-04	1.31E-07	5.32E-05	1.10E-10	3.84E-02	0.00E+00	7.82E-06	3.82E-08	7.86E-06	0.00E+00	7.82E-06	5.10E-08	7.87E-06	0.00E+00	7.82E-06	1.17E-07	7.93E-06	2.49E-06	5.86E-08	8.70E-06	3.06E-08	1.08E-07	7.18E-06
Application	RES	Benzo(g,h,i)perylene	1.73E-04	1.73E-03	8.51E-08	3.46E-05	1.31E-09	2.50E-02	2.28E-05	2.44E-05	1.48E-07	4.73E-05	3.04E-05	2.44E-05	1.97E-07	5.49E-05	6.98E-05	2.44E-05	4.52E-07	9.46E-05	1.57E-06	2.26E-07	2.28E-05	8.97E-08	3.14E-07	4.68E-06
Application	RES	Benzo(k)fluoranthene	2.80E-04	2.80E-03	4.16E-08	1.75E-05	2.12E-09	1.26E-02	1.15E-05	1.95E-06	4.78E-07	1.39E-05	1.53E-05	1.95E-06	6.37E-07	1.79E-05	3.53E-05	1.95E-06	1.46E-06	3.87E-05	2.55E-06	7.32E-07	5.24E-06	2.28E-08	7.46E-08	2.29E-06
Application	RES	Chrysene	4.92E-04	4.92E-03	2.51E-07	1.02E-04	3.74E-09	7.37E-02	2.49E-05	1.50E-06	1.25E-06	2.77E-05	3.32E-05	1.50E-06	1.67E-06	3.64E-05	7.64E-05	1.50E-06	3.84E-06	8.18E-05	6.99E-06	1.92E-06	1.08E-05	4.09E-08	1.34E-07	1.38E-05
Application	RES	Dibenz(a,h)anthracene	5.82E-05	5.82E-04	1.87E-08	6.61E-06	4.43E-10	4.77E-03	5.86E-06	2.69E-06	4.25E-08	8.59E-06	7.82E-06	2.69E-06	5.66E-08	1.06E-05	1.80E-05	2.69E-06	1.30E-07	2.08E-05	3.54E-07	6.51E-08	3.49E-06	1.40E-08	4.84E-08	1.03E-06
Application	RES	Fluoranthene	3.65E-05	3.65E-04	4.43E-07	1.80E-04	2.77E-10	1.30E-01	0.00E+00	4.30E-07	2.21E-07	6.51E-07	0.00E+00	4.30E-07	2.94E-07	7.24E-07	0.00E+00	4.30E-07	6.77E-07	1.11E-06	8.21E-07	3.38E-07	4.02E-06	2.33E-09	7.38E-09	2.44E-05
Application	RES	Fluorene	4.00E-02	4.00E-02	7.04E-07	2.49E-04	3.04E-08	1.80E-01	0.00E+00	4.94E-09	8.92E-04	8.92E-04	0.00E+00	4.94E-09	1.19E-03	1.19E-03	0.00E+00	4.94E-09	2.73E-03	2.73E-03	1.14E-03	1.37E-03	4.07E-06	5.69E-11	1.77E-10	3.87E-05
Application	RES	Indeno(1,2,3-cd)pyrene	3.77E-05	3.77E-04	1.56E-08	5.57E-06	2.87E-10	4.02E-03	5.20E-06	7.38E-08	2.94E-08	5.31E-06	6.94E-06	7.38E-08	3.92E-08	7.05E-06	1.60E-05	7.38E-08	9.01E-08	1.61E-05	2.99E-07	4.51E-08	1.33E-06	5.31E-09	1.81E-08	8.57E-07
Application	RES	Phenanthrene	1.10E-01	1.10E-01	1.82E-06	7.42E-04	8.37E-08	5.36E-01	0.00E+00	6.66E-08	1.69E-03	1.69E-03	0.00E+00	6.66E-08	6.00E-03	6.00E-03	0.00E+00	6.66E-08	7.36E-02	7.36E-02	3.02E-03	6.90E-03	1.22E-05	8.18E-10	2.55E-09	1.00E-04
Application	RES	Pyrene	4.74E-05	4.74E-04	5.21E-07	2.12E-04	3.60E-10	1.53E-01	0.00E+00	1.89E-07	4.16E-07	6.05E-07	0.00E+00	1.89E-07	5.54E-07	7.44E-07	0.00E+00	1.89E-07	1.28E-06	1.46E-06	1.03E-06	6.38E-07	4.20E-06	1.51E-09	4.25E-09	2.86E-05
Application	RES	C9-C18 Aromatics	9.02E-05	9.02E-04	5.15E-03	7.54E-01	6.86E-10	5.44E+02	0.00E+00	2.67E-05	4.35E-06	3.10E-05	0.00E+00	2.67E-05	5.80E-06	3.25E-05	0.00E+00	2.67E-05	1.33E-05	4.00E-05	3.64E-06	6.67E-06	3.19E-04	1.32E-07	4.36E-07	2.83E-01
Application	RES	Formaldehyde	1.27E-08	1.27E-07	2.08E-04	1.04E-01	9.67E-14	7.49E+01	0.00E+00	4.90E-06	1.61E-08	4.91E-06	0.00E+00	4.90E-06	2.14E-08	4.92E-06	0.00E+00	4.90E-06	4.93E-08	4.95E-06	5.82E-07	2.47E-08	1.54E-06	3.79E-09	1.25E-08	6.58E-04
Baseline	RES	2-methylnaphthalene	4.00E-02	4.00E-02	2.46E-06	1.00E-03	3.04E-08	7.22E-01	0.00E+00	1.68E-07	1.36E-03	1.36E-03	0.00E+00	1.68E-07	1.82E-03	1.82E-03	0.00E+00	1.68E-07	5.52E-02	5.52E-02	5.20E-02	2.09E-03	1.62E-07	6.94E-11	2.30E-10	1.33E-03
Baseline	RES	3-methylcholanthrene	3.79E-06	3.79E-05	4.50E-09	1.83E-06	2.88E-11	1.32E-03	1.21E-06	4.87E-08	4.29E-09	1.26E-06	1.61E-06	4.87E-08	5.71E-09	1.66E-06	3.70E-06	4.87E-08	1.31E-08	3.76E-06	1.46E-06	6.57E-09	2.33E-05	8.64E-08	3.00E-07	5.14E-06
Baseline	RES	7,12-Dimethylbenz(a)anthracene	4.71E-05	4.71E-04	4.05E-08	1.65E-05	3.58E-10	1.19E-02	1.08E-05	1.33E-07	1.22E-07	1.11E-05	1.44E-05	1.33E-07	1.62E-07	1.47E-05	3.32E-05	1.33E-07	3.73E-07	3.37E-05	4.28E-07	1.87E-07	3.50E-06	1.32E-08	4.55E-08	2.23E-06
Baseline	RES	Acenaphthene	1.27E-07	1.27E-06	2.29E-07	9.32E-05	9.67E-13	6.73E-02	0.00E+00	5.11E-08	4.01E-09	5.51E-08	0.00E+00	5.11E-08	5.34E-09	5.65E-08	0.00E+00	5.11E-08	1.23E-08	6.34E-08	4.06E-09	6.14E-09	4.28E-06	2.64E-09	3.28E-09	4.60E-05
Baseline	RES	Acenaphthylene	3.20E-06	3.20E-05	4.33E-06	1.77E-03	2.43E-11	1.27E+00	0.00E+00	1.64E-06	9.80E-08	1.74E-06	0.00E+00	1.64E-06	1.31E-07	1.77E-06	0.00E+00	1.64E-06	3.01E-07	1.94E-06	1.02E-07	1.50E-07	8.14E-05	6.26E-08	6.99E-08	8.71E-04
Baseline	RES	Anthracene	1.89E-06	1.89E-05	2.86E-07	1.20E-04	1.44E-11	8.65E-02	0.00E+00	7.97E-09	2.94E-08	3.74E-08	0.00E+00	7.97E-09	3.92E-08	4.72E-08	0.00E+00	7.97E-09	9.01E-08	9.81E-08	4.28E-08	4.51E-08	1.90E-06	6.59E-11	1.93E-10	1.57E-05
Baseline	RES	Benzo(a)anthracene	1.53E-04	1.53E-03	4.11E-07	1.67E-04	1.16E-09	1.21E-01	7.85E-05	6.41E-07	4.17E-07	7.96E-05	1.05E-04	6.41E-07	5.56E-07	1.06E-04	2.41E-04	6.41E-07	1.28E-06	2.43E-04	2.18E-06	6.40E-07	2.60E-05	9.18E-08	3.21E-07	2.26E-05
Baseline	RES	Benzo(a)pyrene	1.44E-04	1.44E-03	8.29E-08	3.38E-05	1.09E-09	2.44E-02	2.22E-05	5.05E-06	2.39E-07	2.75E-05	2.96E-05	5.05E-06	3.19E-07	3.50E-05	6.81E-05	5.05E-06	7.33E-07	7.39E-05	1.30E-06	3.66E-07	1.09E-05	4.25E-08	1.47E-07	4.56E-06
Baseline	RES	Benzo(b)fluoranthene	1.44E-05	1.44E-04	1.31E-07	5.32E-05	1.10E-10	3.84E-02	0.00E+00	7.82E-06	3.82E-08	7.85E-06	0.00E+00	7.82E-06	5.10E-08	7.87E-06	0.00E+00	7.82E-06	1.17E-07	7.93E-06	2.49E-06	5.86E-08	8.70E-06	3.05E-08	1.08E-07	7.18E-06
Baseline	RES	Benzo(g,h,i)perylene	1.73E-04	1.73E-03	8.50E-08	3.46E-05	1.31E-09	2.50E-02	2.28E-05	2.44E-05	1.47E-07	4.73E-05	3.03E-05	2.44E-05	1.97E-07	5.49E-05	6.98E-05	2.44E-05	4.52E-07	9.46E-05	1.57E-06	2.26E-07	2.28E-05	8.97E-08	3.14E-07	4.68E-06
Baseline	RES	Benzo(k)fluoranthene	2.79E-04	2.79E-03	4.16E-08	1.75E-05	2.12E-09	1.26E-02	1.15E-05	1.95E-06	4.77E-07	1.39E-05	1.53E-05	1.95E-06	6.36E-07	1.79E-05	3.52E-05	1.95E-06	1.46E-06	3.87E-05	2.55E-06	7.32E-07	5.24E-06	2.28E-08	7.46E-08	2.29E-06
Baseline	RES	Chrysene	4.91E-04	4.91E-03	2.51E-07	1.02E-04	3.74E-09	7.37E-02	2.49E-05	1.50E-06	1.25E-06	2.77E-05	3.32E-05	1.50E-06	1.67E-06	3.64E-05	7.64E-05	1.50E-06	3.84E-06	8.18E-05	6.99E-06	1.92E-06	1.08E-05	4.09E-08	1.34E-07	1.38E-05
Baseline	RES	Dibenz(a,h)anthracene	5.81E-05	5.81E-04	1.86E-08	6.60E-06	4.42E-10	4.76E-03	5.85E-06	2.68E-06	4.24E-08	8.57E-06	7.80E-06	2.68E-06	5.65E-08	1.05E-05	1.79E-05	2.68E-06	1.30E-07	2.08E-05	3.53E-07	6.50E-08	3.48E-06	1.40E-08	4.83E-08	1.02E-06
Baseline	RES	Fluoranthene	3.65E-05	3.65E-04	4.43E-07	1.80E-04	2.77E-10	1.30E-01	0.00E+00	4.30E-07	2.21E-07	6.50E-07	0.00E+00	4.30E-07	2.94E-07	7.24E-07	0.00E+00	4.30E-07	6.77E-07	1.11E-06	8.21E-07	3.38E-07	4.02E-06	2.33E-09	7.38E-09	2.44E-05
Baseline	RES	Fluorene	4.00E-02	4.00E-02	7.04E-07	2.49E-04	3.04E-08	1.80E-01	0.00E+00	4.94E-09	8.92E-04	8.92E-04	0.00E+00	4.94E-09	1.19E-03	1.19E-03	0.00E+00	4.94E-09	2.73E-03	2.73E-03	1.14E-03	1.37E-03	4.07E-06	5.69E-11	1.77E-10	3.87E-05
Baseline	RES	Indeno(1,2,3-cd)pyrene	3.76E-05	3.76E-04	1.55E-08	5.56E-06	2.86E-10	4.01E-03	5.19E-06	7.36E-08	2.93E-08	5.29E-06	6.92E-06	7.36E-08	3.91E-08	7.03E-06	1.59E-05	7.36E-08	8.99E-08	1.61E-05	2.99E-07	4.49E-08	1.33E-06	5.29E-09	1.80E-08	8.54E-07
Baseline	RES	Phenanthrene	1.10E-01	1.10E-01	1.82E-06	7.42E-04	8.37E-08	5.36E-01	0.00E+00	6.66E-08	1.69E-03	1.69E-03	0.00E+00	6.66E-08	6.00E-03	6.00E-03	0.00E+00	6.66E-08	7.36E-02	7.36E-02	3.02E-03	6.90E-03	1.22E-05	8.18E-10	2.55E-09	1.00E-04
Baseline	RES	Pyrene	4.74E-05	4.74E-04	5.21E-07	2.12E-04	3.60E-10	1.53E-01	0.00E+00	1.89E-07	4.16E-07	6.05E-07	0.00E+00	1.89E-07	5.54E-07	7.44E-07	0.00E+00	1.89E-07	1.28E-06	1.46E-06	1.03E-06	6.38E-07	4.20E-06	1.51E-09	4.25E-09	2.86E-05
Baseline	RES	C9-C18 Aromatics	9.02E-05	9.02E-04	5.15E-03	7.54E-01	6.86E-10	5.44E+02	0.00E+00	2.67E-05	4.35E-06	3.10E-05	0.00E+00	2.67E-05	5.80E-06	3.25E-05	0.00E+00	2.67E-05	1.33E-05	4.00E-05	3.64E-06	6.67E-06	3.19E-04	1.32E-07	4.36E-07	2.83E-01
Baseline	RES	Formaldehyde	1.27E-08	1.27E-07	2.08E-04	1.04E-01	9.66E-14	7.48E+01	0.00E+00	4.89E-06	1.61E-08	4.91E-06	0.00E+00	4.89E-06	2.14E-08	4.91E-06	0.00E+00	4.89E-06	4.93E-08	4.94E-06	5.82E-07	2.46E-08	1.54E-06	3.78E-09	1.25E-08	6.57E-04
Future	RES	2-methylnaphthalene	1.33E-07	1.33E-06	1.94E-06	7.91E-04	1.01E-12	5.71E-01	0.00E+00	1.33E-07	4.55E-09	1.37E-07	0.00E+00	1.33E-07	6.07E-09	1.39E-07	0.00E+00	1.33E-07	1.84E-07	3.17E-07	1.74E-07	6.98E-09	1.28E-07	5.48E-11	1.82E-10	1.05E-03
Future	RES	3-methylcholanthrene	2.41E-07	2.41E-06	5.01E-10	1.17E-07	1.83E-12	8.41E-05	7.65E-08	3.09E-09	2.72E-10	7.99E-08	1.02E-07	3.09E-09	3.63E-10	1.06E-07	2.35E-07	3.09E-09	8.35E-10	2.39E-07	9.27E-08	4.17E-10	2.59E-06	9.61E-09	3.34E-08	5.72E-07
Future	RES	7,12-Dimethylbenz(a)anthracene	2.96E-06	2.96E-05	4.45E-09	1.04E-06	2.25E-11	7.48E-04	6.81E-07	8.38E-09	7.64E-09	6.97E-07	9.08E-07	8.38E-09	1.02E-08	9.26E-07	2.09E-06	8.38E-09	2.34E-08	2.12E-06	2.69E-08	1.17E-08	3.85E-07	1.45E-09	5.01E-09	2.45E-07
Future	RES	Acenaphthene	9.63E-08	9.63E-07	1.73E-07	7.06E-05	7.32E-13	5.10E-02	0.00E+00	3.87E-08	3.03E-09	4.17E-08	0.00E+00	3.87E-08	4.05E-09	4.28E-08	0.00E+00	3.87E-08	9.30E-09	4.80E-08	3.08E-09	4.65E-09	3.24E-06	2.00E-09	2.48E-09	3.48E-05
Future	RES	Acenaphthylene	2.55E-06	2.55E-05	3.45E-06	1.41E-03	1.94E-11	1.02E+00	0.00E+00	1.31E-06	7.81E-08	1.39E-06	0.00E+00	1.31E-06	1.04E-07	1.41E-06	0.00E+00	1.31E-06	2.40E-07	1.55E-06	8.14E-08	1.20E-07	6.49E-05	4.99E-08	5.57E-08	6.94E-04
Future	RES	Anthracene	1.47E-06	1.47E-05	2.23E-07	9.34E-05	1.12E-11	6.74E-02	0.00E+00	6.22E-09	2.29E-08	2.91E-08	0.00E+00	6.22E-09	3.06E-08	3.68E-08	0.00E+00	6.22E-09	7.03E-08	7.65E-08	3.34E-08	3.51E-08	1.48E-06	5.14E-11	1.51E-10	1.23E-05
Future	RES	Benzo(a)anthracene	1.11E-04	1.11E-03	2.96E-07	1.21E-04	8.40E-10	8.72E-02	5.67E-05	4.62E-07	3.01E-07	5.74E-05	7.56E-05	4.62E-07	4.01E-07	7.64E-05	1.74E-04	4.62E-07	9.23E-07	1.75E-04	1.57E-06	4.61E-07	1.87E-05	6.62E-08	2.32E-07	1.63E-05
Future	RES	Benzo(a)pyrene	1.14E-04	1.14E-03	6.58E-08	2.68E-05	8.66E-10	1.93E-02	1.76E-05	4.01E-06	1.89E-07	2.18E-05	2.35E-05	4.01E-06	2.53E-07	2.77E-05	5.40E-05	4.01E-06	5.81E-07	5.86E-05	1.03E-06	2.90E-07	8.65E-06	3.37E-08	1.17E-07	3.62E-06
Future	RES	Benzo(b)fluoranthene	1.02E-05	1.02E-04	9.22E-08	3.76E-05	7.74E-11	2.71E-02	0.00E+00	5.52E-06	2.70E-08	5.55E-06	0.00E+00	5.52E-06	3.60E-08	5.56E-06	0.00E+00	5.52E-06	8.28E-08	5.60E-06	1.76E-06	4.14E-08	6.14E-06	2.16E-08	7.61E-08	5.07E-06
Future	RES	Benzo(g,h,i)perylene	1.35E-04	1.35E-03	6.65E-08	2.71E-05	1.03E-09	1.95E-02	1.78E-05	1.91E-05	1.15E-07	3.70E-05	2.37E-05	1.91E-05	1.54E-07	4.29E-05	5.46E-05	1.91E-05	3.54E-07	7.40E-05	1.22E-06	1.77E-07	1.78E-05	7.01E-08	2.46E-07	3.66E-06
Future	RES	Benzo(k)fluoranthene	2.17E-04	2.17E-03	3.23E-08	1.36E-05	1.65E-09	9.79E-03	8.91E-06	1.51E-06	3.70E-07	1.08E-05	1.19E-05	1.51E-06	4.93E-07	1.39E-05	2.73E-05	1.51E-06	1.14E-06	3.00E-05	1.98E-06	5.68E-07	4.06E-06	1.77E-08	5.78E-08	1.77E-06
Future	RES	Chrysene	3.86E-04	3.86E-03	1.97E-07	8.02E-05	2.93E-09	5.79E-02	1.96E-05	1.18E-06	9.83E-07	2.17E-05	2.61E-05	1.18E-06	1.31E-06	2.86E-05	6.00E-05	1.18E-06	3.01E-06	6.42E-05	5.49E-06	1.51E-06	8.46E-06	3.21E-08	1.05E-07	1.08E-05
Future	RES	Dibenz(a,h)anthracene	3.21E-06	3.21E-05	5.67E-09	3.64E-07	2.44E-11	2.63E-04	3.23E-07	1.48E-07	2.34E-09	4.73E-07	4.30E-07	1.48E-07	3.12E-09	5.81E-07	9.90E-07	1.48E-07	7.17E-09	1.14E-06	1.95E-08	3.58E-09	1.06E-06	4.25E-09	1.47E-08	3.12E-07
Future	RES	Fluoranthene	2.75E-05	2.75E-04	3.33E-07	1.36E-04	2.09E-10	9.81E-02	0.00E+00	3.24E-07	1.66E-07	4.90E-07	0.00E+00	3.24E-07	2.21E-07	5.45E-07	0.00E+00	3.24E-07	5.09E-07	8.33E-07	6.18E-07	2.55E-07	3.02E-06	1.76E-09	5.56E-09	1.83E-05
Future	RES	Fluorene	6.67E-07	6.67E-06	4.25E-07	1.73E-04	5.07E-12	1.25E-01	0.00E+00	3.44E-09	1.49E-08	1.83E-08	0.00E+00	3.44E-09	1.98E-08	2.33E-08	0.00E+00	3.44E-09	4.56E-08	4.90E-08	1.90E-08	2.28E-08	2.46E-06	3.44E-11	1.07E-10	2.34E-05
Future	RES	Indeno(1,2,3-cd)pyrene	2.48E-06	2.48E-05	5.73E-09	3.66E-07	1.88E-11	2.64E-04	3.42E-07	4.85E-09	1.93E-09	3.49E-07	4.56E-07	4.85E-09	2.57E-09	4.63E-07	1.05E-06	4.85E-09	5.92E-09	1.06E-06	1.97E-08	2.96E-09	4.90E-07	1.95E-09	6.65E-09	3.15E-07
Future	RES	Phenanthrene	1.23E-05	1.23E-04	1.36E-06	5.52E-04	9.39E-11	3.98E-01	0.00E+00	4.95E-08	1.90E-07	2.39E-07	0.00E+00	4.95E-08	6.74E-07	7.23E-07	0.00E+00	4.95E-08	8.26E-06	8.31E-06	3.39E-07	7.75E-07	9.09E-06	6.08E-10	1.90E-09	7.45E-05
Future	RES	Pyrene	3.63E-05	3.63E-04	3.99E-07	1.63E-04	2.76E-10	1.17E-01	0.00E+00	1.45E-07	3.19E-07	4.64E-07	0.00E+00	1.45E-07	4.25E-07	5.70E-07	0.00E+00	1.45E-07	9.77E-07	1.12E-06	7.89E-07	4.88E-07	3.22E-06	1.16E-09	3.26E-09	2.19E-05
Future	RES	C9-C18 Aromatics	9.49E-05	9.49E-04	4.57E-03	7.92E-01	7.21E-10	5.72E+02	0.00E+00	2.80E-05	4.57E-06	3.26E-05	0.00E+00	2.80E-05	6.10E-06	3.41E-05	0.00E+00	2.80E-05	1.40E-05	4.21E-05	3.83E-06	7.01E-06	2.83E-04	1.17E-07	3.87E-07	2.51E-01
Future	RES	Formaldehyde	5.80E-09	5.80E-08	2.06E-04	4.72E-02	4.41E-14	3.41E+01	0.00E+00	2.23E-06	7.33E-09	2.24E-06	0.00E+00	2.23E-06	9.77E-09	2.24E-06	0.00E+00	2.23E-06	2.25E-08	2.25E-06	2.65E-07	1.12E-08	1.52E-06	3.75E-09	1.24E-08	6.51E-04
PDC	RES	2-methylnaphthalene	4.00E-02	4.00E-02	4.40E-06	1.79E-03	3.04E-08	1.29E+00	0.00E+00	3.01E-07	1.36E-03	1.37E-03	0.00E+00	3.01E-07	1.82E-03	1.82E-03	0.00E+00	3.01E-07	5.52E-02	5.52E-02	5.20E-02	2.09E-03	2.89E-07	1.24E-10	4.11E-10	2.38E-03
PDC	RES	3-methylcholanthrene	4.03E-06	4.03E-05	4.79E-09	1.95E-06	3.06E-11	1.41E-03	1.28E-06	5.18E-08	4.56E-09	1.34E-06	1.71E-06	5.18E-08	6.08E-09	1.77E-06	3.93E-06	5.18E-08	1.40E-08	4.00E-06	1.55E-06	6.99E-09	2.48E-05	9.19E-08	3.19E-07	5.47E-06
PDC	RES	7,12-Dimethylbenz(a)anthracene	5.01E-05	5.01E-04	4.30E-08	1.75E-05	3.81E-10	1.27E-02	1.15E-05	1.42E-07	1.29E-07	1.18E-05	1.54E-05	1.42E-07	1.72E-07	1.57E-05	3.53E-05	1.42E-07	3.96E-07	3.59E-05	4.55E-07	1.98E-07	3.72E-06	1.40E-08	4.84E-08	2.37E-06
PDC	RES	Acenaphthene	2.23E-07	2.23E-06	4.02E-07	1.64E-04	1.70E-12	1.18E-01	0.00E+00	8.98E-08	7.04E-09	9.69E-08	0.00E+00	8.98E-08	9.39E-09	9.92E-08	0.00E+00	8.98E-08	2.16E-08	1.11E-07	7.14E-09	1.08E-08	7.51E-06	4.65E-09	5.76E-09	8.08E-05
PDC	RES	Acenaphthylene	5.74E-06	5.74E-05	7.79E-06	3.17E-03	4.36E-11	2.29E+00	0.00E+00	2.95E-06	1.76E-07	3.12E-06	0.00E+00	2.95E-06	2.35E-07	3.18E-06	0.00E+00	2.95E-06	5.40E-07	3.49E-06	1.83E-07	2.70E-07	1.46E-04	1.13E-07	1.26E-07	1.57E-03
PDC	RES	Anthracene	3.36E-06	3.36E-05	5.09E-07	2.13E-04	2.55E-11	1.54E-01	0.00E+00	1.42E-08	5.23E-08	6.65E-08	0.00E+00	1.42E-08	6.97E-08	8.39E-08	0.00E+00	1.42E-08	1.60E-07	1.75E-07	7.61E-08	8.02E-08	3.38E-06	1.17E-10	3.44E-10	2.80E-05

Table D-17 Summary of Chemical Concentrations Used to Estimate Exposures

Scenario	Site	Chemical	Soil	Surface Soil	Surface Water	Air	Dust	Deposition Predicted	Environmental Concentrations																	Fish
									Plant Deposition	Plant Air	Plant Soil	Plant SUM	Berries Deposition	Berries Air	Berries Soil	Berries SUM	Lab_tea Deposition	Lab_tea Air	Lab_tea Soil	Lab_tea SUM	Root Soil	Cattail Soil	Moose	Ruffed_grouse	Snowshoe _hare	Water
			mg/kg	mg/kg	mg/L	ug/m3	ug/m3	mg/m2/yr	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww
PDC	RES	Benzo(a)anthracene	2.64E-04	2.64E-03	7.07E-07	2.88E-04	2.01E-09	2.08E-01	1.35E-04	1.10E-06	7.18E-07	1.37E-04	1.80E-04	1.10E-06	9.57E-07	1.82E-04	4.15E-04	1.10E-06	2.20E-06	4.18E-04	3.75E-06	1.10E-06	4.47E-05	1.58E-07	5.53E-07	3.89E-05
PDC	RES	Benzo(a)pyrene	2.58E-04	2.58E-03	1.49E-07	6.06E-05	1.96E-09	4.37E-02	3.98E-05	9.06E-06	4.28E-07	4.93E-05	5.31E-05	9.06E-06	5.71E-07	6.27E-05	1.22E-04	9.06E-06	1.31E-06	1.32E-04	2.34E-06	6.57E-07	1.96E-05	7.61E-08	2.64E-07	8.18E-06
PDC	RES	Benzo(b)fluoranthene	2.46E-05	2.46E-04	2.23E-07	9.07E-05	1.87E-10	6.55E-02	0.00E+00	1.33E-05	6.52E-08	1.34E-05	0.00E+00	1.33E-05	8.70E-08	1.34E-05	0.00E+00	1.33E-05	2.00E-07	1.35E-05	4.25E-06	1.00E-07	1.48E-05	5.21E-08	1.84E-07	1.23E-05
PDC	RES	Benzo(g,h,i)perylene	3.07E-04	3.07E-03	1.52E-07	6.17E-05	2.34E-09	4.46E-02	4.06E-05	4.34E-05	2.63E-07	8.42E-05	5.41E-05	4.34E-05	3.50E-07	9.78E-05	1.24E-04	4.34E-05	8.06E-07	1.69E-04	2.79E-06	4.03E-07	4.06E-05	1.60E-07	5.60E-07	8.33E-06
PDC	RES	Benzo(k)fluoranthene	4.96E-04	4.96E-03	7.39E-08	3.11E-05	3.77E-09	2.24E-02	2.04E-05	3.46E-06	8.47E-07	2.47E-05	2.72E-05	3.46E-06	1.13E-06	3.18E-05	6.26E-05	3.46E-06	2.60E-06	6.86E-05	4.53E-06	1.30E-06	9.31E-06	4.05E-08	1.32E-07	4.06E-06
PDC	RES	Chrysene	8.78E-04	8.78E-03	4.48E-07	1.82E-04	6.67E-09	1.32E-01	4.45E-05	2.68E-06	2.23E-06	4.94E-05	5.93E-05	2.68E-06	2.98E-06	6.50E-05	1.36E-04	2.68E-06	6.85E-06	1.46E-04	1.25E-05	3.43E-06	1.92E-05	7.30E-08	2.39E-07	2.46E-05
PDC	RES	Dibenz(a,h)anthracene	4.92E-05	4.92E-04	1.37E-08	5.58E-06	3.74E-10	4.03E-03	4.95E-06	2.27E-06	3.58E-08	7.25E-06	6.60E-06	2.27E-06	4.78E-08	8.92E-06	1.52E-05	2.27E-06	1.10E-07	1.76E-05	2.99E-07	5.50E-08	2.56E-06	1.03E-08	3.56E-08	7.54E-07
PDC	RES	Fluoranthene	6.39E-05	6.39E-04	7.76E-07	3.16E-04	4.86E-10	2.28E-01	0.00E+00	7.53E-07	3.87E-07	1.14E-06	0.00E+00	7.53E-07	5.16E-07	1.27E-06	0.00E+00	7.53E-07	1.19E-06	1.94E-06	1.44E-06	5.93E-07	7.04E-06	4.09E-09	1.29E-08	4.27E-05
PDC	RES	Fluorene	4.00E-02	4.00E-02	1.02E-06	4.15E-04	3.04E-08	3.00E-01	0.00E+00	8.24E-09	8.92E-04	8.92E-04	0.00E+00	8.24E-09	1.19E-03	1.19E-03	0.00E+00	8.24E-09	2.73E-03	2.73E-03	1.14E-03	1.37E-03	5.89E-06	8.24E-11	2.56E-10	5.61E-05
PDC	RES	Indeno(1,2,3-cd)pyrene	3.20E-05	3.20E-04	1.16E-08	4.73E-06	2.43E-10	3.41E-03	4.42E-06	6.26E-08	2.49E-08	4.50E-06	5.89E-06	6.26E-08	3.33E-08	5.98E-06	1.35E-05	6.26E-08	7.65E-08	1.37E-05	2.54E-07	3.82E-08	9.93E-07	3.96E-09	1.35E-08	6.38E-07
PDC	RES	Phenanthrene	1.10E-01	1.10E-01	3.18E-06	1.29E-03	8.38E-08	9.34E-01	0.00E+00	1.16E-07	1.69E-03	1.69E-03	0.00E+00	1.16E-07	6.00E-03	6.00E-03	0.00E+00	1.16E-07	7.36E-02	7.36E-02	3.02E-03	6.90E-03	2.13E-05	1.43E-09	4.44E-09	1.75E-04
PDC	RES	Pyrene	8.36E-05	8.36E-04	9.20E-07	3.75E-04	6.36E-10	2.71E-01	0.00E+00	3.35E-07	7.34E-07	1.07E-06	0.00E+00	3.35E-07	9.79E-07	1.31E-06	0.00E+00	3.35E-07	2.25E-06	2.59E-06	1.82E-06	1.13E-06	7.42E-06	2.66E-09	7.51E-09	5.06E-05
PDC	RES	C9-C18 Aromatics	1.85E-04	1.85E-03	9.72E-03	1.55E+00	1.41E-09	1.12E+03	0.00E+00	5.47E-05	8.93E-06	6.37E-05	0.00E+00	5.47E-05	1.19E-05	6.66E-05	0.00E+00	5.47E-05	2.74E-05	8.21E-05	7.47E-06	1.37E-05	6.02E-04	2.48E-07	8.22E-07	5.35E-01
PDC	RES	Formaldehyde	1.69E-08	1.69E-07	3.81E-04	1.37E-01	1.28E-13	9.92E+01	0.00E+00	6.49E-06	2.13E-08	6.51E-06	0.00E+00	6.49E-06	2.84E-08	6.52E-06	0.00E+00	6.49E-06	6.53E-08	6.55E-06	7.71E-07	3.27E-08	2.82E-06	6.93E-09	2.29E-08	1.20E-03
Project	RES	2-methylnaphthalene	1.68E-11	1.68E-10	7.98E-09	9.97E-08	1.28E-16	7.20E-05	0.00E+00	1.68E-11	5.75E-13	1.73E-11	0.00E+00	1.68E-11	7.66E-13	1.75E-11	0.00E+00	1.68E-11	2.32E-11	4.00E-11	2.19E-11	8.81E-13	5.25E-10	2.25E-13	7.47E-13	4.33E-06
Project	RES	3-methylcholanthrene	1.50E-08	1.50E-07	7.87E-10	7.27E-09	1.14E-13	5.25E-06	4.78E-09	1.93E-10	1.70E-11	4.99E-09	6.37E-09	1.93E-10	2.26E-11	6.59E-09	1.47E-08	1.93E-10	5.21E-11	1.49E-08	5.78E-09	2.60E-11	4.07E-06	1.51E-08	5.24E-08	8.98E-07
Project	RES	7,12-Dimethylbenz(a)anthracene	1.85E-07	1.85E-06	6.99E-09	6.46E-08	1.40E-12	4.67E-05	4.25E-08	5.23E-10	4.77E-10	4.35E-08	5.66E-08	5.23E-10	6.36E-10	5.78E-08	1.30E-07	5.23E-10	1.46E-09	1.32E-07	1.68E-09	7.31E-10	6.04E-07	2.28E-09	7.86E-09	3.85E-07
Project	RES	Acenaphthene	9.86E-11	9.86E-10	6.28E-09	7.23E-08	7.50E-16	5.22E-05	0.00E+00	3.96E-11	3.11E-12	4.28E-11	0.00E+00	3.96E-11	4.14E-12	4.38E-11	0.00E+00	3.96E-11	9.53E-12	4.92E-11	3.15E-12	4.77E-12	1.17E-07	7.25E-11	9.00E-11	1.26E-06
Project	RES	Acenaphthylene	9.20E-11	9.20E-10	4.42E-09	5.08E-08	7.00E-16	3.67E-05	0.00E+00	4.73E-11	2.82E-12	5.01E-11	0.00E+00	4.73E-11	3.76E-12	5.10E-11	0.00E+00	4.73E-11	8.66E-12	5.59E-11	2.94E-12	4.33E-12	8.31E-08	6.39E-11	7.13E-11	8.89E-07
Project	RES	Anthracene	1.44E-09	1.44E-08	7.69E-09	9.11E-08	1.09E-14	6.57E-05	0.00E+00	6.06E-12	2.23E-11	2.84E-11	0.00E+00	6.06E-12	2.98E-11	3.59E-11	0.00E+00	6.06E-12	6.85E-11	7.46E-11	3.25E-11	3.43E-11	5.10E-08	1.77E-12	5.20E-12	4.23E-07
Project	RES	Benzo(a)anthracene	7.21E-08	7.21E-07	1.17E-07	7.87E-08	5.48E-13	5.68E-05	3.69E-08	3.02E-10	1.96E-10	3.74E-08	4.93E-08	3.02E-10	2.62E-10	4.98E-08	1.13E-07	3.02E-10	6.02E-10	1.14E-07	1.03E-09	3.01E-10	7.36E-06	2.60E-08	9.11E-08	6.41E-06
Project	RES	Benzo(a)pyrene	2.28E-07	2.28E-06	4.66E-09	5.37E-08	1.74E-12	3.88E-05	3.53E-08	8.03E-09	3.80E-10	4.37E-08	4.70E-08	8.03E-09	5.06E-10	5.56E-08	1.08E-07	8.03E-09	1.16E-09	1.17E-07	2.07E-09	5.82E-10	6.13E-07	2.38E-09	8.26E-09	2.56E-07
Project	RES	Benzo(b)fluoranthene	1.15E-08	1.15E-07	3.71E-09	4.26E-08	8.77E-14	3.07E-05	0.00E+00	6.25E-09	3.06E-11	6.28E-09	0.00E+00	6.25E-09	4.08E-11	6.29E-09	0.00E+00	6.25E-09	9.38E-11	6.35E-09	1.99E-09	4.69E-11	2.47E-07	8.68E-10	3.06E-09	2.04E-07
Project	RES	Benzo(g,h,i)perylene	2.97E-07	2.97E-06	4.88E-09	5.96E-08	2.26E-12	4.30E-05	3.92E-08	4.19E-08	2.54E-10	8.14E-08	5.22E-08	4.19E-08	3.38E-10	9.45E-08	1.20E-07	4.19E-08	7.79E-10	1.63E-07	2.69E-09	3.89E-10	1.31E-06	5.14E-09	1.80E-08	2.68E-07
Project	RES	Benzo(k)fluoranthene	6.80E-07	6.80E-06	3.60E-09	4.26E-08	5.17E-12	3.07E-05	2.80E-08	4.74E-09	1.16E-09	3.39E-08	3.73E-08	4.74E-09	1.55E-09	4.36E-08	8.57E-08	4.74E-09	3.56E-09	9.40E-08	6.21E-09	1.78E-09	4.53E-07	1.97E-09	6.44E-09	1.98E-07
Project	RES	Chrysene	4.21E-07	4.21E-06	7.57E-09	8.74E-08	3.20E-12	6.31E-05	2.13E-08	1.28E-09	1.07E-09	2.37E-08	2.84E-08	1.28E-09	1.43E-09	3.11E-08	6.54E-08	1.28E-09	3.28E-09	7.00E-08	5.98E-09	1.64E-09	3.25E-07	1.23E-09	4.04E-09	4.16E-07
Project	RES	Dibenz(a,h)anthracene	6.76E-07	6.76E-06	6.63E-09	7.67E-08	5.13E-12	5.53E-05	6.80E-08	3.12E-08	4.92E-10	9.96E-08	9.07E-08	3.12E-08	6.56E-10	1.22E-07	2.09E-07	3.12E-08	1.51E-09	2.41E-07	4.10E-09	7.55E-10	1.24E-06	4.97E-09	1.72E-08	3.65E-07
Project	RES	Fluoranthene	3.55E-08	3.55E-07	1.52E-08	1.75E-07	2.70E-13	1.27E-04	0.00E+00	4.18E-10	2.15E-10	6.32E-10	0.00E+00	4.18E-10	2.86E-10	7.04E-10	0.00E+00	4.18E-10	6.58E-10	1.08E-09	7.98E-10	3.29E-10	1.38E-07	8.00E-11	2.53E-10	8.35E-07
Project	RES	Fluorene	9.95E-10	9.95E-09	2.24E-08	2.58E-07	7.56E-15	1.86E-04	0.00E+00	5.12E-12	2.22E-11	2.73E-11	0.00E+00	5.12E-12	2.96E-11	3.47E-11	0.00E+00	5.12E-12	6.80E-11	7.31E-11	2.84E-11	3.40E-11	1.29E-07	1.81E-12	5.62E-12	1.23E-06
Project	RES	Indeno(1,2,3-cd)pyrene	5.33E-07	5.33E-06	6.83E-09	7.87E-08	4.05E-12	5.68E-05	7.35E-08	1.04E-09	4.15E-10	7.50E-08	9.80E-08	1.04E-09	5.54E-10	9.96E-08	2.25E-07	1.04E-09	1.27E-09	2.28E-07	4.23E-09	6.37E-10	5.84E-07	2.33E-09	7.92E-09	3.75E-07
Project	RES	Phenanthrene	2.98E-08	2.98E-07	1.15E-07	1.33E-06	2.26E-13	9.61E-04	0.00E+00	1.19E-10	4.57E-10	5.76E-10	0.00E+00	1.19E-10	1.62E-09	1.74E-09	0.00E+00	1.19E-10	1.99E-08	2.00E-08	8.17E-10	1.87E-09	7.72E-07	5.16E-11	1.61E-10	6.33E-06
Project	RES	Pyrene	1.92E-08	1.92E-07	7.52E-09	8.59E-08	1.46E-13	6.20E-05	0.00E+00	7.67E-11	1.68E-10	2.45E-10	0.00E+00	7.67E-11	2.24E-10	3.01E-10	0.00E+00	7.67E-11	5.16E-10	5.93E-10	4.17E-10	2.58E-10	6.07E-08	2.18E-11	6.15E-11	4.14E-07
Project	RES	C9-C18 Aromatics	2.85E-09	2.85E-08	1.12E-05	2.38E-05	2.17E-14	1.72E-02	0.00E+00	8.43E-10	1.38E-10	9.81E-10	0.00E+00	8.43E-10	1.83E-10	1.03E-09	0.00E+00	8.43E-10	4.22E-10	1.26E-09	1.15E-10	2.11E-10	6.94E-07	2.87E-10	9.49E-10	6.17E-04
Project	RES	Formaldehyde	8.29E-11	8.29E-10	6.98E-04	6.76E-04	6.30E-16	4.88E-01	0.00E+00	3.19E-08	1.05E-10	3.20E-08	0.00E+00	3.19E-08	1.40E-10	3.21E-08	0.00E+00	3.19E-08	3.21E-10	3.22E-08	3.79E-09	1.61E-10	5.16E-06	1.27E-08	4.19E-08	2.21E-03
Application	WORK	2-methylnaphthalene	4.00E-02	4.00E-02	2.46E-06	3.17E-05	1.00E-05	2.29E-02	0.00E+00	5.33E-09	1.36E-03	1.36E-03	0.00E+00	5.33E-09	1.82E-03	1.82E-03	0.00E+00	5.33E-09	5.52E-02	5.52E-02	5.20E-02	2.09E-03	1.62E-07	6.94E-11	2.30E-10	1.33E-03
Application	WORK	3-methylcholanthrene	8.67E-07	8.67E-06	4.51E-09	4.20E-07	2.17E-09	3.03E-04	2.76E-07	1.11E-08	9.80E-10	2.88E-07	3.68E-07	1.11E-08	1.31E-09	3.80E-07	8.45E-07	1.11E-08	3.01E-09	8.60E-07	3.34E-07	1.50E-09	2.33E-05	8.64E-08	3.00E-07	5.15E-06
Application	WORK	7,12-Dimethylbenz(a)anthracene	1.07E-05	1.07E-04	4.05E-08	3.76E-06	2.69E-08	2.71E-03	2.47E-06	3.04E-08	2.77E-08	2.53E-06	3.29E-06	3.04E-08	3.70E-08	3.36E-06	7.57E-06	3.04E-08	8.50E-08	7.69E-06	9.75E-08	4.25E-08	3.50E-06	1.32E-08	4.55E-08	2.23E-06
Application	WORK	Acenaphthene	1.21E-08	1.21E-07	2.29E-07	8.87E-06	3.03E-11	6.41E-03	0.00E+00	4.87E-09	3.81E-10	5.25E-09	0.00E+00	4.87E-09	5.09E-10	5.37E-09	0.00E+00	4.87E-09	1.17E-09	6.04E-09	3.87E-10	5.85E-10	4.28E-06	2.64E-09	3.28E-09	4.60E-05
Application	WORK	Acenaphthylene	7.49E-08	7.49E-07	4.33E-06	4.14E-05	1.87E-10	2.99E-02	0.00E+00	3.85E-08	2.30E-09	4.08E-08	0.00E+00	3.85E-08	3.06E-09	4.15E-08	0.00E+00	3.85E-08	7.05E-09	4.55E-08	2.39E-09	3.52E-09	8.14E-05	6.26E-08	6.99E-08	8.71E-04
Application	WORK	Anthracene	8.94E-08	8.94E-07	2.86E-07	5.67E-06	2.24E-10	4.09E-03	0.00E+00	3.77E-10	1.39E-09	1.77E-09	0.00E+00	3.77E-10	1.85E-09	2.23E-09	0.00E+00	3.77E-10	4.27E-09	4.64E-09	2.03E-09	2.13E-09	1.90E-06	6.59E-11	1.93E-10	1.57E-05
Application	WORK	Benzo(a)anthracene	4.31E-06	4.31E-05	4.11E-07	4.71E-06	1.08E-08	3.40E-03	2.21E-06	1.80E-08	1.17E-08	2.24E-06	2.95E-06	1.80E-08	1.57E-08	2.98E-06	6.78E-06	1.80E-08	3.60E-08	6.83E-06	6.14E-08	1.80E-08	2.60E-05	9.18E-08	3.21E-07	2.26E-05
Application	WORK	Benzo(a)pyrene	5.58E-06	5.58E-05	8.30E-08	1.31E-06	1.40E-08	9.48E-04	8.63E-07	1.96E-07	9.29E-09	1.07E-06	1.15E-06	1.96E-07	1.24E-08	1.36E-06	2.65E-06	1.96E-07	2.85E-08	2.87E-06	5.07E-08	1.42E-08	1.09E-05	4.25E-08	1.47E-07	4.56E-06
Application	WORK	Benzo(b)fluoranthene	8.88E-07	8.88E-06	1.31E-07	3.27E-06	2.22E-09	2.36E-03	0.00E+00	4.81E-07	2.35E-09	4.83E-07	0.00E+00	4.81E-07	3.14E-09	4.84E-07	0.00E+00	4.81E-07	7.22E-09	4.88E-07	1.53E-07	3.61E-09	8.70E-06	3.06E-08	1.08E-07	7.18E-06
Application	WORK	Benzo(g,h,i)perylene	9.15E-06	9.15E-05	8.51E-08	1.84E-06	2.29E-08	1.33E-03	1.21E-06	1.29E-06	7.82E-09	2.51E-06	1.61E-06	1.29E-06	1.04E-08	2.91E-06	3.70E-06	1.29E-06	2.40E-08	5.02E-06	8.30E-08	1.20E-08	2.28E-05	8.97E-08	3.14E-07	4.68E-06
Application	WORK	Benzo(k)fluoranthene	1.82E-05	1.82E-04	4.16E-08	1.14E-06	4.54E-08	8.20E-04	7.46E-07	1.27E-07	3.10E-08	9.04E-07	9.95E-07	1.27E-07	4.13E-08	1.16E-06	2.29E-06	1.27E-07	9.51E-08	2.51E-06	1.66E-07	4.75E-08	5.24E-06	2.28E-08	7.46E-08	2.29E-06
Application	WORK	Chrysene	1.89E-05	1.89E-04	2.51E-07	3.93E-06	4.72E-08	2.83E-03	9.58E-07	5.77E-08	4.81E-08	1.06E-06	1.28E-06	5.77E-08	6.42E-08	1.40E-06	2.94E-06	5.77E-08	1.48E-07	3.14E-06	2.69E-07	7.38E-08	1.08E-05	4.09E-08	1.34E-07	1.38E-05
Application	WORK	Dibenz(a,h)anthracene	1.27E-05	1.27E-04	1.87E-08	1.44E-06	3.17E-08	1.04E-03	1.28E-06	5.85E-07	9.25E-09	1.87E-06	1.70E-06	5.85E-07	1.23E-08	2.30E-06	3.92E-06	5.85E-07	2.84E-08	4.53E-06	7.71E-08	1.42E-08	3.49E-06	1.40E-08	4.84E-08	1.03E-06
Application	WORK	Fluoranthene	2.96E-06	2.96E-05	4.43E-07	1.46E-05	7.39E-09	1.06E-02	0.00E+00	3.48E-08	1.79E-08	5.27E-08	0.00E+00	3.48E-08	2.38E-08	5.87E-08	0.00E+00	3.48E-08	5.48E-08	8.96E-08	6.65E-08	2.74E-08	4.02E-06	2.33E-09	7.38E-09	2.44E-05
Application	WORK	Fluorene	4.00E-02	4.00E-02	7.04E-07	4.18E-05	1.00E-05	3.02E-02	0.00E+00	8.30E-10	8.91E-04	8.91E-04	0.00E+00	8.30E-10	1.19E-03	1.19E-03	0.00E+00	8.30E-10	2.73E-03	2.73E-03	1.14E-03	1.37E-03	4.07E-06	5.69E-11	1.77E-10	3.87E-05
Application	WORK	Indeno(1,2,3-cd)pyrene	8.74E-06	8.74E-05	1.56E-08	1.29E-06	2.19E-08	9.32E-04	1.21E-06	1.71E-08	6.81E-09	1.23E-06	1.61E-06	1.71E-08	9.08E-09	1.63E-06	3.70E-06	1.71E-08	2.09E-08	3.74E-06	6.94E-08	1.04E-08	1.33E-06	5.31E-09	1.81E-08	8.57E-07
Application	WORK	Phenanthrene	1.10E-01	1.10E-01	1.82E-06	8.82E-05	2.75E-05	6.37E-02	0.00E+00	7.91E-09	1.69E-03	1.69E-03	0.00E+00	7.91E-09	6.00E-03	6.00E-03	0.00E+00	7.91E-09	7.36E-02	7.36E-02	3.02E-03	6.90E-03	1.22E-05	8.18E-10	2.55E-09	1.00E-04
Application	WORK	Pyrene	2.95E-06	2.95E-05	5.21E-07	1.32E-05	7.38E-09	9.55E-03	0.00E+00	1.18E-08	2.59E-08	3.77E-08	0.00E+00	1.18E-08	3.45E-08	4.64E-08	0.00E+00	1.18E-08	7.95E-08	9.13E-08	6.42E-08	3.97E-08	4.20E-06	1.51E-09	4.25E-09	2.86E-05
Application	WORK	C9-C18 Aromatics	1.37E-05	1.37E-04	5.15E-03	1.15E-01	3.43E-08	8.28E+01	0.00E+00	4.06E-06	6.62E-07	4.72E-06	0.00E+00	4.06E-06	8.83E-07	4.94E-06	0.00E+00	4.06E-06	2.03E-06	6.09E-06	5.54E-07	1.02E-06	3.19E-04	1.32E-07	4.36E-07	2.83E-01
Application	WORK	Formaldehyde	3.33E-09	3.33E-08	2.08E-04	2.72E-02	8.34E-12	1.96E+01	0.00E+00	1.28E-06	4.21E-09	1.29E-06	0.00E+00	1.28E-06	5.62E-09	1.29E-06	0.00E+00	1.28E-06	1.29E-08	1.30E-06	1.53E-07	6.46E-09	1.54E-06	3.79E-09	1.25E-08	6.58E-04
Baseline	WORK	2-methylnaphthalene	4.00E-02	4.00E-02	2.46E-06	3.07E-05	1.00E-05	2.22E-02	0.00E+00	5.17E-09	1.36E-03	1.36E-03	0.00E+00	5.17E-09	1.82E-03	1.82E-03	0.00E+00	5.17E-09	5.52E-02	5.52E-02	5.20E-02	2.09E-03	1.62E-07	6.94E-11	2.30E-10	1.33E-03
Baseline	WORK	3-methylcholanthrene	7.16E-07	7.16E-06	4.50E-09	3.47E-07	1.79E-09	2.50E-04	2.28E-07	9.20E-09	8.09E-10	2.38E-07	3.04E-07	9.20E-09	1.08E-09	3.14E-07	6.98E-07	9.20E-09	2.48E-09	7.10E-07	2.76E-07	1.24E-09	2.33E-05	8.64E-08	3.00E-07	5.14E-06
Baseline	WORK	7,12-Dimethylbenz(a)anthracene	8.89E-06	8.89E-05	4.05E-08	3.11E-06	2.22E-08	2.25E-03	2.04E-06	2.52E-08	2.29E-08	2.09E-06	2.72E-06	2.52E-08	3.06E-08	2.78E-06	6.27E-06	2.52E-08	7.03E-08	6.36E-06	8.07E-08	3.52E-08	3.50E-06	1.32E-08	4.55E-08	2.23E-06
Baseline	WORK	Acenaphthene	1.18E-08	1.18E-07	2.29E-07	8.65E-06	2.95E-11	6.25E-03	0.00E+00	4.74E-09	3.72E-10	5.12E-09	0.00E+00	4.74E-09	4.96E-10	5.24E-09	0.00E+00	4.74E-09	1.14E-09	5.88E-09	3.77E-10	5.70E-10	4.28E-06	2.64E-09	3.28E-09	4.60E-05
Baseline	WORK	Acenaphthylene	7.46E-08	7.46E-07	4.33E-06	4.12E-05	1.86E-10	2.97E-02	0.00E+00	3.83E-08	2.29E-09	4.06E-08	0.00E+00	3.83E-08	3.05E-09	4.13E-08	0.00E+00	3.83E-08	7.02E-09	4.53E-08	2.38E-09	3.51E-09	8.14E-05	6.26E-08	6.99E-08	8.71E-04
Baseline	WORK	Anthracene	8.50E-08	8.50E-07	2.86E-07	5.39E-06	2.13E-10	3.89E-03	0.00E+00	3.59E-10	1.32E-09	1.68E-09	0.00E+00	3.59E-10	1.76E-09	2.12E-09	0.00E+00	3.59E-10	4.06E-09	4.42E-09	1.93E-09	2.03E-09	1.90E-06	6.59E-11	1.93E-10	1.57E-05
Baseline	WORK	Benzo(a)anthracene	4.10E-06	4.10E-05	4.11E-07	4.48E-06	1.03E-08	3.23E-03	2.10E-06	1.72E-08	1.12E-08	2.13E-06	2.80E-06	1.72E-08	1.49E-08	2.83E-06	6.45E-06	1.72E-08	3.42E-08	6.50E-06	5.83E-08	1.71E-08	2.60E-05	9.18E-08	3.21E-07	2.26E-05
Baseline	WORK	Benzo(a)pyrene	4.92E-06	4.92E-05	8.29E-08	1.16E-06	1.23E-08	8.35E-04	7.60E-07	1.73E-07	8.18E-09	9.41E-07	1.01E-06	1.73E-07	1.09E-08	1.20E-06	2.33E-06	1.73E-07	2.51E-08	2.53E-06	4.46E-08	1.25E-08	1.09E-05	4.25E-08	1.47E-07	4.56E-06
Baseline	WORK	Benzo(b)fluoranthene	8.47E-07	8.47E-06	1.31E-07	3.12E-06	2.12E-09	2.25E-03	0.00E+00	4.59E-07	2.24E-09	4.61E-07	0.00E+00	4.59E-07	2.99E-09	4.62E-07	0.00E+00	4.59E-07	6.88E-09	4.65E-07	1.46E-07	3.44E-09	8.70E-06	3.05E-08	1.08E-07	7.18E-06
Baseline	WORK	Benzo(g,h,i)perylene	8.42E-06	8.42E-05	8.50E-08	1.69E-06	2.11E-08	1.22E-03	1.11E-06	1.19E-06	7.20E-09	2.31E-06	1.48E-06	1.19E-06	9.60E-09	2.68E-06	3.41E-06	1.19E-06	2.21E-08	4.62E-06	7.64E-08	1.10E-08	2.28E-05	8.97E-08	3.14E-07	4.68E-06
Baseline	WORK	Benzo(k)fluoranthene	1.57E-05	1.57E-04	4.16E-08	9.83E-07	3.93E-08	7.10E-04	6.46E-07	1.10E-07	2.68E-08	7.83E-07	8.62E-07	1.10E-07	3.58E-08	1.01E-06	1.98E-06	1.10E-07	8.23E-08	2.17E-06	1.44E-07	4.12E-08	5.24E-06	2.28E-08	7.46E-08	2.29E-06
Baseline	WORK	Chrysene	1.77E-05	1.77E-04	2.51E-07	3.68E-06	4.42E-08	2.65E-03	8.97E-07	5.40E-08	4.50E-08	9.96E-07	1.20E-06	5.40E-08	6.01E-08	1.31E-06	2.75E-06	5.40E-08	1.38E-07	2.94E-06	2.52E-07	6.91E-08	1.08E-05	4.09E-08	1.34E-07	1.38E-05

Table D-17 Summary of Chemical Concentrations Used to Estimate Exposures

									Environmental Concentrations																	
Scenario	Site	Chemical	Soil	Surface Soil	Surface Water	Air	Dust	Deposition Predicted	Plant Deposition	Plant Air	Plant Soil	Plant SUM	Berries Deposition	Berries Air	Berries Soil	Berries SUM	Lab_tea Deposition	Lab_tea Air	Lab_tea Soil	Lab_tea SUM	Root Soil	Cattail Soil	Moose	Ruffed_grouse	Snowshoe _hare	Fish Water
			mg/kg	mg/kg	mg/L	ug/m3	ug/m3	mg/m2/yr	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww
Baseline	WORK	Dibenz(a,h)anthracene	1.09E-05	1.09E-04	1.86E-08	1.23E-06	2.72E-08	8.90E-04	1.09E-06	5.01E-07	7.92E-09	1.60E-06	1.46E-06	5.01E-07	1.06E-08	1.97E-06	3.35E-06	5.01E-07	2.43E-08	3.88E-06	6.60E-08	1.21E-08	3.48E-06	1.40E-08	4.83E-08	1.02E-06
Baseline	WORK	Fluoranthene	2.86E-06	2.86E-05	4.43E-07	1.41E-05	7.15E-09	1.02E-02	0.00E+00	3.37E-08	1.73E-08	5.10E-08	0.00E+00	3.37E-08	2.30E-08	5.67E-08	0.00E+00	3.37E-08	5.30E-08	8.67E-08	6.43E-08	2.65E-08	4.02E-06	2.33E-09	7.38E-09	2.44E-05
Baseline	WORK	Fluorene	4.00E-02	4.00E-02	7.04E-07	4.11E-05	1.00E-05	2.97E-02	0.00E+00	8.16E-10	8.91E-04	8.91E-04	0.00E+00	8.16E-10	1.19E-03	1.19E-03	0.00E+00	8.16E-10	2.73E-03	2.73E-03	1.14E-03	1.37E-03	4.07E-06	5.69E-11	1.77E-10	3.87E-05
Baseline	WORK	Indeno(1,2,3-cd)pyrene	7.18E-06	7.18E-05	1.55E-08	1.06E-06	1.79E-08	7.65E-04	9.89E-07	1.40E-08	5.59E-09	1.01E-06	1.32E-06	1.40E-08	7.45E-09	1.34E-06	3.03E-06	1.40E-08	1.71E-08	3.07E-06	5.69E-08	8.57E-09	1.33E-06	5.29E-09	1.80E-08	8.54E-07
Baseline	WORK	Phenanthrene	1.10E-01	1.10E-01	1.82E-06	8.47E-05	2.75E-05	6.12E-02	0.00E+00	7.60E-09	1.69E-03	1.69E-03	0.00E+00	7.60E-09	6.00E-03	6.00E-03	0.00E+00	7.60E-09	7.36E-02	7.36E-02	3.02E-03	6.90E-03	1.22E-05	8.18E-10	2.55E-09	1.00E-04
Baseline	WORK	Pyrene	2.87E-06	2.87E-05	5.21E-07	1.29E-05	7.18E-09	9.29E-03	0.00E+00	1.15E-08	2.52E-08	3.67E-08	0.00E+00	1.15E-08	3.36E-08	4.51E-08	0.00E+00	1.15E-08	7.73E-08	8.88E-08	6.25E-08	3.87E-08	4.20E-06	1.51E-09	4.25E-09	2.86E-05
Baseline	WORK	C9-C18 Aromatics	1.36E-05	1.36E-04	5.15E-03	1.14E-01	3.41E-08	8.22E+01	0.00E+00	4.03E-06	6.58E-07	4.69E-06	0.00E+00	4.03E-06	8.77E-07	4.91E-06	0.00E+00	4.03E-06	2.02E-06	6.05E-06	5.50E-07	1.01E-06	3.19E-04	1.32E-07	4.36E-07	2.83E-01
Baseline	WORK	Formaldehyde	2.85E-09	2.85E-08	2.08E-04	2.32E-02	7.12E-12	1.68E+01	0.00E+00	1.10E-06	3.60E-09	1.10E-06	0.00E+00	1.10E-06	4.80E-09	1.10E-06	0.00E+00	1.10E-06	1.10E-08	1.11E-06	1.30E-07	5.52E-09	1.54E-06	3.78E-09	1.25E-08	6.57E-04
Future	WORK	2-methylnaphthalene	3.75E-09	3.75E-08	1.94E-06	2.22E-05	9.38E-12	1.60E-02	0.00E+00	3.74E-09	1.28E-10	3.86E-09	0.00E+00	3.74E-09	1.71E-10	3.91E-09	0.00E+00	3.74E-09	5.18E-09	8.91E-09	4.88E-09	1.96E-10	1.28E-07	5.48E-11	1.82E-10	1.05E-03
Future	WORK	3-methylcholanthrene	2.09E-07	2.09E-06	5.01E-10	1.01E-07	5.23E-10	7.31E-05	6.65E-08	2.69E-09	2.36E-10	6.94E-08	8.87E-08	2.69E-09	3.15E-10	9.17E-08	2.04E-07	2.69E-09	7.25E-10	2.07E-07	8.05E-08	3.62E-10	2.59E-06	9.61E-09	3.34E-08	5.72E-07
Future	WORK	7,12-Dimethylbenz(a)anthracene	2.57E-06	2.57E-05	4.45E-09	9.00E-07	6.43E-09	6.49E-04	5.91E-07	7.28E-09	6.63E-09	6.05E-07	7.88E-07	7.28E-09	8.85E-09	8.04E-07	1.81E-06	7.28E-09	2.03E-08	1.84E-06	2.33E-08	1.02E-08	3.85E-07	1.45E-09	5.01E-09	2.45E-07
Future	WORK	Acenaphthene	-2.05E-10	-2.05E-09	1.73E-07	-1.51E-07	-5.13E-13	-1.09E-04	0.00E+00	-8.25E-11	-6.47E-12	-8.90E-11	0.00E+00	-8.25E-11	-8.62E-12	-9.12E-11	0.00E+00	-8.25E-11	-1.98E-11	-1.02E-10	-6.56E-12	-9.92E-12	3.24E-06	2.00E-09	2.48E-09	3.48E-05
Future	WORK	Acenaphthylene	4.69E-09	4.69E-08	3.45E-06	2.59E-06	1.17E-11	1.87E-03	0.00E+00	2.41E-09	1.44E-10	2.55E-09	0.00E+00	2.41E-09	1.92E-10	2.60E-09	0.00E+00	2.41E-09	4.41E-10	2.85E-09	1.50E-10	2.20E-10	6.49E-05	4.99E-08	5.57E-08	6.94E-04
Future	WORK	Anthracene	1.74E-08	1.74E-07	2.23E-07	1.10E-06	4.35E-11	7.95E-04	0.00E+00	7.33E-11	2.70E-10	3.44E-10	0.00E+00	7.33E-11	3.61E-10	4.34E-10	0.00E+00	7.33E-11	8.29E-10	9.03E-10	3.94E-10	4.15E-10	1.48E-06	5.14E-11	1.51E-10	1.23E-05
Future	WORK	Benzo(a)anthracene	1.61E-06	1.61E-05	2.96E-07	1.75E-06	4.02E-09	1.27E-03	8.23E-07	6.72E-09	4.37E-09	8.34E-07	1.10E-06	6.72E-09	5.83E-09	1.11E-06	2.52E-06	6.72E-09	1.34E-08	2.54E-06	2.28E-08	6.70E-09	1.87E-05	6.62E-08	2.32E-07	1.63E-05
Future	WORK	Benzo(a)pyrene	2.04E-06	2.04E-05	6.58E-08	4.81E-07	5.11E-09	3.47E-04	3.16E-07	7.19E-08	3.40E-09	3.91E-07	4.21E-07	7.19E-08	4.53E-09	4.98E-07	9.69E-07	7.19E-08	1.04E-08	1.05E-06	1.86E-08	5.21E-09	8.65E-06	3.37E-08	1.17E-07	3.62E-06
Future	WORK	Benzo(b)fluoranthene	1.54E-07	1.54E-06	9.22E-08	5.66E-07	3.84E-10	4.09E-04	0.00E+00	8.32E-08	4.07E-10	8.36E-08	0.00E+00	8.32E-08	5.43E-10	8.38E-08	0.00E+00	8.32E-08	1.25E-09	8.45E-08	2.65E-08	6.24E-10	6.14E-06	2.16E-08	7.61E-08	5.07E-06
Future	WORK	Benzo(g,h,i)perylene	1.95E-06	1.95E-05	6.65E-08	3.91E-07	4.87E-09	2.82E-04	2.57E-07	2.75E-07	1.66E-09	5.34E-07	3.42E-07	2.75E-07	2.22E-09	6.20E-07	7.88E-07	2.75E-07	5.10E-09	1.07E-06	1.77E-08	2.55E-09	1.78E-05	7.01E-08	2.46E-07	3.66E-06
Future	WORK	Benzo(k)fluoranthene	5.00E-06	5.00E-05	3.23E-08	3.13E-07	1.25E-08	2.26E-04	2.06E-07	3.49E-08	8.55E-09	2.49E-07	2.74E-07	3.49E-08	1.14E-08	3.21E-07	6.31E-07	3.49E-08	2.62E-08	6.92E-07	4.57E-08	1.31E-08	4.06E-06	1.77E-08	5.78E-08	1.77E-06
Future	WORK	Chrysene	4.78E-06	4.78E-05	1.97E-07	9.92E-07	1.19E-08	7.16E-04	2.42E-07	1.46E-08	1.22E-08	2.69E-07	3.23E-07	1.46E-08	1.62E-08	3.54E-07	7.43E-07	1.46E-08	3.73E-08	7.95E-07	6.79E-08	1.86E-08	8.46E-06	3.21E-08	1.05E-07	1.08E-05
Future	WORK	Dibenz(a,h)anthracene	8.80E-07	8.80E-06	5.67E-09	9.99E-08	2.20E-09	7.21E-05	8.86E-08	4.06E-08	6.42E-10	1.30E-07	1.18E-07	4.06E-08	8.55E-10	1.60E-07	2.72E-07	4.06E-08	1.97E-09	3.14E-07	5.35E-09	9.84E-10	1.06E-06	4.25E-09	1.47E-08	3.12E-07
Future	WORK	Fluoranthene	1.85E-07	1.85E-06	3.33E-07	9.16E-07	4.63E-10	6.61E-04	0.00E+00	2.18E-09	1.12E-09	3.30E-09	0.00E+00	2.18E-09	1.49E-09	3.68E-09	0.00E+00	2.18E-09	3.44E-09	5.62E-09	4.17E-09	1.72E-09	3.02E-06	1.76E-09	5.56E-09	1.83E-05
Future	WORK	Fluorene	-1.36E-08	-1.36E-07	4.25E-07	-3.53E-06	-3.40E-11	-2.55E-03	0.00E+00	-7.01E-11	-3.03E-10	-3.74E-10	0.00E+00	-7.01E-11	-4.05E-10	-4.75E-10	0.00E+00	-7.01E-11	-9.30E-10	-1.00E-09	-3.88E-10	-4.65E-10	2.46E-06	3.44E-11	1.07E-10	2.34E-05
Future	WORK	Indeno(1,2,3-cd)pyrene	7.76E-07	7.76E-06	5.73E-09	1.15E-07	1.94E-09	8.27E-05	1.07E-07	1.52E-09	6.05E-10	1.09E-07	1.43E-07	1.52E-09	8.06E-10	1.45E-07	3.28E-07	1.52E-09	1.85E-09	3.32E-07	6.16E-09	9.27E-10	4.90E-07	1.95E-09	6.65E-09	3.15E-07
Future	WORK	Phenanthrene	-9.24E-08	-9.24E-07	1.36E-06	-4.13E-06	-2.31E-10	-2.98E-03	0.00E+00	-3.70E-10	-1.42E-09	-1.79E-09	0.00E+00	-3.70E-10	-5.04E-09	-5.41E-09	0.00E+00	-3.70E-10	-6.18E-08	-6.22E-08	-2.54E-09	-5.80E-09	9.09E-06	6.08E-10	1.90E-09	7.45E-05
Future	WORK	Pyrene	3.20E-07	3.20E-06	3.99E-07	1.43E-06	8.00E-10	1.03E-03	0.00E+00	1.28E-09	2.81E-09	4.09E-09	0.00E+00	1.28E-09	3.74E-09	5.02E-09	0.00E+00	1.28E-09	8.61E-09	9.89E-09	6.96E-09	4.31E-09	3.22E-06	1.16E-09	3.26E-09	2.19E-05
Future	WORK	C9-C18 Aromatics	1.89E-05	1.89E-04	4.57E-03	1.58E-01	4.73E-08	1.14E+02	0.00E+00	5.59E-06	9.12E-07	6.51E-06	0.00E+00	5.59E-06	1.22E-06	6.81E-06	0.00E+00	5.59E-06	2.80E-06	8.39E-06	7.63E-07	1.40E-06	2.83E-04	1.17E-07	3.87E-07	2.51E-01
Future	WORK	Formaldehyde	1.94E-09	1.94E-08	2.06E-04	1.58E-02	4.84E-12	1.14E+01	0.00E+00	7.45E-07	2.45E-09	7.47E-07	0.00E+00	7.45E-07	3.26E-09	7.48E-07	0.00E+00	7.45E-07	7.50E-09	7.53E-07	8.86E-08	3.75E-09	1.52E-06	3.75E-09	1.24E-08	6.51E-04
PDC	WORK	2-methylnaphthalene	4.00E-02	4.00E-02	4.40E-06	5.29E-05	1.00E-05	3.82E-02	0.00E+00	8.90E-09	1.36E-03	1.36E-03	0.00E+00	8.90E-09	1.82E-03	1.82E-03	0.00E+00	8.90E-09	5.52E-02	5.52E-02	5.20E-02	2.09E-03	2.89E-07	1.24E-10	4.11E-10	2.38E-03
PDC	WORK	3-methylcholanthrene	9.25E-07	9.25E-06	4.79E-09	4.48E-07	2.31E-09	3.23E-04	2.94E-07	1.19E-08	1.05E-09	3.07E-07	3.92E-07	1.19E-08	1.39E-09	4.06E-07	9.02E-07	1.19E-08	3.21E-09	9.17E-07	3.56E-07	1.60E-09	2.48E-05	9.19E-08	3.19E-07	5.47E-06
PDC	WORK	7,12-Dimethylbenz(a)anthracene	1.15E-05	1.15E-04	4.30E-08	4.01E-06	2.87E-08	2.89E-03	2.63E-06	3.24E-08	2.96E-08	2.70E-06	3.51E-06	3.24E-08	3.94E-08	3.58E-06	8.08E-06	3.24E-08	9.07E-08	8.20E-06	1.04E-07	4.53E-08	3.72E-06	1.40E-08	4.84E-08	2.37E-06
PDC	WORK	Acenaphthene	1.16E-08	1.16E-07	4.02E-07	8.50E-06	2.90E-11	6.14E-03	0.00E+00	4.66E-09	3.65E-10	5.03E-09	0.00E+00	4.66E-09	4.87E-10	5.15E-09	0.00E+00	4.66E-09	1.12E-09	5.78E-09	3.71E-10	5.60E-10	7.51E-06	4.65E-09	5.76E-09	8.08E-05
PDC	WORK	Acenaphthylene	7.93E-08	7.93E-07	7.79E-06	4.38E-05	1.98E-10	3.16E-02	0.00E+00	4.07E-08	2.43E-09	4.31E-08	0.00E+00	4.07E-08	3.24E-09	4.39E-08	0.00E+00	4.07E-08	7.46E-09	4.82E-08	2.53E-09	3.73E-09	1.46E-04	1.13E-07	1.26E-07	1.57E-03
PDC	WORK	Anthracene	1.02E-07	1.02E-06	5.09E-07	6.49E-06	2.56E-10	4.69E-03	0.00E+00	4.32E-10	1.59E-09	2.03E-09	0.00E+00	4.32E-10	2.12E-09	2.56E-09	0.00E+00	4.32E-10	4.89E-09	5.32E-09	2.32E-09	2.44E-09	3.38E-06	1.17E-10	3.44E-10	2.80E-05
PDC	WORK	Benzo(a)anthracene	5.71E-06	5.71E-05	7.07E-07	6.23E-06	1.43E-08	4.50E-03	2.93E-06	2.39E-08	1.55E-08	2.96E-06	3.90E-06	2.39E-08	2.07E-08	3.94E-06	8.97E-06	2.39E-08	4.76E-08	9.04E-06	8.12E-08	2.38E-08	4.47E-05	1.58E-07	5.53E-07	3.89E-05
PDC	WORK	Benzo(a)pyrene	6.96E-06	6.96E-05	1.49E-07	1.64E-06	1.74E-08	1.18E-03	1.08E-06	2.45E-07	1.16E-08	1.33E-06	1.43E-06	2.45E-07	1.54E-08	1.69E-06	3.30E-06	2.45E-07	3.55E-08	3.58E-06	6.32E-08	1.78E-08	1.96E-05	7.61E-08	2.64E-07	8.18E-06
PDC	WORK	Benzo(b)fluoranthene	1.00E-06	1.00E-05	2.23E-07	3.69E-06	2.50E-09	2.66E-03	0.00E+00	5.42E-07	2.65E-09	5.44E-07	0.00E+00	5.42E-07	3.53E-09	5.45E-07	0.00E+00	5.42E-07	8.13E-09	5.50E-07	1.73E-07	4.06E-09	1.48E-05	5.21E-08	1.84E-07	1.23E-05
PDC	WORK	Benzo(g,h,i)perylene	1.04E-05	1.04E-04	1.52E-07	2.08E-06	2.59E-08	1.50E-03	1.37E-06	1.46E-06	8.86E-09	2.84E-06	1.82E-06	1.46E-06	1.18E-08	3.30E-06	4.19E-06	1.46E-06	2.72E-08	5.69E-06	9.41E-08	1.36E-08	4.06E-05	1.60E-07	5.60E-07	8.33E-06
PDC	WORK	Benzo(k)fluoranthene	2.07E-05	2.07E-04	7.39E-08	1.30E-06	5.18E-08	9.36E-04	8.52E-07	1.44E-07	3.54E-08	1.03E-06	1.14E-06	1.44E-07	4.72E-08	1.33E-06	2.61E-06	1.44E-07	1.09E-07	2.87E-06	1.89E-07	5.43E-08	9.31E-06	4.05E-08	1.32E-07	4.06E-06
PDC	WORK	Chrysene	2.25E-05	2.25E-04	4.48E-07	4.67E-06	5.62E-08	3.37E-03	1.14E-06	6.86E-08	5.72E-08	1.27E-06	1.52E-06	6.86E-08	7.63E-08	1.66E-06	3.49E-06	6.86E-08	1.75E-07	3.74E-06	3.19E-07	8.77E-08	1.92E-05	7.30E-08	2.39E-07	2.46E-05
PDC	WORK	Dibenz(a,h)anthracene	1.17E-05	1.17E-04	1.37E-08	1.33E-06	2.94E-08	9.62E-04	1.18E-06	5.42E-07	8.56E-09	1.73E-06	1.58E-06	5.42E-07	1.14E-08	2.13E-06	3.62E-06	5.42E-07	2.62E-08	4.19E-06	7.13E-08	1.31E-08	2.56E-06	1.03E-08	3.56E-08	7.54E-07
PDC	WORK	Fluoranthene	3.04E-06	3.04E-05	7.76E-07	1.50E-05	7.61E-09	1.09E-02	0.00E+00	3.59E-08	1.84E-08	5.43E-08	0.00E+00	3.59E-08	2.45E-08	6.04E-08	0.00E+00	3.59E-08	5.64E-08	9.23E-08	6.85E-08	2.82E-08	7.04E-06	4.09E-09	1.29E-08	4.27E-05
PDC	WORK	Fluorene	4.00E-02	4.00E-02	1.02E-06	3.75E-05	1.00E-05	2.71E-02	0.00E+00	7.45E-10	8.91E-04	8.91E-04	0.00E+00	7.45E-10	1.19E-03	1.19E-03	0.00E+00	7.45E-10	2.73E-03	2.73E-03	1.14E-03	1.37E-03	5.89E-06	8.24E-11	2.56E-10	5.61E-05
PDC	WORK	Indeno(1,2,3-cd)pyrene	7.95E-06	7.95E-05	1.16E-08	1.17E-06	1.99E-08	8.48E-04	1.10E-06	1.55E-08	6.19E-09	1.12E-06	1.46E-06	1.55E-08	8.26E-09	1.49E-06	3.36E-06	1.55E-08	1.90E-08	3.40E-06	6.31E-08	9.50E-09	9.93E-07	3.96E-09	1.35E-08	6.38E-07
PDC	WORK	Phenanthrene	1.10E-01	1.10E-01	3.18E-06	8.06E-05	2.75E-05	5.82E-02	0.00E+00	7.23E-09	1.69E-03	1.69E-03	0.00E+00	7.23E-09	6.00E-03	6.00E-03	0.00E+00	7.23E-09	7.36E-02	7.36E-02	3.02E-03	6.90E-03	2.13E-05	1.43E-09	4.44E-09	1.75E-04
PDC	WORK	Pyrene	3.19E-06	3.19E-05	9.20E-07	1.43E-05	7.98E-09	1.03E-02	0.00E+00	1.28E-08	2.80E-08	4.08E-08	0.00E+00	1.28E-08	3.74E-08	5.01E-08	0.00E+00	1.28E-08	8.60E-08	9.87E-08	6.94E-08	4.30E-08	7.42E-06	2.66E-09	7.51E-09	5.06E-05
PDC	WORK	C9-C18 Aromatics	3.26E-05	3.26E-04	9.72E-03	2.72E-01	8.14E-08	1.96E+02	0.00E+00	9.63E-06	1.57E-06	1.12E-05	0.00E+00	9.63E-06	2.09E-06	1.17E-05	0.00E+00	9.63E-06	4.81E-06	1.44E-05	1.31E-06	2.41E-06	6.02E-04	2.48E-07	8.22E-07	5.35E-01
PDC	WORK	Formaldehyde	4.78E-09	4.78E-08	3.81E-04	3.90E-02	1.20E-11	2.81E+01	0.00E+00	1.84E-06	6.05E-09	1.85E-06	0.00E+00	1.84E-06	8.06E-09	1.85E-06	0.00E+00	1.84E-06	1.85E-08	1.86E-06	2.19E-07	9.27E-09	2.82E-06	6.93E-09	2.29E-08	1.20E-03
Project	WORK	2-methylnaphthalene	2.48E-10	2.48E-09	7.98E-09	1.47E-06	6.19E-13	1.06E-03	0.00E+00	2.47E-10	8.45E-12	2.55E-10	0.00E+00	2.47E-10	1.13E-11	2.58E-10	0.00E+00	2.47E-10	3.42E-10	5.88E-10	3.22E-10	1.30E-11	5.25E-10	2.25E-13	7.47E-13	4.33E-06
Project	WORK	3-methylcholanthrene	3.31E-07	3.31E-06	7.87E-10	1.60E-07	8.26E-10	1.16E-04	1.05E-07	4.25E-09	3.74E-10	1.10E-07	1.40E-07	4.25E-09	4.98E-10	1.45E-07	3.22E-07	4.25E-09	1.15E-09	3.28E-07	1.27E-07	5.73E-10	4.07E-06	1.51E-08	5.24E-08	8.98E-07
Project	WORK	7,12-Dimethylbenz(a)anthracene	4.07E-06	4.07E-05	6.99E-09	1.42E-06	1.02E-08	1.03E-03	9.35E-07	1.15E-08	1.05E-08	9.57E-07	1.25E-06	1.15E-08	1.40E-08	1.27E-06	2.87E-06	1.15E-08	3.22E-08	2.91E-06	3.69E-08	1.61E-08	6.04E-07	2.28E-09	7.86E-09	3.85E-07
Project	WORK	Acenaphthene	8.58E-10	8.58E-09	6.28E-09	6.29E-07	2.15E-12	4.54E-04	0.00E+00	3.45E-10	2.70E-11	3.72E-10	0.00E+00	3.45E-10	3.60E-11	3.81E-10	0.00E+00	3.45E-10	8.29E-11	4.28E-10	2.74E-11	4.14E-11	1.17E-07	7.25E-11	9.00E-11	1.26E-06
Project	WORK	Acenaphthylene	8.53E-10	8.53E-09	4.42E-09	4.71E-07	2.13E-12	3.40E-04	0.00E+00	4.38E-10	2.62E-11	4.64E-10	0.00E+00	4.38E-10	3.49E-11	4.73E-10	0.00E+00	4.38E-10	8.03E-11	5.18E-10	2.73E-11	4.01E-11	8.31E-08	6.39E-11	7.13E-11	8.89E-07
Project	WORK	Anthracene	1.25E-08	1.25E-07	7.69E-09	7.91E-07	3.12E-11	5.71E-04	0.00E+00	5.26E-11	1.94E-10	2.47E-10	0.00E+00	5.26E-11	2.59E-10	3.11E-10	0.00E+00	5.26E-11	5.95E-10	6.48E-10	2.82E-10	2.98E-10	5.10E-08	1.77E-12	5.20E-12	4.23E-07
Project	WORK	Benzo(a)anthracene	4.35E-05	4.35E-04	1.17E-07	4.75E-05	1.09E-07	3.43E-02	2.23E-05	1.82E-07	1.18E-07	2.26E-05	2.97E-05	1.82E-07	1.58E-07	3.00E-05	6.83E-05	1.82E-07	3.63E-07	6.89E-05	6.18E-07	1.81E-07	7.36E-06	2.60E-08	9.11E-08	6.41E-06
Project	WORK	Benzo(a)pyrene	1.92E-06	1.92E-05	4.66E-09	4.52E-07	4.81E-09	3.26E-04	2.97E-07	6.76E-08	3.20E-09	3.68E-07	3.96E-07	6.76E-08	4.26E-09	4.68E-07	9.11E-07	6.76E-08	9.81E-09	9.89E-07	1.74E-08	4.90E-09	6.13E-07	2.38E-09	8.26E-09	2.56E-07
Project	WORK	Benzo(b)fluoranthene	1.12E-07	1.12E-06	3.71E-09	4.13E-07	2.80E-10	2.99E-04	0.00E+00	6.08E-08	2.97E-10	6.11E-08	0.00E+00	6.08E-08	3.96E-10	6.12E-08	0.00E+00	6.08E-08	9.12E-10	6.17E-08	1.94E-08	4.56E-10	2.47E-07	8.68E-10	3.06E-09	2.04E-07
Project	WORK	Benzo(g,h,i)perylene	2.08E-06	2.08E-05	4.88E-09	4.18E-07	5.20E-09	3.02E-04	2.75E-07	2.94E-07	1.78E-09	5.70E-07	3.66E-07	2.94E-07	2.37E-09	6.62E-07	8.42E-07	2.94E-07	5.46E-09	1.14E-06	1.89E-08	2.73E-09	1.31E-06	5.14E-09	1.80E-08	2.68E-07
Project	WORK	Benzo(k)fluoranthene	6.61E-06	6.61E-05	3.60E-09	4.13E-07	1.65E-08	2.99E-04	2.72E-07	4.61E-08	1.13E-08	3.29E-07	3.62E-07	4.61E-08	1.50E-08	4.23E-07	8.33E-07	4.61E-08	3.46E-08	9.14E-07	6.04E-08	1.73E-08	4.53E-07	1.97E-09	6.44E-09	1.98E-07
Project	WORK	Chrysene	3.49E-06	3.49E-05	7.57E-09	7.26E-07	8.73E-09	5.24E-04	1.77E-07	1.07E-08	8.90E-09	1.97E-07	2.36E-07	1.07E-08	1.19E-08	2.59E-07	5.43E-07	1.07E-08	2.73E-08	5.81E-07	4.97E-08	1.36E-08	3.25E-07	1.23E-09	4.04E-09	4.16E-07
Project	WORK	Dibenz(a,h)anthracene	5.39E-06	5.39E-05	6.63E-09	6.12E-07	1.35E-08	4.42E-04	5.43E-07	2.49E-07	3.93E-09	7.96E-07	7.24E-07	2.49E-07	5.24E-09	9.78E-07	1.67E-06	2.49E-07	1.21E-08	1.93E-06	3.28E-08	6.03E-09	1.24E-06	4.97E-09	1.72E-08	3.65E-07
Project	WORK	Fluoranthene	2.87E-07	2.87E-06	1.52E-08	1.42E-06	7.16E-10	1.02E-03	0.00E+00	3.38E-09	1.73E-09	5.11E-09	0.00E+00	3.38E-09	2.31E-09	5.69E-09	0.00E+00	3.38E-09	5.31E-09	8.69E-09	6.45E-09	2.66E-09	1.38E-07	8.00E-11	2.53E-10	8.35E-07
Project	WORK	Fluorene	7.88E-09	7.88E-08	2.24E-08	2.05E-06	1.97E-11	1.48E-03	0.00E+00	4.06E-11	1.76E-10	2.16E-10	0.00E+00	4.06E-11	2.34E-10	2.75E-10	0.00E+00	4.06E-11	5.39E-10	5.79E-10	2.25E-10	2.69E-10	1.29E-07	1.81E-12	5.62E-12	1.23E-06
Project	WORK	Indeno(1,2,3-cd)pyrene	4.51E-06	4.51E-05	6.83E-09	6.65E-07	1.13E-08	4.80E-04	6.22E-07	8.81E-09	3.51E-09	6.34E-07	8.29E-07	8.81E-09	4.68E-09	8.42E-07	1.91E-06	8.81E-09	1.08E-08	1.93E-06	3.58E-08	5.38E-09	5.84E-07	2.33E-09	7.92E-09	3.75E-07
Project	WORK	Phenanthrene	2.32E-07	2.32E-06	1.15E-07	1.04E-05	5.80E-10	7.49E-03	0.00E+00	9.31E-10	3.57E-09	4.50E-09	0.00E+00	9.31E-10	1.27E-08	1.36E-08	0.00E+00	9.31E-10	1.55E-07	1.56E-07	6.37E-09	1.46E-08	7.72E-07	5.16E-11	1.61E-10	6.33E-06
Project	WORK	Pyrene	2.06E-07	2.06E-06	7.52E-09	9.24E-07	5.15E-10	6.67E-04	0.00E+00	8.24E-10	1.81E-09	2.63E-09	0.00E+00	8.24E-10	2.41E-09	3.24E-09	0.00E+00	8.24E-10	5.55E-09	6.37E-09	4.48E-09	2.78E-09	6.07E-08	2.18E-11	6.15E-11	4.14E-07

Table D-17 Summary of Chemical Concentrations Used to Estimate Exposures

Scenario	Site	Chemical	Soil	Surface Soil	Surface Water	Air	Dust	Deposition Predicted	Environmental Concentrations																	
									Plant Deposition	Plant Air	Plant Soil	Plant SUM	Berries Deposition	Berries Air	Berries Soil	Berries SUM	Lab_tea Deposition	Lab_tea Air	Lab_tea Soil	Lab_tea SUM	Root Soil	Cattail Soil	Moose	Ruffed_grouse	Snowshoe _hare	Fish Water
			mg/kg	mg/kg	mg/L	ug/m3	ug/m3	mg/m2/yr	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww	mg/kg ww
Project	WORK	C9-C18 Aromatics	1.28E-07	1.28E-06	1.12E-05	1.07E-03	3.21E-10	7.73E-01	0.00E+00	3.79E-08	6.19E-09	4.41E-08	0.00E+00	3.79E-08	8.25E-09	4.62E-08	0.00E+00	3.79E-08	1.90E-08	5.69E-08	5.18E-09	9.49E-09	6.94E-07	2.87E-10	9.49E-10	6.17E-04
Project	WORK	Formaldehyde	4.27E-08	4.27E-07	6.98E-04	3.48E-01	1.07E-10	2.51E+02	0.00E+00	1.64E-05	5.39E-08	1.65E-05	0.00E+00	1.64E-05	7.19E-08	1.65E-05	0.00E+00	1.64E-05	1.65E-07	1.66E-05	1.95E-06	8.27E-08	5.16E-06	1.27E-08	4.19E-08	2.21E-03

Table D-18 Human Oral Exposure Limits

Chemical	Exposure Limit Type	Water Exposure Limit [ug/kg/day]	Oral Exposure Limit [ug/kg/day]	Reference / Comment
2-methylnaphthalene	RfD	4	4	Part of C9-C18 aromatics group
3-methylcholanthrene	RfD	30	30	Using C19-C34 aromatics group limit
7,12-Dimethylbenz(a)anthracene	RsD	0.0014	0.0014	Using B(a)P equivalent
Acenaphthene	RfD	40	40	Part of C9-C18 aromatics group
Acenaphthylene	RfD	40	40	Part of C9-C18 aromatics group
Anthracene	RfD	40	40	US EPA IRIS
Benzo(a)anthracene	RsD	0.0014	0.0014	Using B(a)P equivalent
Benzo(a)pyrene	RsD	0.0014	0.0014	Using B(a)P equivalent
Benzo(b)fluoranthene	RsD	0.0014	0.0014	Using B(a)P equivalent
Benzo(g,h,i)perylene	RsD	0.0014	0.0014	Using B(a)P equivalent
Benzo(k)fluoranthene	RsD	0.0014	0.0014	Using B(a)P equivalent
Chrysene	RsD	0.0014	0.0014	Using B(a)P equivalent
Dibenz(a,h)anthracene	RsD	0.0014	0.0014	Using B(a)P equivalent
Fluoranthene	RsD	0.0014	0.0014	Using B(a)P equivalent
Fluorene	RfD	40	40	Part of C9-C18 aromatics group
Indeno(1,2,3-cd)pyrene	RsD	0.0014	0.0014	Using B(a)P equivalent
Phenanthrene	RsD	0.0014	0.0014	Using B(a)P equivalent
Pyrene	RfD	30	30	See toxicity profiles for detail
C9-C18 Aromatics	RfD	40	40	See toxicity profiles for detail
Formaldehyde	RfD	150	150	See toxicity profiles for detail

Table D-19 Human Receptor Exposure Variables

Type	Receptor	Variable	Value	Units	Reference/Comment
RES	Adolescent	AIR	1.56E+01	m^3/d	Health Canada (2009a); air inhalation rate
RES	Adult	AIR	1.66E+01	m^3/d	Health Canada (2009a); air inhalation rate
RES	Child	AIR	1.45E+01	m^3/d	Health Canada (2009a); air inhalation rate
RES	Infant	AIR	2.20E+00	m^3/d	Health Canada (2009a); air inhalation rate
RES	Toddler	AIR	8.30E+00	m^3/d	Health Canada (2009a); air inhalation rate
RES	Adolescent	Berries	1.90E+01	g/d	Wein (1989); AHW (2007)
RES	Adult	Berries	2.30E+01	g/d	Wein (1989); AHW (2007)
RES	Child	Berries	1.10E+01	g/d	Wein (1989); AHW (2007)
RES	Infant	Berries	0.00E+00	g/d	assumed, diet entirely breast milk
RES	Toddler	Berries	5.00E+00	g/d	Wein (1989); AHW (2007)
RES	Adolescent	BW	5.97E+01	kg	Health Canada (2009a); body weight
RES	Adult	BW	7.07E+01	kg	Health Canada (2009a); body weight
RES	Child	BW	3.29E+01	kg	Health Canada (2009a); body weight
RES	Infant	BW	8.20E+00	kg	Health Canada (2009a); body weight
RES	Toddler	BW	1.65E+01	kg	Health Canada (2009a); body weight
RES	Adolescent	Cattail	3.00E+00	g/d	Wein (1989); AHW (2007)
RES	Adult	Cattail	3.00E+00	g/d	Wein (1989); AHW (2007)
RES	Child	Cattail	1.00E+00	g/d	Wein (1989); AHW (2007)
RES	Infant	Cattail	0.00E+00	g/d	assumed, diet entirely breast milk
RES	Toddler	Cattail	1.00E+00	g/d	Wein (1989); AHW (2007)
RES	Adolescent	Fish	4.00E+01	g/d	Health Canada (2007)
RES	Adult	Fish	4.00E+01	g/d	Health Canada (2007)
RES	Child	Fish	3.30E+01	g/d	Health Canada (2007)
RES	Infant	Fish	0.00E+00	g/d	Health Canada (2007)
RES	Toddler	Fish	2.00E+01	g/d	Health Canada (2007)
RES	Adolescent	Lab_tea	3.00E+00	g/d	Wein (1989); AHW (2007)
RES	Adult	Lab_tea	3.00E+00	g/d	Wein (1989); AHW (2007)
RES	Child	Lab_tea	1.00E+00	g/d	Wein (1989); AHW (2007)
RES	Infant	Lab_tea	0.00E+00	g/d	assumed, diet entirely breast milk
RES	Toddler	Lab_tea	1.00E+00	g/d	Wein (1989); AHW (2007)
RES	Adolescent	LAF	1.00E-01	yr-lifestage/yr-total	Health Canada (2009a); lifetime adjustment factor for gen. pop.
RES	Adult	LAF	7.50E-01	yr-lifestage/yr-total	Health Canada (2009a); lifetime adjustment factor for gen. pop.
RES	Child	LAF	8.75E-02	yr-lifestage/yr-total	Health Canada (2009a); lifetime adjustment factor for gen. pop.
RES	Infant	LAF	6.67E-03	yr-lifestage/yr-total	Health Canada (2009a); lifetime adjustment factor for gen. pop.
RES	Toddler	LAF	6.00E-02	yr-lifestage/yr-total	Health Canada (2009a); lifetime adjustment factor for gen. pop.
RES	Adolescent	Moose	1.33E+02	g/d	Health Canada (2009); Wein (1989)
RES	Adult	Moose	2.05E+02	g/d	Health Canada (2009); Wein (1989)
RES	Child	Moose	9.50E+01	g/d	Health Canada (2009); Wein (1989)
RES	Infant	Moose	0.00E+00	g/d	Health Canada (2009); Wein (1989)
RES	Toddler	Moose	6.50E+01	g/d	Health Canada (2009); Wein (1989)
RES	Adolescent	Plant	1.20E+02	g/d	Health Canada (2009a); other vegetable for general population

Table D-19 Human Receptor Exposure Variables

Type	Receptor	Variable	Value	Units	Reference/Comment
RES	Adult	Plant	1.37E+02	g/d	Health Canada (2009a); other vegetable for general population
RES	Child	Plant	9.80E+01	g/d	Health Canada (2009a); other vegetable for general population
RES	Infant	Plant	0.00E+00	g/d	assumed, diet entirely breast milk
RES	Toddler	Plant	6.70E+01	g/d	Health Canada (2009a); other vegetable for general population
RES	Adolescent	Root	2.27E+02	g/d	Health Canada (2009a); root vegetable for general population
RES	Adult	Root	1.88E+02	g/d	Health Canada (2009a); root vegetable for general population
RES	Child	Root	1.61E+02	g/d	Health Canada (2009a); root vegetable for general population
RES	Infant	Root	0.00E+00	g/d	assumed, diet entirely breast milk
RES	Toddler	Root	1.05E+02	g/d	Health Canada (2009a); root vegetable for general population
RES	Adolescent	Ruffed_Grouse	1.40E+01	g/d	Health Canada (2009); Wein (1989)
RES	Adult	Ruffed_Grouse	2.20E+01	g/d	Health Canada (2009); Wein (1989)
RES	Child	Ruffed_Grouse	1.00E+01	g/d	Health Canada (2009); Wein (1989)
RES	Infant	Ruffed_Grouse	0.00E+00	g/d	Health Canada (2009); Wein (1989)
RES	Toddler	Ruffed_Grouse	7.00E+00	g/d	Health Canada (2009); Wein (1989)
RES	Adolescent	SAH	8.00E+02	cm^2	Health Canada (2009a); surface area hands
RES	Adult	SAH	8.90E+02	cm^2	Health Canada (2009a); surface area hands
RES	Child	SAH	5.90E+02	cm^2	Health Canada (2009a); surface area hands
RES	Infant	SAH	3.20E+02	cm^2	Health Canada (2009a); surface area hands
RES	Toddler	SAH	4.30E+02	cm^2	Health Canada (2009a); surface area hands
RES	Adolescent	SAO	7.20E+03	cm^2	Health Canada (2009a); surface area other(arms and legs)
RES	Adult	SAO	8.22E+03	cm^2	Health Canada (2009a); surface area other(arms and legs)
RES	Child	SAO	4.55E+03	cm^2	Health Canada (2009a); surface area other(arms and legs)
RES	Infant	SAO	1.46E+03	cm^2	Health Canada (2009a); surface area other(arms and legs)
RES	Toddler	SAO	2.58E+03	cm^2	Health Canada (2009a); surface area other(arms and legs)
RES	Adolescent	SAT	1.55E+04	cm^2	Health Canada (2009a); surface area hands
RES	Adult	SAT	1.76E+04	cm^2	Health Canada (2009a); surface area hands
RES	Child	SAT	1.01E+04	cm^2	Health Canada (2009a); surface area hands
RES	Infant	SAT	3.62E+03	cm^2	Health Canada (2009a); surface area hands
RES	Toddler	SAT	6.13E+03	cm^2	Health Canada (2009a); surface area hands
RES	Adolescent	SEF	2.55E-01	hr/d	Assumed: 1hr/day and 93 days/365 days; swim exposure factor
RES	Adult	SEF	2.55E-01	hr/d	Assumed: 1hr/day and 93 days/365 days; swim exposure factor
RES	Child	SEF	2.55E-01	hr/d	Assumed: 1hr/day and 93 days/365 days; swim exposure factor
RES	Infant	SEF	2.55E-01	hr/d	Assumed: 1hr/day and 93 days/365 days; swim exposure factor
RES	Toddler	SEF	2.55E-01	hr/d	Assumed: 1hr/day and 93 days/365 days; swim exposure factor
RES	Adolescent	SIR	2.00E-02	g/d	Health Canada (2009a); soil ingestion rate
RES	Adult	SIR	2.00E-02	g/d	Health Canada (2009a); soil ingestion rate
RES	Child	SIR	2.00E-02	g/d	Health Canada (2009a); soil ingestion rate
RES	Infant	SIR	2.00E-02	g/d	Health Canada (2009a); soil ingestion rate
RES	Toddler	SIR	8.00E-02	g/d	Health Canada (2009a); soil ingestion rate

Table D-19 Human Receptor Exposure Variables

Type	Receptor	Variable	Value	Units	Reference/Comment
RES	Adolescent	SLH	1.00E-04	g/cm^2/event	Health Canada (2009a); skin loading hands
RES	Adult	SLH	1.00E-04	g/cm^2/event	Health Canada (2009a); skin loading hands
RES	Child	SLH	1.00E-04	g/cm^2/event	Health Canada (2009a); skin loading hands
RES	Infant	SLH	1.00E-04	g/cm^2/event	Health Canada (2009a); skin loading hands
RES	Toddler	SLH	1.00E-04	g/cm^2/event	Health Canada (2009a); skin loading hands
RES	Adolescent	SLO	1.00E-05	g/cm^2/event	Health Canada (2009a); skin loading other
RES	Adult	SLO	1.00E-05	g/cm^2/event	Health Canada (2009a); skin loading other
RES	Child	SLO	1.00E-05	g/cm^2/event	Health Canada (2009a); skin loading other
RES	Infant	SLO	1.00E-05	g/cm^2/event	Health Canada (2009a); skin loading other
RES	Toddler	SLO	1.00E-05	g/cm^2/event	Health Canada (2009a); skin loading other
RES	Adolescent	Snowshoe_Hare	2.80E+01	g/d	Health Canada (2009); Wein (1989)
RES	Adult	Snowshoe_Hare	4.30E+01	g/d	Health Canada (2009); Wein (1989)
RES	Child	Snowshoe_Hare	2.00E+01	g/d	Health Canada (2009); Wein (1989)
RES	Infant	Snowshoe_Hare	0.00E+00	g/d	Health Canada (2009); Wein (1989)
RES	Toddler	Snowshoe_Hare	1.40E+01	g/d	Health Canada (2009); Wein (1989)
RES	Adolescent	SW_IR	2.50E-02	L/d	US EPA 2003; Assumed 1hr / day; swim ingestion rate
RES	Adult	SW_IR	2.50E-02	L/d	US EPA 2003; Assumed 1hr / day; swim ingestion rate
RES	Child	SW_IR	5.00E-02	L/d	US EPA 2003; Assumed 1hr / day; swim ingestion rate
RES	Infant	SW_IR	0.00E+00	L/d	US EPA 2003; Assumed 1hr / day; swim ingestion rate
RES	Toddler	SW_IR	5.00E-02	L/d	US EPA 2003; Assumed 1hr / day; swim ingestion rate
RES	Adolescent	WIR	1.00E+00	L/d	Health Canada (2009a); water or drinking water ingestion rate
RES	Adult	WIR	1.50E+00	L/d	Health Canada (2009a); water or drinking water ingestion rate
RES	Child	WIR	8.00E-01	L/d	Health Canada (2009a); water or drinking water ingestion rate
RES	Infant	WIR	3.00E-01	L/d	Health Canada (2009a); water or drinking water ingestion rate
RES	Toddler	WIR	6.00E-01	L/d	Health Canada (2009a); water or drinking water ingestion rate

Table D-20 Chemical Group

Chemical	Group	Comment
2-methylnaphthalene	VOC	
3-methylcholanthrene	VOC	
7,12-Dimethylbenz(a)anthracene	PAH	
Acenaphthene	PAH	
Acenaphthylene	PAH	
Anthracene	PAH	
Benzo(a)anthracene	PAH	
Benzo(a)pyrene	PAH	
Benzo(b)fluoranthene	PAH	
Benzo(g,h,i)perylene	PAH	
Benzo(k)fluoranthene	PAH	
Chrysene	PAH	
Dibenz(a,h)anthracene	PAH	
Fluoranthene	PAH	
Fluorene	PAH	
Indeno(1,2,3-cd)pyrene	PAH	
Phenanthrene	PAH	
Pyrene	PAH	
C9-C18 aromatics	VOC	
Formaldehyde	VOC	

Table D-21 Molecular weight [grams/mole]

Chemical	Value	Comment / Reference
2-methylnaphthalene	1.42E+02	Syracuse Research Corporation 2011
3-methylcholanthrene	2.68E+02	Syracuse Research Corporation 2011
7,12-Dimethylbenz(a)anthracene	2.56E+02	Syracuse Research Corporation 2011
Acenaphthene	1.54E+02	Syracuse Research Corporation 2011
Acenaphthylene	1.52E+02	Syracuse Research Corporation 2011
Anthracene	1.78E+02	Syracuse Research Corporation 2011
Benzo(a)anthracene	2.28E+02	Syracuse Research Corporation 2011
Benzo(a)pyrene	2.52E+02	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	2.52E+02	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	2.76E+02	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	2.52E+02	Syracuse Research Corporation 2011
Chrysene	2.28E+02	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	2.78E+02	Syracuse Research Corporation 2011
Fluoranthene	2.02E+02	Syracuse Research Corporation 2011
Fluorene	1.66E+02	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	2.76E+02	Syracuse Research Corporation 2011
Phenanthrene	1.78E+02	Syracuse Research Corporation 2011
Pyrene	2.02E+02	Syracuse Research Corporation 2011
C9-C18 Aromatics	1.50E+02	CCME 2008
Formaldehyde	3.00E+01	Syracuse Research Corporation 2011

Table D-22 Kow

Chemical	Value	Log(Kow)	Reference
2-methylnaphthalene	7.24E+03	3.86E+00	Syracuse Research Corporation 2011
3-methylcholanthrene	2.63E+06	6.42E+00	Syracuse Research Corporation 2011
7,12-Dimethylbenz(a)anthracene	6.31E+05	5.80E+00	Syracuse Research Corporation 2011
Acenaphthene	8.32E+03	3.92E+00	Syracuse Research Corporation 2011
Acenaphthylene	8.71E+03	3.94E+00	Syracuse Research Corporation 2011
Anthracene	2.82E+04	4.45E+00	Syracuse Research Corporation 2011
Benzo(a)anthracene	5.75E+05	5.76E+00	Syracuse Research Corporation 2011
Benzo(a)pyrene	1.35E+06	6.13E+00	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	6.03E+05	5.78E+00	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	4.27E+06	6.63E+00	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	1.29E+06	6.11E+00	Syracuse Research Corporation 2011
Chrysene	6.46E+05	5.81E+00	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	5.62E+06	6.75E+00	Syracuse Research Corporation 2011
Fluoranthene	1.45E+05	5.16E+00	Syracuse Research Corporation 2011
Fluorene	1.51E+04	4.18E+00	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	5.01E+06	6.70E+00	Syracuse Research Corporation 2011
Phenanthrene	2.88E+04	4.46E+00	Syracuse Research Corporation 2011
Pyrene	7.59E+04	4.88E+00	Syracuse Research Corporation 2011
C9-C18 Aromatics	3.98E+03	3.60E+00	CCME 2008
Formaldehyde	2.24E+00	3.50E-01	Syracuse Research Corporation 2011

Table D-23 Henry's Constant [atm m3 / mol]

Chemical	Value	H [Pa m^3/mol]	H' [Unitless]	Reference
2-methylnaphthalene	5.18E-04	5.25E+01	2.12E-02	Syracuse Research Corporation 2011
3-methylcholanthrene	5.24E-06	5.31E-01	2.15E-04	Syracuse Research Corporation 2011
7,12-Dimethylbenz(a)anthracene	3.76E-06	3.81E-01	1.54E-04	Syracuse Research Corporation 2011
Acenaphthene	1.84E-04	1.86E+01	7.54E-03	Syracuse Research Corporation 2011
Acenaphthylene	1.14E-04	1.16E+01	4.67E-03	Syracuse Research Corporation 2011
Anthracene	5.56E-05	5.63E+00	2.28E-03	Syracuse Research Corporation 2011
Benzo(a)anthracene	1.20E-05	1.22E+00	4.92E-04	Syracuse Research Corporation 2011
Benzo(a)pyrene	4.57E-07	4.63E-02	1.87E-05	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	6.57E-07	6.66E-02	2.69E-05	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	3.31E-07	3.35E-02	1.36E-05	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	5.84E-07	5.92E-02	2.39E-05	Syracuse Research Corporation 2011
Chrysene	5.23E-06	5.30E-01	2.14E-04	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	1.41E-07	1.43E-02	5.78E-06	Syracuse Research Corporation 2011
Fluoranthene	8.86E-06	8.98E-01	3.63E-04	Syracuse Research Corporation 2011
Fluorene	9.62E-05	9.75E+00	3.94E-03	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	3.48E-07	3.53E-02	1.43E-05	Syracuse Research Corporation 2011
Phenanthrene	4.23E-05	4.29E+00	1.73E-03	Syracuse Research Corporation 2011
Pyrene	1.19E-05	1.21E+00	4.88E-04	Syracuse Research Corporation 2011
C9-C18 Aromatics	1.30E-03	1.32E+02	5.33E-02	CCME 2008
Formaldehyde	3.37E-07	3.41E-02	1.38E-05	Syracuse Research Corporation 2011

Table D-24 Vapour Pressure [mmHg]

Chemical	Value	VP[atm]	VP[Pa]	VP[kPa]	Reference
2-methylnaphthalene	5.50E-02	7.24E-05	7.33E+00	7.33E-03	Syracuse Research Corporation 2011
3-methylcholanthrene	4.30E-08	5.66E-11	5.73E-06	5.73E-09	Syracuse Research Corporation 2011
7,12-Dimethylbenz(a)anthracene	6.80E-07	8.95E-10	9.07E-05	9.07E-08	Syracuse Research Corporation 2011
Acenaphthene	2.15E-03	2.83E-06	2.87E-01	2.87E-04	Syracuse Research Corporation 2011
Acenaphthylene	6.68E-03	8.79E-06	8.91E-01	8.91E-04	Syracuse Research Corporation 2011
Anthracene	6.53E-06	8.59E-09	8.71E-04	8.71E-07	Syracuse Research Corporation 2011
Benzo(a)anthracene	2.10E-07	2.76E-10	2.80E-05	2.80E-08	Syracuse Research Corporation 2011
Benzo(a)pyrene	5.49E-09	7.22E-12	7.32E-07	7.32E-10	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	5.00E-07	6.58E-10	6.67E-05	6.67E-08	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	1.00E-10	1.32E-13	1.33E-08	1.33E-11	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	9.65E-10	1.27E-12	1.29E-07	1.29E-10	Syracuse Research Corporation 2011
Chrysene	6.23E-09	8.20E-12	8.31E-07	8.31E-10	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	9.55E-10	1.26E-12	1.27E-07	1.27E-10	Syracuse Research Corporation 2011
Fluoranthene	9.22E-06	1.21E-08	1.23E-03	1.23E-06	Syracuse Research Corporation 2011
Fluorene	6.00E-04	7.89E-07	8.00E-02	8.00E-05	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	1.25E-10	1.64E-13	1.67E-08	1.67E-11	Syracuse Research Corporation 2011
Phenanthrene	1.21E-04	1.59E-07	1.61E-02	1.61E-05	Syracuse Research Corporation 2011
Pyrene	4.50E-06	5.92E-09	6.00E-04	6.00E-07	Syracuse Research Corporation 2011
C9-C18 Aromatics	3.65E-02	4.80E-05	4.86E+00	4.86E-03	CCME 2008
Formaldehyde	3.89E+03	5.12E+00	5.19E+05	5.19E+02	Syracuse Research Corporation 2011

Table D-25 Solubility [mg/L] or [ppm]

Chemical	Value	S[kg/m3]	Reference
2-methylnaphthalene	2.46E+01	2.46E-02	Syracuse Research Corporation 2011
3-methylcholanthrene	2.90E-03	2.90E-06	Syracuse Research Corporation 2011
7,12-Dimethylbenz(a)anthracene	6.10E-02	6.10E-05	Syracuse Research Corporation 2011
Acenaphthene	3.90E+00	3.90E-03	Syracuse Research Corporation 2011
Acenaphthylene	1.61E+01	1.61E-02	Syracuse Research Corporation 2011
Anthracene	4.34E-02	4.34E-05	Syracuse Research Corporation 2011
Benzo(a)anthracene	9.40E-03	9.40E-06	Syracuse Research Corporation 2011
Benzo(a)pyrene	1.62E-03	1.62E-06	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	1.50E-03	1.50E-06	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	2.60E-04	2.60E-07	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	8.00E-04	8.00E-07	Syracuse Research Corporation 2011
Chrysene	2.00E-03	2.00E-06	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	2.49E-03	2.49E-06	Syracuse Research Corporation 2011
Fluoranthene	2.60E-01	2.60E-04	Syracuse Research Corporation 2011
Fluorene	1.69E+00	1.69E-03	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	1.90E-04	1.90E-07	Syracuse Research Corporation 2011
Phenanthrene	1.15E+00	1.15E-03	Syracuse Research Corporation 2011
Pyrene	1.35E-01	1.35E-04	Syracuse Research Corporation 2011
C9-C18 Aromatics	5.80E+00	5.80E-03	CCME 2008
Formaldehyde	4.00E+05	4.00E+02	Syracuse Research Corporation 2011

Table D-26 Koc [(mg/g) / (mg/mL)] or [L/kg]

Chemical	Value	Log(Koc)	Reference
2-methylnaphthalene	2.51E+03	3.40E+00	US EPA 2011 (EPI Suite Database)
3-methylcholanthrene	7.94E+05	5.90E+00	US EPA 2011 (EPI Suite Database)
7,12-Dimethylbenz(a)anthracene	4.93E+05	5.69E+00	US EPA 2011 (EPI Suite Database)
Acenaphthene	5.01E+03	3.70E+00	US EPA 2011 (EPI Suite Database)
Acenaphthylene	5.01E+03	3.70E+00	US EPA 2011 (EPI Suite Database)
Anthracene	1.58E+04	4.20E+00	US EPA 2011 (EPI Suite Database)
Benzo(a)anthracene	1.58E+05	5.20E+00	US EPA 2011 (EPI Suite Database)
Benzo(a)pyrene	6.31E+05	5.80E+00	US EPA 2011 (EPI Suite Database)
Benzo(b)fluoranthene	6.31E+05	5.80E+00	US EPA 2011 (EPI Suite Database)
Benzo(g,h,i)perylene	1.95E+06	6.29E+00	US EPA 2011 (EPI Suite Database)
Benzo(k)fluoranthene	6.31E+05	5.80E+00	US EPA 2011 (EPI Suite Database)
Chrysene	2.00E+05	5.30E+00	US EPA 2011 (EPI Suite Database)
Dibenz(a,h)anthracene	2.00E+06	6.30E+00	US EPA 2011 (EPI Suite Database)
Fluoranthene	5.01E+04	4.70E+00	US EPA 2011 (EPI Suite Database)
Fluorene	9.16E+03	3.96E+00	US EPA 2011 (EPI Suite Database)
Indeno(1,2,3-cd)pyrene	2.00E+06	6.30E+00	US EPA 2011 (EPI Suite Database)
Phenanthrene	1.58E+04	4.20E+00	US EPA 2011 (EPI Suite Database)
Pyrene	5.01E+04	4.70E+00	US EPA 2011 (EPI Suite Database)
C9-C18 Aromatics	5.01E+03	3.70E+00	CCME 2008
Formaldehyde	7.94E+00	9.00E-01	US EPA 2011 (EPI Suite Database)

Table D-27 Fraction of Chemical in the Vapour Phase [%]

Chemical	Value	Reference
2-methylnaphthalene	100.0%	US EPA OSW 2005; Assumed similar to naphthalene
3-methylcholanthrene	30.0%	Assumed similar to benzo(a)pyrene
7,12-Dimethylbenz(a)anthracene	30.0%	Assumed similar to benzo(a)pyrene
Acenaphthene	100.0%	US EPA OSW 2005
Acenaphthylene	100.0%	Assumed similar to acenaphthene
Anthracene	100.0%	US EPA OSW 2005
Benzo(a)anthracene	50.0%	US EPA OSW 2005
Benzo(a)pyrene	30.0%	US EPA OSW 2005
Benzo(b)fluoranthene	100.0%	US EPA OSW 2005
Benzo(g,h,i)perylene	30.0%	Assumed similar to benzo(a)pyrene
Benzo(k)fluoranthene	30.0%	US EPA OSW 2005
Chrysene	74.0%	US EPA OSW 2005
Dibenz(a,h)anthracene	5.5%	US EPA OSW 2005
Fluoranthene	100.0%	US EPA OSW 2005
Fluorene	100.0%	US EPA OSW 2005
Indeno(1,2,3-cd)pyrene	0.5%	US EPA OSW 2005
Phenanthrene	100.0%	US EPA OSW 2005
Pyrene	100.0%	US EPA OSW 2005
C9-C18 Aromatics	100.0%	US EPA OSW 2005; Assumed similar to naphthalene
Formaldehyde	100.0%	US EPA OSW 2005

Table D-28 Degradation and Volatilization Soil Loss Constant (kt) [yr-1]

Chemical	Kt	Ks(yr-1)	Half-life [Days]	Reference	Kv(yr-1)	Half-life [Days]	Comment/Reference
2-methylnaphthalene	1.43E+04	1.45E-01	1.75E+03	CCME 2008 (aromatic c9-c16)	1.43E+04	1.78E-02	Lyman et al. 1990
3-methylcholanthrene	1.16E+00	1.45E-01	1.75E+03	Assumed similar to F2	1.02E+00	2.48E+02	Lyman et al. 1990
7,12-Dimethylbenz(a)anthracene	8.42E-01	4.80E-01	5.27E+02	Assumed similar to b(a)p	3.62E-01	6.99E+02	Lyman et al. 1990
Acenaphthene	1.76E+03	2.48E+00	1.02E+02	US EPA OSW 2005	1.76E+03	1.44E-01	Lyman et al. 1990
Acenaphthylene	1.33E+03	3.48E+00	7.27E+01	US EPA OSW 2005	1.33E+03	1.91E-01	Lyman et al. 1990
Anthracene	1.53E+02	5.50E-01	4.60E+02	US EPA OSW 2005	1.52E+02	1.66E+00	Lyman et al. 1990
Benzo(a)anthracene	2.63E+00	3.70E-01	6.84E+02	US EPA OSW 2005	2.26E+00	1.12E+02	Lyman et al. 1990
Benzo(a)pyrene	5.66E-01	4.80E-01	5.27E+02	US EPA OSW 2005	8.60E-02	2.94E+03	Lyman et al. 1990
Benzo(b)fluoranthene	8.87E+00	4.10E-01	6.17E+02	US EPA OSW 2005	8.46E+00	2.99E+01	Lyman et al. 1990
Benzo(g,h,i)perylene	4.83E-01	4.80E-01	5.27E+02	Assumed similar to b(a)p	3.16E-03	8.01E+04	Lyman et al. 1990
Benzo(k)fluoranthene	1.51E-01	1.20E-01	2.11E+03	US EPA OSW 2005	3.06E-02	8.26E+03	Lyman et al. 1990
Chrysene	5.00E-01	2.50E-01	1.01E+03	US EPA OSW 2005	2.50E-01	1.01E+03	Lyman et al. 1990
Dibenz(a,h)anthracene	2.73E-01	2.70E-01	9.38E+02	US EPA OSW 2005	3.08E-03	8.22E+04	Lyman et al. 1990
Fluoranthene	1.19E+01	5.70E-01	4.44E+02	US EPA OSW 2005	1.13E+01	2.23E+01	Lyman et al. 1990
Fluorene	6.25E+02	4.22E+00	6.00E+01	US EPA OSW 2005	6.20E+02	4.08E-01	Lyman et al. 1990
Indeno(1,2,3-cd)pyrene	3.55E-01	3.50E-01	7.23E+02	US EPA OSW 2005	5.28E-03	4.79E+04	Lyman et al. 1990
Phenanthrene	1.08E+02	1.26E+00	2.01E+02	US EPA OSW 2005	1.06E+02	2.38E+00	Lyman et al. 1990
Pyrene	1.08E+01	1.30E-01	1.95E+03	US EPA OSW 2005	1.06E+01	2.38E+01	Lyman et al. 1990
C9-C18 Aromatics	2.01E+04	1.45E-01	1.75E+03	CCME 2008	2.01E+04	1.26E-02	Lyman et al. 1990
Formaldehyde	1.96E+07	3.60E+01	7.03E+00	US EPA OSW 2005	1.96E+07	1.29E-05	Lyman et al. 1990

NOTES:
Volatilization half-life [Days] = (0.0000000158 x Koc x S) / VP

Table D-29 Plant (i.e. garden produce) Adjustment Factor [Unitless]

Chemical	Value	Log(Kow)
2-methylnaphthalene	1.00	3.86
3-methylcholanthrene	0.01	6.42
7,12-Dimethylbenz(a)anthracene	0.01	5.80
Acenaphthene	1.00	3.92
Acenaphthylene	1.00	3.94
Anthracene	0.01	4.45
Benzo(a)anthracene	0.01	5.76
Benzo(a)pyrene	0.01	6.13
Benzo(b)fluoranthene	0.01	5.78
Benzo(g,h,i)perylene	0.01	6.63
Benzo(k)fluoranthene	0.01	6.11
Chrysene	0.01	5.81
Dibenz(a,h)anthracene	0.01	6.75
Fluoranthene	0.01	5.16
Fluorene	0.01	4.18
Indeno(1,2,3-cd)pyrene	0.01	6.70
Phenanthrene	0.01	4.46
Pyrene	0.01	4.88
C9-C18 Aromatics	1.00	3.60
Formaldehyde	1.00	0.35

Table D-30 Dermal permeability coefficient in water [cm/hr]

Chemical	Value	Reference
2-methylnaphthalene	8.94E-02	Eqn #3.8; US EPA 2004
3-methylcholanthrene	8.60E-01	Eqn #3.8; US EPA 2004
7,12-Dimethylbenz(a)anthracene	3.91E-01	Eqn #3.8; US EPA 2004
Acenaphthene	8.39E-02	Eqn #3.8; US EPA 2004
Acenaphthylene	8.87E-02	Eqn #3.8; US EPA 2004
Anthracene	1.38E-01	Eqn #3.8; US EPA 2004
Benzo(a)anthracene	5.29E-01	Eqn #3.8; US EPA 2004
Benzo(a)pyrene	6.80E-01	Eqn #3.8; US EPA 2004
Benzo(b)fluoranthene	4.00E-01	Eqn #3.8; US EPA 2004
Benzo(g,h,i)perylene	1.07E+00	Eqn #3.8; US EPA 2004
Benzo(k)fluoranthene	6.60E-01	Eqn #3.8; US EPA 2004
Chrysene	5.70E-01	Eqn #3.8; US EPA 2004
Dibenz(a,h)anthracene	1.25E+00	Eqn #3.8; US EPA 2004
Fluoranthene	2.97E-01	Eqn #3.8; US EPA 2004
Fluorene	1.07E-01	Eqn #3.8; US EPA 2004
Indeno(1,2,3-cd)pyrene	1.19E+00	Eqn #3.8; US EPA 2004
Phenanthrene	1.40E-01	Eqn #3.8; US EPA 2004
Pyrene	1.94E-01	Eqn #3.8; US EPA 2004
C9-C18 Aromatics	5.45E-02	Eqn #3.8; US EPA 2004
Formaldehyde	1.83E-03	Eqn #3.8; US EPA 2004

Table D-31 Soil to Pore Water Partition Coefficient (Kd) [L/kg]

Chemical	Value	Reference
2-methylnaphthalene	2.51E+01	Calculated; CCME 2008
3-methylcholanthrene	7.94E+03	Calculated; CCME 2008
7,12-Dimethylbenz(a)anthracene	4.93E+03	Calculated; CCME 2008
Acenaphthene	5.01E+01	Calculated; CCME 2008
Acenaphthylene	5.01E+01	Calculated; CCME 2008
Anthracene	1.58E+02	Calculated; CCME 2008
Benzo(a)anthracene	1.58E+03	Calculated; CCME 2008
Benzo(a)pyrene	6.31E+03	Calculated; CCME 2008
Benzo(b)fluoranthene	6.31E+03	Calculated; CCME 2008
Benzo(g,h,i)perylene	1.95E+04	Calculated; CCME 2008
Benzo(k)fluoranthene	6.31E+03	Calculated; CCME 2008
Chrysene	2.00E+03	Calculated; CCME 2008
Dibenz(a,h)anthracene	2.00E+04	Calculated; CCME 2008
Fluoranthene	5.01E+02	Calculated; CCME 2008
Fluorene	9.16E+01	Calculated; CCME 2008
Indeno(1,2,3-cd)pyrene	2.00E+04	Calculated; CCME 2008
Phenanthrene	1.58E+02	Calculated; CCME 2008
Pyrene	5.01E+02	Calculated; CCME 2008
C9-C18 aromatics	5.01E+01	Calculated; CCME 2008
Formaldehyde	7.94E-02	Calculated; CCME 2008
NOTES: *Calculated Kd = Koc x foc* *assumed foc(g/g) =*	*1.0%*	

Table D-32 Relative Dermal Absorption Factors (RAFDermal) [%]

Chemical	Value	Reference
2-methylnaphthalene	15.0%	Health Canada 2009b
3-methylcholanthrene	10.0%	RAIS 2009
7,12-Dimethylbenz(a)anthracene	13.0%	RAIS 2009
Acenaphthene	15.0%	Health Canada 2009b
Acenaphthylene	15.0%	Health Canada 2009b
Anthracene	15.0%	Health Canada 2009b
Benzo(a)anthracene	15.0%	Health Canada 2009b
Benzo(a)pyrene	15.0%	Health Canada 2009b
Benzo(b)fluoranthene	15.0%	Health Canada 2009b
Benzo(g,h,i)perylene	15.0%	Health Canada 2009b
Benzo(k)fluoranthene	15.0%	Health Canada 2009b
Chrysene	15.0%	Health Canada 2009b
Dibenz(a,h)anthracene	15.0%	Health Canada 2009b
Fluoranthene	15.0%	Health Canada 2009b
Fluorene	15.0%	Health Canada 2009b
Indeno(1,2,3-cd)pyrene	15.0%	Health Canada 2009b
Phenanthrene	15.0%	Health Canada 2009b
Pyrene	15.0%	Health Canada 2009b
C9-C18 Aromatics	20.0%	CCME 2008
Formaldehyde	10.0%	RAIS 2009

Table D-33 PAH PEF Values

Chemical	Value	Reference
2-methylnaphthalene	0	Not required
3-methylcholanthrene	0	Not required
7,12-Dimethylbenz(a)anthracene	10	Health Canada 2009a
Acenaphthene	0	Not required
Acenaphthylene	0	Not required
Anthracene	0	Not required
Benzo(a)anthracene	0.1	Health Canada 2009a
Benzo(a)pyrene	1	Health Canada 2009a
Benzo(b)fluoranthene	0.1	Health Canada 2009a
Benzo(g,h,i)perylene	0.01	Health Canada 2009a
Benzo(k)fluoranthene	0.1	Health Canada 2009a
Chrysene	0.01	Health Canada 2009a
Dibenz(a,h)anthracene	1	Health Canada 2009a
Fluoranthene	0.001	Health Canada 2009a
Fluorene	0	Not required
Indeno(1,2,3-cd)pyrene	0.1	Health Canada 2009a
Phenanthrene	0.001	Health Canada 2009a
Pyrene	0	Not required
C9-C18 aromatics	0	Not required
Formaldehyde	0	Not required

Table D-34 Food-specific Chemical Apportionment [%]

Food	Chemical	Value	Comment
Moose	2-methylnaphthalene	100%	Assumed most conservative value
Moose	3-methylcholanthrene	100%	Assumed most conservative value
Moose	7,12-Dimethylbenz(a)anthracene	100%	Assumed most conservative value
Moose	Acenaphthene	100%	Assumed most conservative value
Moose	Acenaphthylene	100%	Assumed most conservative value
Moose	Anthracene	100%	Assumed most conservative value
Moose	Benzo(a)anthracene	100%	Assumed most conservative value
Moose	Benzo(a)pyrene	100%	Assumed most conservative value
Moose	Benzo(b)fluoranthene	100%	Assumed most conservative value
Moose	Benzo(g,h,i)perylene	100%	Assumed most conservative value
Moose	Benzo(k)fluoranthene	100%	Assumed most conservative value
Moose	Chrysene	100%	Assumed most conservative value
Moose	Dibenz(a,h)anthracene	100%	Assumed most conservative value
Moose	Fluoranthene	100%	Assumed most conservative value
Moose	Fluorene	100%	Assumed most conservative value
Moose	Indeno(1,2,3-cd)pyrene	100%	Assumed most conservative value
Moose	Phenanthrene	100%	Assumed most conservative value
Moose	Pyrene	100%	Assumed most conservative value
Moose	C9-C18 Aromatics	100%	Assumed most conservative value
Moose	Formaldehyde	100%	Assumed most conservative value
Plant	2-methylnaphthalene	100%	Assumed most conservative value
Plant	3-methylcholanthrene	100%	Assumed most conservative value
Plant	7,12-Dimethylbenz(a)anthracene	100%	Assumed most conservative value
Plant	Acenaphthene	100%	Assumed most conservative value
Plant	Acenaphthylene	100%	Assumed most conservative value
Plant	Anthracene	100%	Assumed most conservative value
Plant	Benzo(a)anthracene	100%	Assumed most conservative value
Plant	Benzo(a)pyrene	100%	Assumed most conservative value
Plant	Benzo(b)fluoranthene	100%	Assumed most conservative value
Plant	Benzo(g,h,i)perylene	100%	Assumed most conservative value
Plant	Benzo(k)fluoranthene	100%	Assumed most conservative value
Plant	Chrysene	100%	Assumed most conservative value
Plant	Dibenz(a,h)anthracene	100%	Assumed most conservative value
Plant	Fluoranthene	100%	Assumed most conservative value
Plant	Fluorene	100%	Assumed most conservative value
Plant	Indeno(1,2,3-cd)pyrene	100%	Assumed most conservative value
Plant	Phenanthrene	100%	Assumed most conservative value
Plant	Pyrene	100%	Assumed most conservative value
Plant	C9-C18 Aromatics	100%	Assumed most conservative value
Plant	Formaldehyde	100%	Assumed most conservative value
Ruffed_grouse	2-methylnaphthalene	100%	Assumed most conservative value
Ruffed_grouse	3-methylcholanthrene	100%	Assumed most conservative value
Ruffed_grouse	7,12-Dimethylbenz(a)anthracene	100%	Assumed most conservative value
Ruffed_grouse	Acenaphthene	100%	Assumed most conservative value
Ruffed_grouse	Acenaphthylene	100%	Assumed most conservative value
Ruffed_grouse	Anthracene	100%	Assumed most conservative value
Ruffed_grouse	Benzo(a)anthracene	100%	Assumed most conservative value
Ruffed_grouse	Benzo(a)pyrene	100%	Assumed most conservative value
Ruffed_grouse	Benzo(b)fluoranthene	100%	Assumed most conservative value
Ruffed_grouse	Benzo(g,h,i)perylene	100%	Assumed most conservative value
Ruffed_grouse	Benzo(k)fluoranthene	100%	Assumed most conservative value
Ruffed_grouse	Chrysene	100%	Assumed most conservative value
Ruffed_grouse	Dibenz(a,h)anthracene	100%	Assumed most conservative value

Table D-34 Food-specific Chemical Apportionment [%]

Food	Chemical	Value	Comment
Ruffed_grouse	Fluoranthene	100%	Assumed most conservative value
Ruffed_grouse	Fluorene	100%	Assumed most conservative value
Ruffed_grouse	Indeno(1,2,3-cd)pyrene	100%	Assumed most conservative value
Ruffed_grouse	Phenanthrene	100%	Assumed most conservative value
Ruffed_grouse	Pyrene	100%	Assumed most conservative value
Ruffed_grouse	C9-C18 Aromatics	100%	Assumed most conservative value
Ruffed_grouse	Formaldehyde	100%	Assumed most conservative value
Snowshoe_hare	2-methylnaphthalene	100%	Assumed most conservative value
Snowshoe_hare	3-methylcholanthrene	100%	Assumed most conservative value
Snowshoe_hare	7,12-Dimethylbenz(a)anthracene	100%	Assumed most conservative value
Snowshoe_hare	Acenaphthene	100%	Assumed most conservative value
Snowshoe_hare	Acenaphthylene	100%	Assumed most conservative value
Snowshoe_hare	Anthracene	100%	Assumed most conservative value
Snowshoe_hare	Benzo(a)anthracene	100%	Assumed most conservative value
Snowshoe_hare	Benzo(a)pyrene	100%	Assumed most conservative value
Snowshoe_hare	Benzo(b)fluoranthene	100%	Assumed most conservative value
Snowshoe_hare	Benzo(g,h,i)perylene	100%	Assumed most conservative value
Snowshoe_hare	Benzo(k)fluoranthene	100%	Assumed most conservative value
Snowshoe_hare	Chrysene	100%	Assumed most conservative value
Snowshoe_hare	Dibenz(a,h)anthracene	100%	Assumed most conservative value
Snowshoe_hare	Fluoranthene	100%	Assumed most conservative value
Snowshoe_hare	Fluorene	100%	Assumed most conservative value
Snowshoe_hare	Indeno(1,2,3-cd)pyrene	100%	Assumed most conservative value
Snowshoe_hare	Phenanthrene	100%	Assumed most conservative value
Snowshoe_hare	Pyrene	100%	Assumed most conservative value
Snowshoe_hare	C9-C18 Aromatics	100%	Assumed most conservative value
Snowshoe_hare	Formaldehyde	100%	Assumed most conservative value

Table D-35 Water Content in Wildlife Food [%]

Receptor	Value	Reference
Berries	80%	Site-specific berries (avg of data from AOSC 2009 and Dover 2010)
Cattail	77%	Site-specific Cattail (avg of data from AOSC 2009 and Dover 2010)
Fish	75%	Suter et al. 2000 (Table 3.5)
Lab_tea	54%	Site-specific Labrador tea (avg of data from AOSC 2009 and Dover 2010)
Plant	85%	US EPA OSW 2005
Root	85%	US EPA OSW 2005

Table D-36 Equation Variables for Plant Concentration due to Direct Deposition

Variable	Value	Units	Reference
Empirical Constant - (y)	2.88	Unitless	US EPA OSW 2005
Yield or Standing Biomass for Garden Produce (Yp)	2.24	kg DW/m^2	US EPA OSW 2005
Plant Surface Loss Coefficient - (kp)	18	yr^{-1}	US EPA OSW 2005
Period of Garden Exposure - (Tp)	0.16	yr	US EPA OSW 2005
Fraction of COPC in Vapour Phase	NA	Chemical Specific	
Deposition Velocity	NA	Chemical Specific	

Table D-37 Time Period of Deposition [years]

Variable	Value	Comment
Time	80	Life of facility

Table D-38 Soil Properties

Variable	Value	Units	Reference
Surface Soil Mixing Depth = Depth1	0.02	m	US EPA OSW 2005
Soil Mixing Depth for Plants = Depth2	0.2	m	US EPA OSW 2005
Soil Bulk Density	1500	kg/m^3	US EPA OSW 2005

Table D-39 Gas Constants

Variable	Value	Units
Universal Gas Constant (R)	8.21E-05	atm m^3 / mol
Temperature (T)	288	Kelvin
R x T	2.36E-02	Kelvin atm m^3 / mol

Table D-40 Food Preperation

Variable	Value	Units
Washing and peeling factor (WPF)	100%	%

Table D-41 Deposition Velocities [m/s]

Chemical	Wet	Dry	Reference Wet	Reference Dry
2-methylnaphthalene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
3-methylcholanthrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
7,12-Dimethylbenz(a)anthracene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Acenaphthene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Acenaphthylene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Anthracene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(a)anthracene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(a)pyrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(b)fluoranthene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(g,h,i)perylene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(k)fluoranthene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Chrysene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Dibenz(a,h)anthracene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Fluoranthene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Fluorene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Indeno(1,2,3-cd)pyrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Phenanthrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Pyrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
C9-C18 Aromatics	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Formaldehyde	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
NOTES: Wet deposition velocity based on annual average precipitation of 456 mm (Environment Canada 2011)				

Table D-42 Literature Derived Regression Models and Bio-concentration Factors for the Human Health Risk Assessment Exposure Model [DW Basis] A

Media	Chemical	UF	Reference/Commnet
Berries	2-methylnaphthalene	2.27E-01	US EPA OSW 2005
Berries	3-methylcholanthrene	7.54E-03	US EPA OSW 2005
Berries	7,12-Dimethylbenz(a)anthracene	1.72E-02	US EPA OSW 2005
Berries	Acenaphthene	2.10E-01	US EPA OSW 2005
Berries	Acenaphthylene	2.04E-01	US EPA OSW 2005
Berries	Anthracene	1.04E-01	US EPA OSW 2005
Berries	C9-C18 Aromatics	3.22E-01	US EPA OSW 2005
Berries	Benzo(a)anthracene	1.81E-02	US EPA OSW 2005
Berries	Benzo(a)pyrene	1.11E-02	US EPA OSW 2005
Berries	Benzo(b)fluoranthene	1.77E-02	US EPA OSW 2005
Berries	Benzo(g,h,i)perylene	5.70E-03	US EPA OSW 2005
Berries	Benzo(k)fluoranthene	1.14E-02	US EPA OSW 2005
Berries	Chrysene	1.70E-02	US EPA OSW 2005
Berries	Dibenz(a,h)anthracene	4.86E-03	US EPA OSW 2005
Berries	Fluoranthene	4.03E-02	US EPA OSW 2005
Berries	Formaldehyde	8.42E+00	US EPA OSW 2005
Berries	Fluorene	1.49E-01	US EPA OSW 2005
Berries	Indeno(1,2,3-cd)pyrene	5.19E-03	US EPA OSW 2005
Berries	Phenanthrene	2.73E-01	Site-specific
Berries	Pyrene	5.85E-02	US EPA OSW 2005
Cattail	2-methylnaphthalene	2.27E-01	US EPA OSW 2005
Cattail	3-methylcholanthrene	7.54E-03	US EPA OSW 2005
Cattail	7,12-Dimethylbenz(a)anthracene	1.72E-02	US EPA OSW 2005
Cattail	Acenaphthene	2.10E-01	US EPA OSW 2005
Cattail	Acenaphthylene	2.04E-01	US EPA OSW 2005
Cattail	Anthracene	1.04E-01	US EPA OSW 2005
Cattail	C9-C18 Aromatics	3.22E-01	US EPA OSW 2005
Cattail	Benzo(a)anthracene	1.81E-02	US EPA OSW 2005
Cattail	Benzo(a)pyrene	1.11E-02	US EPA OSW 2005
Cattail	Benzo(b)fluoranthene	1.77E-02	US EPA OSW 2005
Cattail	Benzo(g,h,i)perylene	5.70E-03	US EPA OSW 2005
Cattail	Benzo(k)fluoranthene	1.14E-02	US EPA OSW 2005
Cattail	Chrysene	1.70E-02	US EPA OSW 2005
Cattail	Dibenz(a,h)anthracene	4.86E-03	US EPA OSW 2005
Cattail	Fluoranthene	4.03E-02	US EPA OSW 2005
Cattail	Formaldehyde	8.42E+00	US EPA OSW 2005
Cattail	Fluorene	1.49E-01	US EPA OSW 2005
Cattail	Indeno(1,2,3-cd)pyrene	5.19E-03	US EPA OSW 2005
Cattail	Phenanthrene	2.73E-01	Site-specific
Cattail	Pyrene	5.85E-02	US EPA OSW 2005
Lab_tea	2-methylnaphthalene	3.00E+00	Site-specific
Lab_tea	3-methylcholanthrene	7.54E-03	US EPA OSW 2005
Lab_tea	7,12-Dimethylbenz(a)anthracene	1.72E-02	US EPA OSW 2005
Lab_tea	Acenaphthene	2.10E-01	US EPA OSW 2005
Lab_tea	Acenaphthylene	2.04E-01	US EPA OSW 2005
Lab_tea	Anthracene	1.04E-01	US EPA OSW 2005
Lab_tea	C9-C18 Aromatics	3.22E-01	US EPA OSW 2005
Lab_tea	Benzo(a)anthracene	1.81E-02	US EPA OSW 2005
Lab_tea	Benzo(a)pyrene	1.11E-02	US EPA OSW 2005
Lab_tea	Benzo(b)fluoranthene	1.77E-02	US EPA OSW 2005
Lab_tea	Benzo(g,h,i)perylene	5.70E-03	US EPA OSW 2005

Table D-42 Literature Derived Regression Models and Bio-concentration Factors for the Human Health Risk Assessment Exposure Model [DW Basis] A

Media	Chemical	UF	Reference/Commnet
Lab_tea	Benzo(k)fluoranthene	1.14E-02	US EPA OSW 2005
Lab_tea	Chrysene	1.70E-02	US EPA OSW 2005
Lab_tea	Dibenz(a,h)anthracene	4.86E-03	US EPA OSW 2005
Lab_tea	Fluoranthene	4.03E-02	US EPA OSW 2005
Lab_tea	Formaldehyde	8.42E+00	US EPA OSW 2005
Lab_tea	Fluorene	1.49E-01	US EPA OSW 2005
Lab_tea	Indeno(1,2,3-cd)pyrene	5.19E-03	US EPA OSW 2005
Lab_tea	Phenanthrene	1.45E+00	Site-specific
Lab_tea	Pyrene	5.85E-02	US EPA OSW 2005
Plant	2-methylnaphthalene	2.27E-01	US EPA OSW 2005
Plant	3-methylcholanthrene	7.54E-03	US EPA OSW 2005
Plant	7,12-Dimethylbenz(a)anthracene	1.72E-02	US EPA OSW 2005
Plant	Acenaphthene	2.10E-01	US EPA OSW 2005
Plant	Acenaphthylene	2.04E-01	US EPA OSW 2005
Plant	Anthracene	1.04E-01	US EPA OSW 2005
Plant	C9-C18 Aromatics	3.22E-01	US EPA OSW 2005
Plant	Benzo(a)anthracene	1.81E-02	US EPA OSW 2005
Plant	Benzo(a)pyrene	1.11E-02	US EPA OSW 2005
Plant	Benzo(b)fluoranthene	1.77E-02	US EPA OSW 2005
Plant	Benzo(g,h,i)perylene	5.70E-03	US EPA OSW 2005
Plant	Benzo(k)fluoranthene	1.14E-02	US EPA OSW 2005
Plant	Chrysene	1.70E-02	US EPA OSW 2005
Plant	Dibenz(a,h)anthracene	4.86E-03	US EPA OSW 2005
Plant	Fluoranthene	4.03E-02	US EPA OSW 2005
Plant	Formaldehyde	8.42E+00	US EPA OSW 2005
Plant	Fluorene	1.49E-01	US EPA OSW 2005
Plant	Indeno(1,2,3-cd)pyrene	5.19E-03	US EPA OSW 2005
Plant	Phenanthrene	1.02E-01	US EPA OSW 2005
Plant	Pyrene	5.85E-02	US EPA OSW 2005
Root	2-methylnaphthalene	8.67E+00	US EPA OSW 2005
Root	3-methylcholanthrene	2.57E+00	US EPA OSW 2005
Root	7,12-Dimethylbenz(a)anthracene	6.05E-02	Assumed same as B(a)P
Root	Acenaphthene	2.13E-01	US EPA OSW 2005
Root	Acenaphthylene	2.13E-01	Assumed same as acenaphthene
Root	Anthracene	1.51E-01	US EPA OSW 2005
Root	C9-C18 Aromatics	2.69E-01	Assumed same as naphthalene
Root	Benzo(a)anthracene	9.48E-02	US EPA OSW 2005
Root	Benzo(a)pyrene	6.05E-02	US EPA OSW 2005
Root	Benzo(b)fluoranthene	1.15E+00	US EPA OSW 2005
Root	Benzo(g,h,i)perylene	6.05E-02	Assumed same as B(a)P
Root	Benzo(k)fluoranthene	6.09E-02	US EPA OSW 2005
Root	Chrysene	9.48E-02	US EPA OSW 2005
Root	Dibenz(a,h)anthracene	4.05E-02	US EPA OSW 2005
Root	Fluoranthene	1.50E-01	US EPA OSW 2005
Root	Formaldehyde	3.05E+02	US EPA OSW 2005
Root	Fluorene	1.90E-01	US EPA OSW 2005
Root	Indeno(1,2,3-cd)pyrene	5.29E-02	US EPA OSW 2005
Root	Phenanthrene	1.83E-01	US EPA OSW 2005
Root	Pyrene	1.45E-01	US EPA OSW 2005
Fish	2-methylnaphthalene	5.42E+02	US EPA OSW 2005
Fish	3-methylcholanthrene	1.14E+03	US EPA OSW 2005

Table D-42 Literature Derived Regression Models and Bio-concentration Factors for the Human Health Risk Assessment Exposure Model [DW Basis] A

Media	Chemical	UF	Reference/Commnet
Fish	7,12-Dimethylbenz(a)anthracene	5.50E+01	ATSDR 1995
Fish	Acenaphthene	2.01E+02	US EPA OSW 2005
Fish	Acenaphthylene	2.01E+02	ATSDR 1995
Fish	Anthracene	5.50E+01	ATSDR 1995
Fish	C9-C18 Aromatics	5.50E+01	ATSDR 1995 (assumed similar to PAHs)
Fish	Benzo(a)anthracene	5.50E+01	ATSDR 1995
Fish	Benzo(a)pyrene	5.50E+01	ATSDR 1995
Fish	Benzo(b)fluoranthene	5.50E+01	ATSDR 1995
Fish	Benzo(g,h,i)perylene	5.50E+01	ATSDR 1995
Fish	Benzo(k)fluoranthene	5.50E+01	ATSDR 1995
Fish	Chrysene	5.50E+01	ATSDR 1995
Fish	Dibenz(a,h)anthracene	5.50E+01	ATSDR 1995
Fish	Fluoranthene	5.50E+01	ATSDR 1995
Fish	Formaldehyde	3.16E+00	US EPA OSW 2005
Fish	Fluorene	5.50E+01	ATSDR 1995
Fish	Indeno(1,2,3-cd)pyrene	5.50E+01	ATSDR 1995
Fish	Phenanthrene	5.50E+01	ATSDR 1995
Fish	Pyrene	5.50E+01	ATSDR 1995

NOTES:
(A) All BCFs are in dry weight except for the fish BCFs which are wet weight.
Predicted Linear Uptake Factors:
UF Soil - Plant [dry weight] = logBCF = 1.588 - 0.578log(Kow); Travis and Arms 1988
UF Soil - Invertebrate [dry weight] = logBCF = 1.146 - 0.819log(Kow); Southworth et al.1978

Table D-43 Breast Milk Bio-transfer Factors [(ug/kg-milk) / (ug/day-intake)]

Media	Chemical	Value	Comment
Breast milk	2-methylnaphthalene	1.45E-03	McKone 1992
Breast milk	3-methylcholanthrene	5.26E-01	McKone 1992
Breast milk	7,12-Dimethylbenz(a)anthracene	1.26E-01	McKone 1992
Breast milk	Acenaphthene	1.66E-03	McKone 1992
Breast milk	Acenaphthylene	1.74E-03	McKone 1992
Breast milk	Anthracene	5.64E-03	McKone 1992
Breast milk	Benzo(a)anthracene	1.15E-01	McKone 1992
Breast milk	Benzo(a)pyrene	2.70E-01	McKone 1992
Breast milk	Benzo(b)fluoranthene	1.21E-01	McKone 1992
Breast milk	Benzo(g,h,i)perylene	8.53E-01	McKone 1992
Breast milk	Benzo(k)fluoranthene	2.58E-01	McKone 1992
Breast milk	Chrysene	1.29E-01	McKone 1992
Breast milk	Dibenz(a,h)anthracene	1.12E+00	McKone 1992
Breast milk	Fluoranthene	2.89E-02	McKone 1992
Breast milk	Fluorene	3.03E-03	McKone 1992
Breast milk	Indeno(1,2,3-cd)pyrene	1.00E+00	McKone 1992
Breast milk	Phenanthrene	5.77E-03	McKone 1992
Breast milk	Pyrene	1.52E-02	McKone 1992
Breast milk	C9-C18 aromatics	7.96E-04	McKone 1992
Breast milk	Formaldehyde	4.48E-07	McKone 1992

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Appendix E
Terrestrial Wildlife Exposure Model

Table E-1 Maximum Predicted Soil Concentration (mg/kg)

Chemical	Baseline	Application	PDC	Project	Future	SQG [mg/kg] AENV 2010	ECO SSL - US EPA 2007 mammalian	ECO SSL - US EPA 2007 avian
2-methylnaphthalene	4.0E-02	4.0E-02	4.0E-02	5.5E-10	1.3E-07	-	-	-
3-methylcholanthrene	1.6E-05	1.6E-05	1.7E-05	2.8E-06	1.8E-06	-	-	-
7,12-Dimethylbenz(a)anthracene	4.7E-05	4.7E-05	5.0E-05	8.1E-06	5.2E-06	-	-	-
Acenaphthene	1.3E-07	1.3E-07	2.2E-07	3.5E-09	9.6E-08	2.2E+01	-	-
Acenaphthylene	3.2E-06	3.2E-06	5.7E-06	3.3E-09	2.5E-06	-	-	-
Anthracene	1.9E-06	1.9E-06	3.4E-06	5.1E-08	1.5E-06	6.2E+01	-	-
Benzo(a)anthracene	1.5E-04	1.5E-04	2.6E-04	4.3E-05	1.1E-04	6.2E+00	-	-
Benzo(a)pyrene	1.4E-04	1.4E-04	2.6E-04	8.1E-06	1.1E-04	6.0E-01	-	-
Benzo(b)fluoranthene	1.4E-05	1.4E-05	2.5E-05	4.1E-07	1.0E-05	-	-	-
Benzo(g,h,i)perylene	1.7E-04	1.7E-04	3.1E-04	9.9E-06	1.3E-04	-	-	-
Benzo(k)fluoranthene	2.8E-04	2.8E-04	5.0E-04	2.4E-05	2.2E-04	6.2E+00	-	-
Chrysene	4.9E-04	4.9E-04	8.8E-04	1.5E-05	3.9E-04	6.2E+00	-	-
Dibenz(a,h)anthracene	6.7E-05	6.7E-05	4.9E-05	2.4E-05	2.0E-05	-	-	-
Fluoranthene	3.6E-05	3.6E-05	6.4E-05	1.3E-06	2.7E-05	1.5E+01	-	-
Fluorene	4.0E-02	4.0E-02	4.0E-02	3.5E-08	6.7E-07	1.5E+01	-	-
Indeno(1,2,3-cd)pyrene	4.3E-05	4.3E-05	3.2E-05	1.9E-05	1.6E-05	-	-	-
Phenanthrene	1.1E-01	1.1E-01	1.1E-01	1.0E-06	1.2E-05	4.3E+01	-	-
Pyrene	4.7E-05	4.7E-05	8.4E-05	6.8E-07	3.6E-05	7.7E+00	-	-
C9-C18 aromatics	2.5E-04	2.5E-04	4.7E-04	5.5E-07	2.2E-04	-	-	-
Formaldehyde	1.3E-08	1.3E-08	2.3E-08	4.3E-08	1.3E-08	-	-	-
F2 Fraction	1.9E-01	1.9E-01	1.9E-01	3.1E-06	8.1E-05	9.8E+03	-	-
F3 Fraction	1.4E-03	1.4E-03	2.4E-03	1.5E-04	1.0E-03	1.6E+04	-	-
LMW PAH group	1.5E-01	1.5E-01	1.5E-01	2.4E-06	4.5E-05	-	1.0E+02	-
HMW PAH group	1.2E-03	1.2E-03	2.0E-03	1.3E-04	8.4E-04	-	1.1E+00	-

Notes:

- = soil quality guideline was not available

AENV SQGs are referenced from AENV (2010) Surface Soil Remediation Guideline Values for Natural Area Land Use - Wildlife and Livestock Soil and Food Ingestion (Table A-1)

F2 Fraction is composed of C11-C16 aromatics and aliphatics (CCME 2008). Chemical constituents of this group consists of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, phenanthrene, and pyrene

F3 Fraction is composed of C17-C34 aromatics and aliphatics (CCME 2008). Chemical constituents of this group consists of 3-methylcholanthrene, 7,12-dimethylbenz(a)anthracene,benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene

LMW PAH includes all 2 and 3 ring PAHs (CCME 2008; US EPA 2007)

HMW PAH includes all PAHs with 4 or more rings (CCME 2008; US EPA 2007)

Table E-2 Maximum Predicted Surface Water Concentration (mg/L)

Chemical	Baseline	Application	PDC	Project	Future	AENV SWQG [mg/L]
2-methylnaphthalene	2.5E-06	2.5E-06	4.4E-06	8.0E-09	1.9E-06	-
3-methylcholanthrene	4.5E-09	4.5E-09	4.8E-09	7.9E-10	5.0E-10	-
7,12-Dimethylbenz(a)anthracene	4.0E-08	4.1E-08	4.3E-08	7.0E-09	4.5E-09	-
Acenaphthene	2.3E-07	2.3E-07	4.0E-07	6.3E-09	1.7E-07	-
Acenaphthylene	4.3E-06	4.3E-06	7.8E-06	4.4E-09	3.5E-06	-
Anthracene	2.9E-07	2.9E-07	5.1E-07	7.7E-09	2.2E-07	-
Benzo(a)anthracene	4.1E-07	4.1E-07	7.1E-07	1.2E-07	3.0E-07	-
Benzo(a)pyrene	8.3E-08	8.3E-08	1.5E-07	4.7E-09	6.6E-08	-
Benzo(b)fluoranthene	1.3E-07	1.3E-07	2.2E-07	3.7E-09	9.2E-08	-
Benzo(g,h,i)perylene	8.5E-08	8.5E-08	1.5E-07	4.9E-09	6.6E-08	-
Benzo(k)fluoranthene	4.2E-08	4.2E-08	7.4E-08	3.6E-09	3.2E-08	-
Chrysene	2.5E-07	2.5E-07	4.5E-07	7.6E-09	2.0E-07	-
Dibenz(a,h)anthracene	1.9E-08	1.9E-08	1.4E-08	6.6E-09	5.7E-09	-
Fluoranthene	4.4E-07	4.4E-07	7.8E-07	1.5E-08	3.3E-07	-
Fluorene	7.0E-07	7.0E-07	1.0E-06	2.2E-08	4.3E-07	-
Indeno(1,2,3-cd)pyrene	1.6E-08	1.6E-08	1.2E-08	6.8E-09	5.7E-09	-
Phenanthrene	1.8E-06	1.8E-06	3.2E-06	1.2E-07	1.4E-06	-
Pyrene	5.2E-07	5.2E-07	9.2E-07	7.5E-09	4.0E-07	-
C9-C18 aromatics	5.2E-03	5.2E-03	9.7E-03	1.1E-05	4.6E-03	42.6
Formaldehyde	2.1E-04	2.1E-04	3.8E-04	7.0E-04	2.1E-04	-
F2 Fraction	1.1E-05	1.1E-05	1.9E-05	1.9E-07	8.3E-06	42.6
F3 Fraction	1.1E-06	1.1E-06	1.8E-06	1.6E-07	7.7E-07	69

Notes:

AENV SWQGs are referenced from AENV (2010) Surface Water Quality Guidelines for Wildlife Water (Table C-11)

F2 Fraction is composed of C11-C16 aromatics and aliphatics (CCME 2008). Chemical constituents of this group consists of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, phenanthrene, and pyrene

F3 Fraction is composed of C17-C34 aromatics and aliphatics (CCME 2008). Chemical constituents of this group consists of 3-methylcholanthrene, 7,12-dimethylbenz(a)anthracene,benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene

Table E-3 Maximum Predicted Browse & Aquatic Plant Concentrations (mg/kg-DW)

Chemical	Browse					Aquatic Plant				
	Baseline	Application	PDC	Project	Future	Baseline	Application	PDC	Project	Future
2-methylnaphthalene	1.1E-01	1.1E-01	1.1E-01	2.9E-09	7.2E-07	5.0E-04	5.0E-04	9.0E-04	1.6E-06	4.0E-04
3-methylcholanthrene	9.4E-05	9.5E-05	1.0E-04	1.6E-05	1.1E-05	6.9E-05	6.9E-05	7.4E-05	1.2E-05	7.7E-06
7,12-Dimethylbenz(a)anthracene	8.5E-04	8.5E-04	9.0E-04	1.5E-04	9.3E-05	6.2E-04	6.2E-04	6.6E-04	1.1E-04	6.8E-05
Acenaphthene	1.6E-07	1.6E-07	2.8E-07	4.4E-09	1.2E-07	1.2E-04	1.2E-04	2.1E-04	3.3E-06	9.1E-05
Acenaphthylene	5.0E-06	5.0E-06	8.9E-06	5.1E-09	4.0E-06	2.3E-03	2.3E-03	4.1E-03	2.3E-06	1.8E-03
Anthracene	2.3E-06	2.3E-06	4.1E-06	6.2E-08	1.8E-06	4.4E-03	4.4E-03	7.8E-03	1.2E-04	3.4E-03
Benzo(a)anthracene	6.0E-03	6.0E-03	1.0E-02	1.7E-03	4.4E-03	6.3E-03	6.3E-03	1.1E-02	1.8E-03	4.6E-03
Benzo(a)pyrene	3.0E-03	3.0E-03	5.4E-03	1.7E-04	2.4E-03	1.3E-03	1.3E-03	2.3E-03	7.1E-05	1.0E-03
Benzo(b)fluoranthene	2.1E-03	2.1E-03	3.5E-03	5.8E-05	1.5E-03	2.0E-03	2.0E-03	3.4E-03	5.7E-05	1.4E-03
Benzo(g,h,i)perylene	8.1E-03	8.1E-03	1.4E-02	4.7E-04	6.3E-03	1.3E-03	1.3E-03	2.3E-03	7.5E-05	1.0E-03
Benzo(k)fluoranthene	1.4E-03	1.4E-03	2.4E-03	1.2E-04	1.1E-03	6.4E-04	6.4E-04	1.1E-03	5.5E-05	5.0E-04
Chrysene	2.3E-03	2.3E-03	4.0E-03	6.8E-05	1.8E-03	3.8E-03	3.8E-03	6.9E-03	1.2E-04	3.0E-03
Dibenz(a,h)anthracene	1.3E-03	1.3E-03	9.7E-04	4.7E-04	4.0E-04	2.9E-04	2.9E-04	2.1E-04	1.0E-04	8.7E-05
Fluoranthene	1.1E-04	1.1E-04	2.0E-04	3.9E-06	8.6E-05	6.8E-03	6.8E-03	1.2E-02	2.3E-04	5.1E-03
Fluorene	5.9E-03	5.9E-03	5.9E-03	5.3E-08	1.0E-06	1.1E-02	1.1E-02	1.6E-02	3.4E-04	6.5E-03
Indeno(1,2,3-cd)pyrene	4.6E-04	4.7E-04	3.5E-04	2.0E-04	1.7E-04	2.4E-04	2.4E-04	1.8E-04	1.0E-04	8.8E-05
Phenanthrene	1.6E-01	1.6E-01	1.6E-01	2.6E-06	3.1E-05	2.8E-02	2.8E-02	4.9E-02	1.8E-03	2.1E-02
Pyrene	5.3E-05	5.3E-05	9.3E-05	7.6E-07	4.0E-05	8.0E-03	8.0E-03	1.4E-02	1.2E-04	6.1E-03
C9-C18 aromatics	2.0E-02	2.0E-02	3.7E-02	4.3E-05	1.7E-02	1.1E+00	1.1E+00	2.0E+00	2.3E-03	9.3E-01
Formaldehyde	1.3E-05	1.3E-05	2.4E-05	4.4E-05	1.3E-05	8.5E-05	8.5E-05	1.6E-04	2.9E-04	8.4E-05

Table E-4 Predicted Game Concentration (mg/kg-WW)

Chemical	Game	Baseline	Application	PDC	Project	Future
2-methylnaphthalene	Moose	2.5E-02	2.5E-02	2.5E-02	6.1E-08	1.5E-05
3-methylcholanthrene	Moose	3.3E-05	3.3E-05	3.5E-05	5.7E-06	3.6E-06
7,12-Dimethylbenz(a)anthracene	Moose	3.5E-06	3.5E-06	3.7E-06	6.0E-07	3.8E-07
Acenaphthene	Moose	4.2E-06	4.2E-06	7.4E-06	1.1E-07	3.2E-06
Acenaphthylene	Moose	8.1E-05	8.1E-05	1.5E-04	8.3E-08	6.4E-05
Anthracene	Moose	1.9E-06	1.9E-06	3.4E-06	5.1E-08	1.5E-06
Benzo(a)anthracene	Moose	2.6E-05	2.6E-05	4.5E-05	7.4E-06	1.9E-05
Benzo(a)pyrene	Moose	1.1E-05	1.1E-05	2.0E-05	6.1E-07	8.7E-06
Benzo(b)fluoranthene	Moose	8.7E-06	8.7E-06	1.5E-05	2.5E-07	6.1E-06
Benzo(g,h,i)perylene	Moose	2.3E-05	2.3E-05	4.1E-05	1.3E-06	1.8E-05
Benzo(k)fluoranthene	Moose	5.2E-06	5.2E-06	9.3E-06	4.5E-07	4.1E-06
Chrysene	Moose	1.1E-05	1.1E-05	1.9E-05	3.3E-07	8.5E-06
Dibenz(a,h)anthracene	Moose	3.5E-06	3.5E-06	2.6E-06	1.2E-06	1.1E-06
Fluoranthene	Moose	4.0E-06	4.0E-06	7.0E-06	1.4E-07	3.0E-06
Fluorene	Moose	2.3E-05	2.3E-05	2.5E-05	1.3E-07	2.5E-06
Indeno(1,2,3-cd)pyrene	Moose	1.3E-06	1.3E-06	9.9E-07	5.8E-07	4.9E-07
Phenanthrene	Moose	5.2E-04	5.2E-04	5.3E-04	7.7E-07	9.1E-06
Pyrene	Moose	4.2E-06	4.2E-06	7.4E-06	6.1E-08	3.2E-06
C9-C18 aromatics	Moose	3.5E-04	3.5E-04	6.7E-04	7.7E-07	3.1E-04
Formaldehyde	Moose	1.5E-06	1.5E-06	2.8E-06	5.2E-06	1.5E-06
2-methylnaphthalene	Ruffed_grouse	1.0E-04	1.0E-04	1.0E-04	2.7E-11	6.6E-09
3-methylcholanthrene	Ruffed_grouse	1.3E-07	1.3E-07	1.4E-07	2.3E-08	1.5E-08
7,12-Dimethylbenz(a)anthracene	Ruffed_grouse	1.3E-08	1.3E-08	1.4E-08	2.3E-09	1.4E-09
Acenaphthene	Ruffed_grouse	2.5E-09	2.5E-09	4.4E-09	6.8E-11	1.9E-09
Acenaphthylene	Ruffed_grouse	6.1E-08	6.1E-08	1.1E-07	6.3E-11	4.9E-08
Anthracene	Ruffed_grouse	6.6E-11	6.6E-11	1.2E-10	1.8E-12	5.1E-11
Benzo(a)anthracene	Ruffed_grouse	9.2E-08	9.2E-08	1.6E-07	2.6E-08	6.6E-08
Benzo(a)pyrene	Ruffed_grouse	4.2E-08	4.2E-08	7.6E-08	2.4E-09	3.4E-08
Benzo(b)fluoranthene	Ruffed_grouse	3.1E-08	3.1E-08	5.2E-08	8.7E-10	2.2E-08
Benzo(g,h,i)perylene	Ruffed_grouse	9.0E-08	9.0E-08	1.6E-07	5.1E-09	7.0E-08
Benzo(k)fluoranthene	Ruffed_grouse	2.3E-08	2.3E-08	4.0E-08	2.0E-09	1.8E-08
Chrysene	Ruffed_grouse	4.1E-08	4.1E-08	7.3E-08	1.2E-09	3.2E-08
Dibenz(a,h)anthracene	Ruffed_grouse	1.4E-08	1.4E-08	1.0E-08	5.0E-09	4.3E-09
Fluoranthene	Ruffed_grouse	2.3E-09	2.3E-09	4.1E-09	8.0E-11	1.8E-09
Fluorene	Ruffed_grouse	1.3E-07	1.3E-07	1.3E-07	1.8E-12	3.4E-11
Indeno(1,2,3-cd)pyrene	Ruffed_grouse	5.3E-09	5.3E-09	4.0E-09	2.3E-09	2.0E-09
Phenanthrene	Ruffed_grouse	2.2E-06	2.2E-06	2.2E-06	5.2E-11	6.1E-10
Pyrene	Ruffed_grouse	1.5E-09	1.5E-09	2.7E-09	2.2E-11	1.2E-09
C9-C18 aromatics	Ruffed_grouse	2.7E-07	2.7E-07	5.1E-07	5.9E-10	2.4E-07
Formaldehyde	Ruffed_grouse	3.8E-09	3.8E-09	6.9E-09	1.3E-08	3.7E-09
2-methylnaphthalene	Snowshoe_hare	3.5E-04	3.5E-04	3.5E-04	9.1E-11	2.2E-08
3-methylcholanthrene	Snowshoe_hare	4.4E-07	4.5E-07	4.7E-07	7.8E-08	4.9E-08
7,12-Dimethylbenz(a)anthracene	Snowshoe_hare	4.6E-08	4.6E-08	4.8E-08	7.9E-09	5.0E-09
Acenaphthene	Snowshoe_hare	3.2E-09	3.2E-09	5.6E-09	8.7E-11	2.4E-09
Acenaphthylene	Snowshoe_hare	6.9E-08	6.9E-08	1.2E-07	7.1E-11	5.5E-08
Anthracene	Snowshoe_hare	1.9E-10	1.9E-10	3.4E-10	5.2E-12	1.5E-10
Benzo(a)anthracene	Snowshoe_hare	3.2E-07	3.2E-07	5.5E-07	9.1E-08	2.3E-07
Benzo(a)pyrene	Snowshoe_hare	1.5E-07	1.5E-07	2.6E-07	8.3E-09	1.2E-07
Benzo(b)fluoranthene	Snowshoe_hare	1.1E-07	1.1E-07	1.8E-07	3.1E-09	7.6E-08
Benzo(g,h,i)perylene	Snowshoe_hare	3.1E-07	3.1E-07	5.6E-07	1.8E-08	2.5E-07
Benzo(k)fluoranthene	Snowshoe_hare	7.5E-08	7.5E-08	1.3E-07	6.4E-09	5.8E-08
Chrysene	Snowshoe_hare	1.3E-07	1.3E-07	2.4E-07	4.0E-09	1.0E-07
Dibenz(a,h)anthracene	Snowshoe_hare	4.8E-08	4.8E-08	3.6E-08	1.7E-08	1.5E-08
Fluoranthene	Snowshoe_hare	7.4E-09	7.4E-09	1.3E-08	2.5E-10	5.6E-09
Fluorene	Snowshoe_hare	3.2E-07	3.2E-07	3.2E-07	5.6E-12	1.1E-10
Indeno(1,2,3-cd)pyrene	Snowshoe_hare	1.8E-08	1.8E-08	1.3E-08	7.9E-09	6.6E-09
Phenanthrene	Snowshoe_hare	7.3E-06	7.3E-06	7.3E-06	1.6E-10	1.9E-09
Pyrene	Snowshoe_hare	4.3E-09	4.3E-09	7.5E-09	6.1E-11	3.3E-09
C9-C18 aromatics	Snowshoe_hare	9.3E-07	9.3E-07	1.8E-06	2.0E-09	8.3E-07
Formaldehyde	Snowshoe_hare	1.2E-08	1.2E-08	2.3E-08	4.2E-08	1.2E-08

Table E-5 Summary of Predicted Exposures and Game Meat Concentrations

Scenario	Site	Receptor	Chemical	EDI Soil EDI mg/day	EDI Browse EDI mg/day	EDI Aquatic Plant EDI mg/day	EDI Invert EDI mg/day	EDI Water EDI mg/day	EDI Air EDI mg/day	EDI Total EDI mg/day	EDI Total EDI mg/kg-BW/day	Game Meat Concentration mg/kg ww
Application	MAX	Moose	2-methylnaphthalene	8.60E-03	1.04E+00	6.50E-04	0.00E+00	5.94E-05	7.24E-05	1.05E+00	2.33E-03	2.48E-02
Baseline	MAX	Moose	2-methylnaphthalene	8.60E-03	1.04E+00	6.50E-04	0.00E+00	5.94E-05	7.24E-05	1.05E+00	2.33E-03	2.48E-02
Future	MAX	Moose	2-methylnaphthalene	2.87E-07	6.77E-06	5.14E-04	0.00E+00	4.69E-05	5.72E-05	6.25E-04	1.39E-06	1.48E-05
PDC	MAX	Moose	2-methylnaphthalene	8.60E-03	1.04E+00	1.16E-03	0.00E+00	1.06E-04	1.30E-04	1.05E+00	2.33E-03	2.48E-02
Project	MAX	Moose	2-methylnaphthalene	1.18E-09	2.78E-08	2.11E-06	0.00E+00	1.93E-07	2.35E-07	2.57E-06	5.71E-09	6.08E-08
Application	MAX	Ruffed_grouse	2-methylnaphthalene	2.10E-04	5.58E-03	0.00E+00	9.42E-05	1.14E-07	3.12E-07	5.88E-03	8.38E-03	1.03E-04
Baseline	MAX	Ruffed_grouse	2-methylnaphthalene	2.10E-04	5.58E-03	0.00E+00	9.42E-05	1.14E-07	3.12E-07	5.88E-03	8.38E-03	1.03E-04
Future	MAX	Ruffed_grouse	2-methylnaphthalene	6.99E-09	3.63E-08	0.00E+00	3.14E-10	9.03E-08	2.46E-07	3.80E-07	5.42E-07	6.63E-09
PDC	MAX	Ruffed_grouse	2-methylnaphthalene	2.10E-04	5.58E-03	0.00E+00	9.42E-05	2.05E-07	5.58E-07	5.88E-03	8.38E-03	1.03E-04
Project	MAX	Ruffed_grouse	2-methylnaphthalene	2.87E-11	1.49E-10	0.00E+00	1.29E-12	3.72E-10	1.01E-09	1.56E-09	2.23E-09	2.72E-11
Application	MAX	Snowshoe_hare	2-methylnaphthalene	3.33E-04	1.45E-02	0.00E+00	0.00E+00	3.29E-07	7.15E-07	1.49E-02	1.06E-02	3.52E-04
Baseline	MAX	Snowshoe_hare	2-methylnaphthalene	3.33E-04	1.45E-02	0.00E+00	0.00E+00	3.29E-07	7.15E-07	1.49E-02	1.06E-02	3.52E-04
Future	MAX	Snowshoe_hare	2-methylnaphthalene	1.11E-08	9.48E-08	0.00E+00	0.00E+00	2.60E-07	5.65E-07	9.31E-07	6.65E-07	2.20E-08
PDC	MAX	Snowshoe_hare	2-methylnaphthalene	3.33E-04	1.45E-02	0.00E+00	0.00E+00	5.89E-07	1.28E-06	1.49E-02	1.06E-02	3.52E-04
Project	MAX	Snowshoe_hare	2-methylnaphthalene	4.57E-11	3.90E-10	0.00E+00	0.00E+00	1.07E-09	2.32E-09	3.83E-09	2.73E-09	9.05E-11
Application	MAX	Moose	3-methylcholanthrene	3.44E-05	8.93E-04	8.96E-05	0.00E+00	1.09E-07	1.33E-07	1.02E-03	2.26E-06	3.27E-05
Baseline	MAX	Moose	3-methylcholanthrene	3.44E-05	8.92E-04	8.96E-05	0.00E+00	1.09E-07	1.33E-07	1.02E-03	2.26E-06	3.27E-05
Future	MAX	Moose	3-methylcholanthrene	3.83E-06	9.92E-05	9.97E-06	0.00E+00	1.21E-08	1.48E-08	1.13E-04	2.51E-07	3.64E-06
PDC	MAX	Moose	3-methylcholanthrene	3.66E-05	9.49E-04	9.53E-05	0.00E+00	1.16E-07	1.41E-07	1.08E-03	2.40E-06	3.48E-05
Project	MAX	Moose	3-methylcholanthrene	6.01E-06	1.56E-04	1.56E-05	0.00E+00	1.90E-08	2.32E-08	1.78E-04	3.94E-07	5.71E-06
Application	MAX	Ruffed_grouse	3-methylcholanthrene	8.38E-07	4.79E-06	0.00E+00	3.77E-08	2.10E-10	5.72E-10	5.67E-06	8.08E-06	1.34E-07
Baseline	MAX	Ruffed_grouse	3-methylcholanthrene	8.38E-07	4.79E-06	0.00E+00	3.77E-08	2.10E-10	5.71E-10	5.67E-06	8.07E-06	1.34E-07
Future	MAX	Ruffed_grouse	3-methylcholanthrene	9.32E-08	5.33E-07	0.00E+00	4.19E-09	2.33E-11	6.36E-11	6.30E-07	8.98E-07	1.50E-08
PDC	MAX	Ruffed_grouse	3-methylcholanthrene	8.91E-07	5.09E-06	0.00E+00	4.00E-08	2.23E-10	6.08E-10	6.03E-06	8.58E-06	1.43E-07
Project	MAX	Ruffed_grouse	3-methylcholanthrene	1.46E-07	8.37E-07	0.00E+00	6.58E-09	3.66E-11	9.98E-11	9.90E-07	1.41E-06	2.35E-08
Application	MAX	Snowshoe_hare	3-methylcholanthrene	1.33E-06	1.25E-05	0.00E+00	0.00E+00	6.04E-10	1.31E-09	1.38E-05	9.88E-06	4.45E-07
Baseline	MAX	Snowshoe_hare	3-methylcholanthrene	1.33E-06	1.25E-05	0.00E+00	0.00E+00	6.04E-10	1.31E-09	1.38E-05	9.87E-06	4.45E-07
Future	MAX	Snowshoe_hare	3-methylcholanthrene	1.48E-07	1.39E-06	0.00E+00	0.00E+00	6.72E-11	1.46E-10	1.54E-06	1.10E-06	4.95E-08
PDC	MAX	Snowshoe_hare	3-methylcholanthrene	1.42E-06	1.33E-05	0.00E+00	0.00E+00	6.42E-10	1.39E-09	1.47E-05	1.05E-05	4.73E-07
Project	MAX	Snowshoe_hare	3-methylcholanthrene	2.33E-07	2.18E-06	0.00E+00	0.00E+00	1.05E-10	2.29E-10	2.41E-06	1.72E-06	7.77E-08
Application	MAX	Moose	7,12-Dimethylbenz(a)anthracene	1.01E-04	8.00E-03	8.06E-04	0.00E+00	9.80E-07	1.19E-06	8.91E-03	1.98E-05	3.50E-06
Baseline	MAX	Moose	7,12-Dimethylbenz(a)anthracene	1.01E-04	7.99E-03	8.05E-04	0.00E+00	9.79E-07	1.19E-06	8.90E-03	1.98E-05	3.50E-06
Future	MAX	Moose	7,12-Dimethylbenz(a)anthracene	1.11E-05	8.79E-04	8.86E-05	0.00E+00	1.08E-07	1.31E-07	9.79E-04	2.18E-06	3.85E-07
PDC	MAX	Moose	7,12-Dimethylbenz(a)anthracene	1.08E-04	8.49E-03	8.56E-04	0.00E+00	1.04E-06	1.27E-06	9.46E-03	2.10E-05	3.72E-06
Project	MAX	Moose	7,12-Dimethylbenz(a)anthracene	1.75E-05	1.38E-03	1.39E-04	0.00E+00	1.69E-07	2.06E-07	1.54E-03	3.42E-06	6.04E-07
Application	MAX	Ruffed_grouse	7,12-Dimethylbenz(a)anthracene	2.47E-06	4.29E-05	0.00E+00	1.11E-07	1.89E-09	5.14E-09	4.55E-05	6.48E-05	1.32E-08
Baseline	MAX	Ruffed_grouse	7,12-Dimethylbenz(a)anthracene	2.47E-06	4.29E-05	0.00E+00	1.11E-07	1.88E-09	5.14E-09	4.55E-05	6.48E-05	1.32E-08
Future	MAX	Ruffed_grouse	7,12-Dimethylbenz(a)anthracene	2.72E-07	4.72E-06	0.00E+00	1.22E-08	2.07E-10	5.65E-10	5.00E-06	7.13E-06	1.45E-09
PDC	MAX	Ruffed_grouse	7,12-Dimethylbenz(a)anthracene	2.62E-06	4.56E-05	0.00E+00	1.18E-07	2.00E-09	5.46E-09	4.83E-05	6.89E-05	1.40E-08
Project	MAX	Ruffed_grouse	7,12-Dimethylbenz(a)anthracene	4.26E-07	7.41E-06	0.00E+00	1.92E-08	3.26E-10	8.87E-10	7.86E-06	1.12E-05	2.28E-09
Application	MAX	Snowshoe_hare	7,12-Dimethylbenz(a)anthracene	3.93E-06	1.12E-04	0.00E+00	0.00E+00	5.43E-09	1.18E-08	1.16E-04	8.28E-05	4.55E-08
Baseline	MAX	Snowshoe_hare	7,12-Dimethylbenz(a)anthracene	3.93E-06	1.12E-04	0.00E+00	0.00E+00	5.43E-09	1.18E-08	1.16E-04	8.27E-05	4.55E-08
Future	MAX	Snowshoe_hare	7,12-Dimethylbenz(a)anthracene	4.32E-07	1.23E-05	0.00E+00	0.00E+00	5.97E-10	1.30E-09	1.27E-05	9.10E-06	5.01E-09
PDC	MAX	Snowshoe_hare	7,12-Dimethylbenz(a)anthracene	4.17E-06	1.19E-04	0.00E+00	0.00E+00	5.77E-09	1.25E-08	1.23E-04	8.79E-05	4.84E-08
Project	MAX	Snowshoe_hare	7,12-Dimethylbenz(a)anthracene	6.78E-07	1.93E-05	0.00E+00	0.00E+00	9.37E-10	2.04E-09	2.00E-05	1.43E-05	7.86E-09
Application	MAX	Moose	Acenaphthene	2.73E-07	1.52E-06	1.56E-04	0.00E+00	5.54E-06	6.75E-06	1.70E-04	3.78E-07	4.19E-06
Baseline	MAX	Moose	Acenaphthene	2.73E-07	1.52E-06	1.56E-04	0.00E+00	5.53E-06	6.75E-06	1.70E-04	3.78E-07	4.19E-06
Future	MAX	Moose	Acenaphthene	2.07E-07	1.15E-06	1.18E-04	0.00E+00	4.19E-06	5.11E-06	1.29E-04	2.86E-07	3.17E-06

Table E-5 Summary of Predicted Exposures and Game Meat Concentrations

Scenario	Site	Receptor	Chemical	EDI								Game Meat
				Soil	Browse	Aquatic Plant	Invert	Water	Air	Total	Total	Concentration
				EDI	EDI	EDI	EDI	EDI	EDI	EDI	EDI	
				mg/day	mg/day	mg/day	mg/day	mg/day	mg/day	mg/day	mg/kg-BW/day	mg/kg ww
PDC	MAX	Moose	Acenaphthene	4.81E-07	2.68E-06	2.74E-04	0.00E+00	9.73E-06	1.19E-05	2.99E-04	6.63E-07	7.36E-06
Project	MAX	Moose	Acenaphthene	7.50E-09	4.18E-08	4.28E-06	0.00E+00	1.52E-07	1.85E-07	4.66E-06	1.04E-08	1.15E-07
Application	MAX	Ruffed_grouse	Acenaphthene	6.66E-09	8.18E-09	0.00E+00	8.28E-08	1.07E-08	2.90E-08	1.37E-07	1.96E-07	2.50E-09
Baseline	MAX	Ruffed_grouse	Acenaphthene	6.66E-09	8.17E-09	0.00E+00	8.28E-08	1.07E-08	2.90E-08	1.37E-07	1.96E-07	2.49E-09
Future	MAX	Ruffed_grouse	Acenaphthene	5.04E-09	6.19E-09	0.00E+00	6.27E-08	8.07E-09	2.20E-08	1.04E-07	1.48E-07	1.89E-09
PDC	MAX	Ruffed_grouse	Acenaphthene	1.17E-08	1.44E-08	0.00E+00	1.46E-07	1.87E-08	5.10E-08	2.41E-07	3.44E-07	4.38E-09
Project	MAX	Ruffed_grouse	Acenaphthene	1.83E-10	2.24E-10	0.00E+00	2.27E-09	2.92E-10	7.97E-10	3.77E-09	5.37E-09	6.85E-11
Application	MAX	Snowshoe_hare	Acenaphthene	1.06E-08	2.13E-08	0.00E+00	0.00E+00	3.07E-08	6.66E-08	1.29E-07	9.23E-08	3.18E-09
Baseline	MAX	Snowshoe_hare	Acenaphthene	1.06E-08	2.13E-08	0.00E+00	0.00E+00	3.07E-08	6.66E-08	1.29E-07	9.23E-08	3.18E-09
Future	MAX	Snowshoe_hare	Acenaphthene	8.02E-09	1.61E-08	0.00E+00	0.00E+00	2.32E-08	5.04E-08	9.78E-08	6.99E-08	2.41E-09
PDC	MAX	Snowshoe_hare	Acenaphthene	1.86E-08	3.75E-08	0.00E+00	0.00E+00	5.39E-08	1.17E-07	2.27E-07	1.62E-07	5.60E-09
Project	MAX	Snowshoe_hare	Acenaphthene	2.91E-10	5.85E-10	0.00E+00	0.00E+00	8.42E-10	1.83E-09	3.54E-09	2.53E-09	8.74E-11
Application	MAX	Moose	Acenaphthylene	6.87E-06	4.69E-05	2.95E-03	0.00E+00	1.05E-04	1.28E-04	3.24E-03	7.19E-06	8.09E-05
Baseline	MAX	Moose	Acenaphthylene	6.87E-06	4.69E-05	2.95E-03	0.00E+00	1.05E-04	1.28E-04	3.24E-03	7.19E-06	8.09E-05
Future	MAX	Moose	Acenaphthylene	5.48E-06	3.74E-05	2.35E-03	0.00E+00	8.35E-05	1.02E-04	2.58E-03	5.73E-06	6.45E-05
PDC	MAX	Moose	Acenaphthylene	1.23E-05	8.44E-05	5.30E-03	0.00E+00	1.88E-04	2.30E-04	5.82E-03	1.29E-05	1.45E-04
Project	MAX	Moose	Acenaphthylene	7.01E-09	4.79E-08	3.01E-06	0.00E+00	1.07E-07	1.30E-07	3.30E-06	7.34E-09	8.26E-08
Application	MAX	Ruffed_grouse	Acenaphthylene	1.67E-07	2.52E-07	0.00E+00	2.16E-06	2.02E-07	5.50E-07	3.33E-06	4.75E-06	6.13E-08
Baseline	MAX	Ruffed_grouse	Acenaphthylene	1.67E-07	2.52E-07	0.00E+00	2.16E-06	2.02E-07	5.50E-07	3.33E-06	4.75E-06	6.13E-08
Future	MAX	Ruffed_grouse	Acenaphthylene	1.33E-07	2.01E-07	0.00E+00	1.72E-06	1.61E-07	4.38E-07	2.66E-06	3.78E-06	4.89E-08
PDC	MAX	Ruffed_grouse	Acenaphthylene	3.01E-07	4.53E-07	0.00E+00	3.88E-06	3.62E-07	9.88E-07	5.99E-06	8.53E-06	1.10E-07
Project	MAX	Ruffed_grouse	Acenaphthylene	1.71E-10	2.57E-10	0.00E+00	2.21E-09	2.06E-10	5.61E-10	3.40E-09	4.85E-09	6.26E-11
Application	MAX	Snowshoe_hare	Acenaphthylene	2.66E-07	6.57E-07	0.00E+00	0.00E+00	5.81E-07	1.26E-06	2.76E-06	1.97E-06	6.91E-08
Baseline	MAX	Snowshoe_hare	Acenaphthylene	2.66E-07	6.57E-07	0.00E+00	0.00E+00	5.81E-07	1.26E-06	2.76E-06	1.97E-06	6.91E-08
Future	MAX	Snowshoe_hare	Acenaphthylene	2.12E-07	5.24E-07	0.00E+00	0.00E+00	4.63E-07	1.01E-06	2.20E-06	1.57E-06	5.51E-08
PDC	MAX	Snowshoe_hare	Acenaphthylene	4.78E-07	1.18E-06	0.00E+00	0.00E+00	1.04E-06	2.27E-06	4.97E-06	3.55E-06	1.24E-07
Project	MAX	Snowshoe_hare	Acenaphthylene	2.72E-10	6.71E-10	0.00E+00	0.00E+00	5.93E-10	1.29E-09	2.82E-09	2.02E-09	7.05E-11
Application	MAX	Moose	Anthracene	4.06E-06	2.17E-05	5.69E-03	0.00E+00	6.92E-06	8.67E-06	5.73E-03	1.27E-05	1.90E-06
Baseline	MAX	Moose	Anthracene	4.06E-06	2.17E-05	5.69E-03	0.00E+00	6.92E-06	8.67E-06	5.73E-03	1.27E-05	1.90E-06
Future	MAX	Moose	Anthracene	3.17E-06	1.69E-05	4.44E-03	0.00E+00	5.39E-06	6.76E-06	4.47E-03	9.93E-06	1.48E-06
PDC	MAX	Moose	Anthracene	7.23E-06	3.86E-05	1.01E-02	0.00E+00	1.23E-05	1.54E-05	1.02E-02	2.27E-05	3.38E-06
Project	MAX	Moose	Anthracene	1.09E-07	5.82E-07	1.53E-04	0.00E+00	1.86E-07	2.33E-07	1.54E-04	3.42E-07	5.10E-08
Application	MAX	Ruffed_grouse	Anthracene	9.89E-08	1.16E-07	0.00E+00	4.45E-09	1.33E-08	3.73E-08	2.70E-07	3.85E-07	6.59E-11
Baseline	MAX	Ruffed_grouse	Anthracene	9.89E-08	1.16E-07	0.00E+00	4.45E-09	1.33E-08	3.73E-08	2.70E-07	3.85E-07	6.59E-11
Future	MAX	Ruffed_grouse	Anthracene	7.71E-08	9.07E-08	0.00E+00	3.47E-09	1.04E-08	2.91E-08	2.11E-07	3.00E-07	5.14E-11
PDC	MAX	Ruffed_grouse	Anthracene	1.76E-07	2.07E-07	0.00E+00	7.91E-09	2.37E-08	6.64E-08	4.81E-07	6.85E-07	1.17E-10
Project	MAX	Ruffed_grouse	Anthracene	2.66E-09	3.13E-09	0.00E+00	1.20E-10	3.58E-10	1.00E-09	7.27E-09	1.04E-08	1.77E-12
Application	MAX	Snowshoe_hare	Anthracene	1.57E-07	3.03E-07	0.00E+00	0.00E+00	3.83E-08	8.56E-08	5.84E-07	4.17E-07	1.93E-10
Baseline	MAX	Snowshoe_hare	Anthracene	1.57E-07	3.03E-07	0.00E+00	0.00E+00	3.83E-08	8.56E-08	5.84E-07	4.17E-07	1.93E-10
Future	MAX	Snowshoe_hare	Anthracene	1.23E-07	2.36E-07	0.00E+00	0.00E+00	2.99E-08	6.67E-08	4.56E-07	3.25E-07	1.51E-10
PDC	MAX	Snowshoe_hare	Anthracene	2.80E-07	5.40E-07	0.00E+00	0.00E+00	6.82E-08	1.52E-07	1.04E-06	7.43E-07	3.44E-10
Project	MAX	Snowshoe_hare	Anthracene	4.23E-09	8.15E-09	0.00E+00	0.00E+00	1.03E-09	2.30E-09	1.57E-08	1.12E-08	5.20E-12
Application	MAX	Moose	Benzo(a)anthracene	3.30E-04	5.71E-02	8.17E-03	0.00E+00	9.94E-06	1.21E-05	6.56E-02	1.46E-04	2.60E-05
Baseline	MAX	Moose	Benzo(a)anthracene	3.30E-04	5.71E-02	8.17E-03	0.00E+00	9.94E-06	1.21E-05	6.56E-02	1.46E-04	2.60E-05
Future	MAX	Moose	Benzo(a)anthracene	2.38E-04	4.12E-02	5.89E-03	0.00E+00	7.17E-06	8.74E-06	4.73E-02	1.05E-04	1.87E-05
PDC	MAX	Moose	Benzo(a)anthracene	5.67E-04	9.83E-02	1.41E-02	0.00E+00	1.71E-05	2.08E-05	1.13E-01	2.51E-04	4.47E-05
Project	MAX	Moose	Benzo(a)anthracene	9.35E-05	1.62E-02	2.32E-03	0.00E+00	2.82E-06	3.44E-06	1.86E-02	4.13E-05	7.36E-06
Application	MAX	Ruffed_grouse	Benzo(a)anthracene	8.03E-06	3.06E-04	0.00E+00	1.55E-07	1.91E-08	5.21E-08	3.15E-04	4.48E-04	9.18E-08

Table E-5 Summary of Predicted Exposures and Game Meat Concentrations

Scenario	Site	Receptor	Chemical	EDI Soil EDI mg/day	EDI Browse EDI mg/day	EDI Aquatic Plant EDI mg/day	EDI Invert EDI mg/day	EDI Water EDI mg/day	EDI Air EDI mg/day	EDI Total EDI mg/day	EDI Total EDI mg/kg-BW/day	Game Meat Concentration mg/kg ww
Baseline	MAX	Ruffed_grouse	Benzo(a)anthracene	8.03E-06	3.06E-04	0.00E+00	1.55E-07	1.91E-08	5.21E-08	3.15E-04	4.48E-04	9.18E-08
Future	MAX	Ruffed_grouse	Benzo(a)anthracene	5.79E-06	2.21E-04	0.00E+00	1.12E-07	1.38E-08	3.76E-08	2.27E-04	3.23E-04	6.62E-08
PDC	MAX	Ruffed_grouse	Benzo(a)anthracene	1.38E-05	5.28E-04	0.00E+00	2.66E-07	3.29E-08	8.97E-08	5.42E-04	7.72E-04	1.58E-07
Project	MAX	Ruffed_grouse	Benzo(a)anthracene	2.28E-06	8.69E-05	0.00E+00	4.39E-08	5.42E-09	1.48E-08	8.93E-05	1.27E-04	2.60E-08
Application	MAX	Snowshoe_hare	Benzo(a)anthracene	1.28E-05	7.99E-04	0.00E+00	0.00E+00	5.51E-08	1.20E-07	8.12E-04	5.80E-04	3.21E-07
Baseline	MAX	Snowshoe_hare	Benzo(a)anthracene	1.28E-05	7.99E-04	0.00E+00	0.00E+00	5.51E-08	1.20E-07	8.12E-04	5.80E-04	3.21E-07
Future	MAX	Snowshoe_hare	Benzo(a)anthracene	9.21E-06	5.76E-04	0.00E+00	0.00E+00	3.97E-08	8.62E-08	5.86E-04	4.18E-04	2.32E-07
PDC	MAX	Snowshoe_hare	Benzo(a)anthracene	2.20E-05	1.38E-03	0.00E+00	0.00E+00	9.48E-08	2.06E-07	1.40E-03	9.98E-04	5.53E-07
Project	MAX	Snowshoe_hare	Benzo(a)anthracene	3.62E-06	2.27E-04	0.00E+00	0.00E+00	1.56E-08	3.39E-08	2.30E-04	1.64E-04	9.11E-08
Application	MAX	Moose	Benzo(a)pyrene	3.09E-04	2.83E-02	1.65E-03	0.00E+00	2.01E-06	2.45E-06	3.02E-02	6.71E-05	1.09E-05
Baseline	MAX	Moose	Benzo(a)pyrene	3.09E-04	2.82E-02	1.65E-03	0.00E+00	2.01E-06	2.45E-06	3.02E-02	6.71E-05	1.09E-05
Future	MAX	Moose	Benzo(a)pyrene	2.45E-04	2.24E-02	1.31E-03	0.00E+00	1.59E-06	1.94E-06	2.40E-02	5.32E-05	8.65E-06
PDC	MAX	Moose	Benzo(a)pyrene	5.54E-04	5.06E-02	2.96E-03	0.00E+00	3.60E-06	4.38E-06	5.42E-02	1.20E-04	1.96E-05
Project	MAX	Moose	Benzo(a)pyrene	1.73E-05	1.59E-03	9.26E-05	0.00E+00	1.13E-07	1.37E-07	1.70E-03	3.77E-06	6.13E-07
Application	MAX	Ruffed_grouse	Benzo(a)pyrene	7.52E-06	1.52E-04	0.00E+00	3.38E-07	3.86E-09	1.05E-08	1.60E-04	2.27E-04	4.25E-08
Baseline	MAX	Ruffed_grouse	Benzo(a)pyrene	7.52E-06	1.52E-04	0.00E+00	3.38E-07	3.86E-09	1.05E-08	1.60E-04	2.27E-04	4.25E-08
Future	MAX	Ruffed_grouse	Benzo(a)pyrene	5.97E-06	1.20E-04	0.00E+00	2.68E-07	3.06E-09	8.34E-09	1.26E-04	1.80E-04	3.37E-08
PDC	MAX	Ruffed_grouse	Benzo(a)pyrene	1.35E-05	2.72E-04	0.00E+00	6.06E-07	6.92E-09	1.89E-08	2.86E-04	4.07E-04	7.61E-08
Project	MAX	Ruffed_grouse	Benzo(a)pyrene	4.22E-07	8.51E-06	0.00E+00	1.90E-08	2.17E-10	5.91E-10	8.95E-06	1.28E-05	2.38E-09
Application	MAX	Snowshoe_hare	Benzo(a)pyrene	1.20E-05	3.95E-04	0.00E+00	0.00E+00	1.11E-08	2.41E-08	4.07E-04	2.91E-04	1.47E-07
Baseline	MAX	Snowshoe_hare	Benzo(a)pyrene	1.20E-05	3.95E-04	0.00E+00	0.00E+00	1.11E-08	2.41E-08	4.07E-04	2.91E-04	1.47E-07
Future	MAX	Snowshoe_hare	Benzo(a)pyrene	9.49E-06	3.14E-04	0.00E+00	0.00E+00	8.81E-09	1.91E-08	3.23E-04	2.31E-04	1.17E-07
PDC	MAX	Snowshoe_hare	Benzo(a)pyrene	2.14E-05	7.09E-04	0.00E+00	0.00E+00	1.99E-08	4.33E-08	7.30E-04	5.22E-04	2.64E-07
Project	MAX	Snowshoe_hare	Benzo(a)pyrene	6.71E-07	2.22E-05	0.00E+00	0.00E+00	6.24E-10	1.35E-09	2.29E-05	1.63E-05	8.26E-09
Application	MAX	Moose	Benzo(b)fluoranthene	3.10E-05	1.94E-02	2.60E-03	0.00E+00	3.16E-06	3.85E-06	2.21E-02	4.90E-05	8.70E-06
Baseline	MAX	Moose	Benzo(b)fluoranthene	3.10E-05	1.94E-02	2.60E-03	0.00E+00	3.16E-06	3.85E-06	2.21E-02	4.90E-05	8.70E-06
Future	MAX	Moose	Benzo(b)fluoranthene	2.19E-05	1.37E-02	1.83E-03	0.00E+00	2.23E-06	2.72E-06	1.56E-02	3.46E-05	6.14E-06
PDC	MAX	Moose	Benzo(b)fluoranthene	5.29E-05	3.31E-02	4.43E-03	0.00E+00	5.39E-06	6.57E-06	3.76E-02	8.37E-05	1.48E-05
Project	MAX	Moose	Benzo(b)fluoranthene	8.82E-07	5.52E-04	7.38E-05	0.00E+00	8.97E-08	1.09E-07	6.27E-04	1.39E-06	2.47E-07
Application	MAX	Ruffed_grouse	Benzo(b)fluoranthene	7.56E-07	1.04E-04	0.00E+00	3.40E-08	6.08E-09	1.66E-08	1.05E-04	1.50E-04	3.06E-08
Baseline	MAX	Ruffed_grouse	Benzo(b)fluoranthene	7.56E-07	1.04E-04	0.00E+00	3.40E-08	6.08E-09	1.66E-08	1.05E-04	1.50E-04	3.05E-08
Future	MAX	Ruffed_grouse	Benzo(b)fluoranthene	5.34E-07	7.37E-05	0.00E+00	2.40E-08	4.29E-09	1.17E-08	7.42E-05	1.06E-04	2.16E-08
PDC	MAX	Ruffed_grouse	Benzo(b)fluoranthene	1.29E-06	1.78E-04	0.00E+00	5.80E-08	1.04E-08	2.83E-08	1.79E-04	2.55E-04	5.21E-08
Project	MAX	Ruffed_grouse	Benzo(b)fluoranthene	2.15E-08	2.96E-06	0.00E+00	9.65E-10	1.73E-10	4.71E-10	2.99E-06	4.26E-06	8.68E-10
Application	MAX	Snowshoe_hare	Benzo(b)fluoranthene	1.20E-06	2.72E-04	0.00E+00	0.00E+00	1.75E-08	3.80E-08	2.73E-04	1.95E-04	1.08E-07
Baseline	MAX	Snowshoe_hare	Benzo(b)fluoranthene	1.20E-06	2.72E-04	0.00E+00	0.00E+00	1.75E-08	3.80E-08	2.73E-04	1.95E-04	1.08E-07
Future	MAX	Snowshoe_hare	Benzo(b)fluoranthene	8.49E-07	1.92E-04	0.00E+00	0.00E+00	1.24E-08	2.68E-08	1.93E-04	1.38E-04	7.61E-08
PDC	MAX	Snowshoe_hare	Benzo(b)fluoranthene	2.05E-06	4.64E-04	0.00E+00	0.00E+00	2.99E-08	6.48E-08	4.66E-04	3.33E-04	1.84E-07
Project	MAX	Snowshoe_hare	Benzo(b)fluoranthene	3.41E-08	7.73E-06	0.00E+00	0.00E+00	4.97E-10	1.08E-09	7.76E-06	5.55E-06	3.06E-09
Application	MAX	Moose	Benzo(g,h,i)perylene	3.71E-04	7.67E-02	1.69E-03	0.00E+00	2.06E-06	2.51E-06	7.87E-02	1.75E-04	2.28E-05
Baseline	MAX	Moose	Benzo(g,h,i)perylene	3.71E-04	7.67E-02	1.69E-03	0.00E+00	2.06E-06	2.51E-06	7.87E-02	1.75E-04	2.28E-05
Future	MAX	Moose	Benzo(g,h,i)perylene	2.90E-04	5.99E-02	1.32E-03	0.00E+00	1.61E-06	1.96E-06	6.15E-02	1.37E-04	1.78E-05
PDC	MAX	Moose	Benzo(g,h,i)perylene	6.61E-04	1.37E-01	3.01E-03	0.00E+00	3.66E-06	4.47E-06	1.40E-01	3.12E-04	4.06E-05
Project	MAX	Moose	Benzo(g,h,i)perylene	2.13E-05	4.40E-03	9.70E-05	0.00E+00	1.18E-07	1.44E-07	4.52E-03	1.00E-05	1.31E-06
Application	MAX	Ruffed_grouse	Benzo(g,h,i)perylene	9.04E-06	4.12E-04	0.00E+00	4.06E-07	3.96E-09	1.08E-08	4.21E-04	6.00E-04	8.97E-08
Baseline	MAX	Ruffed_grouse	Benzo(g,h,i)perylene	9.04E-06	4.12E-04	0.00E+00	4.06E-07	3.96E-09	1.08E-08	4.21E-04	6.00E-04	8.97E-08
Future	MAX	Ruffed_grouse	Benzo(g,h,i)perylene	7.06E-06	3.22E-04	0.00E+00	3.17E-07	3.09E-09	8.43E-09	3.29E-04	4.69E-04	7.01E-08
PDC	MAX	Ruffed_grouse	Benzo(g,h,i)perylene	1.61E-05	7.33E-04	0.00E+00	7.24E-07	7.05E-09	1.92E-08	7.50E-04	1.07E-03	1.60E-07

Table E-5 Summary of Predicted Exposures and Game Meat Concentrations

Scenario	Site	Receptor	Chemical	EDI Soil EDI mg/day	EDI Browse EDI mg/day	EDI Aquatic Plant EDI mg/day	EDI Invert EDI mg/day	EDI Water EDI mg/day	EDI Air EDI mg/day	EDI Total EDI mg/day	EDI Total EDI mg/kg-BW/day	Game Meat Concentration mg/kg ww
Project	MAX	Ruffed_grouse	Benzo(g,h,i)perylene	5.18E-07	2.36E-05	0.00E+00	2.33E-08	2.27E-10	6.19E-10	2.41E-05	3.44E-05	5.14E-09
Application	MAX	Snowshoe_hare	Benzo(g,h,i)perylene	1.44E-05	1.07E-03	0.00E+00	0.00E+00	1.14E-08	2.47E-08	1.09E-03	7.77E-04	3.14E-07
Baseline	MAX	Snowshoe_hare	Benzo(g,h,i)perylene	1.44E-05	1.07E-03	0.00E+00	0.00E+00	1.14E-08	2.47E-08	1.09E-03	7.77E-04	3.14E-07
Future	MAX	Snowshoe_hare	Benzo(g,h,i)perylene	1.12E-05	8.39E-04	0.00E+00	0.00E+00	8.91E-09	1.93E-08	8.50E-04	6.07E-04	2.46E-07
PDC	MAX	Snowshoe_hare	Benzo(g,h,i)perylene	2.56E-05	1.91E-03	0.00E+00	0.00E+00	2.03E-08	4.41E-08	1.94E-03	1.38E-03	5.60E-07
Project	MAX	Snowshoe_hare	Benzo(g,h,i)perylene	8.24E-07	6.15E-05	0.00E+00	0.00E+00	6.54E-10	1.42E-09	6.24E-05	4.45E-05	1.80E-08
Application	MAX	Moose	Benzo(k)fluoranthene	6.01E-04	1.30E-02	8.28E-04	0.00E+00	1.01E-06	1.27E-06	1.44E-02	3.21E-05	5.24E-06
Baseline	MAX	Moose	Benzo(k)fluoranthene	6.01E-04	1.30E-02	8.28E-04	0.00E+00	1.01E-06	1.27E-06	1.44E-02	3.20E-05	5.24E-06
Future	MAX	Moose	Benzo(k)fluoranthene	4.66E-04	1.01E-02	6.42E-04	0.00E+00	7.80E-07	9.82E-07	1.12E-02	2.48E-05	4.06E-06
PDC	MAX	Moose	Benzo(k)fluoranthene	1.07E-03	2.31E-02	1.47E-03	0.00E+00	1.79E-06	2.25E-06	2.56E-02	5.69E-05	9.31E-06
Project	MAX	Moose	Benzo(k)fluoranthene	5.19E-05	1.12E-03	7.15E-05	0.00E+00	8.70E-08	1.09E-07	1.25E-03	2.77E-06	4.53E-07
Application	MAX	Ruffed_grouse	Benzo(k)fluoranthene	1.46E-05	6.98E-05	0.00E+00	7.52E-07	1.94E-09	5.45E-09	8.52E-05	1.21E-04	2.28E-08
Baseline	MAX	Ruffed_grouse	Benzo(k)fluoranthene	1.46E-05	6.97E-05	0.00E+00	7.52E-07	1.94E-09	5.45E-09	8.51E-05	1.21E-04	2.28E-08
Future	MAX	Ruffed_grouse	Benzo(k)fluoranthene	1.13E-05	5.41E-05	0.00E+00	5.83E-07	1.50E-09	4.22E-09	6.60E-05	9.40E-05	1.77E-08
PDC	MAX	Ruffed_grouse	Benzo(k)fluoranthene	2.60E-05	1.24E-04	0.00E+00	1.33E-06	3.44E-09	9.67E-09	1.51E-04	2.15E-04	4.05E-08
Project	MAX	Ruffed_grouse	Benzo(k)fluoranthene	1.26E-06	6.03E-06	0.00E+00	6.50E-08	1.67E-10	4.71E-10	7.36E-06	1.05E-05	1.97E-09
Application	MAX	Snowshoe_hare	Benzo(k)fluoranthene	2.33E-05	1.82E-04	0.00E+00	0.00E+00	5.58E-09	1.25E-08	2.05E-04	1.47E-04	7.46E-08
Baseline	MAX	Snowshoe_hare	Benzo(k)fluoranthene	2.33E-05	1.82E-04	0.00E+00	0.00E+00	5.58E-09	1.25E-08	2.05E-04	1.46E-04	7.46E-08
Future	MAX	Snowshoe_hare	Benzo(k)fluoranthene	1.80E-05	1.41E-04	0.00E+00	0.00E+00	4.32E-09	9.69E-09	1.59E-04	1.14E-04	5.78E-08
PDC	MAX	Snowshoe_hare	Benzo(k)fluoranthene	4.13E-05	3.23E-04	0.00E+00	0.00E+00	9.90E-09	2.22E-08	3.64E-04	2.60E-04	1.32E-07
Project	MAX	Snowshoe_hare	Benzo(k)fluoranthene	2.01E-06	1.57E-05	0.00E+00	0.00E+00	4.82E-10	1.08E-09	1.77E-05	1.27E-05	6.44E-09
Application	MAX	Moose	Chrysene	1.06E-03	2.14E-02	4.99E-03	0.00E+00	6.06E-06	7.39E-06	2.75E-02	6.10E-05	1.08E-05
Baseline	MAX	Moose	Chrysene	1.06E-03	2.14E-02	4.99E-03	0.00E+00	6.06E-06	7.39E-06	2.75E-02	6.10E-05	1.08E-05
Future	MAX	Moose	Chrysene	8.30E-04	1.68E-02	3.92E-03	0.00E+00	4.76E-06	5.81E-06	2.16E-02	4.79E-05	8.46E-06
PDC	MAX	Moose	Chrysene	1.89E-03	3.82E-02	8.90E-03	0.00E+00	1.08E-05	1.32E-05	4.90E-02	1.09E-04	1.92E-05
Project	MAX	Moose	Chrysene	3.19E-05	6.47E-04	1.51E-04	0.00E+00	1.83E-07	2.23E-07	8.30E-04	1.84E-06	3.25E-07
Application	MAX	Ruffed_grouse	Chrysene	2.57E-05	1.15E-04	0.00E+00	6.61E-07	1.17E-08	3.18E-08	1.41E-04	2.01E-04	4.09E-08
Baseline	MAX	Ruffed_grouse	Chrysene	2.57E-05	1.15E-04	0.00E+00	6.61E-07	1.17E-08	3.18E-08	1.41E-04	2.01E-04	4.09E-08
Future	MAX	Ruffed_grouse	Chrysene	2.02E-05	9.03E-05	0.00E+00	5.19E-07	9.17E-09	2.50E-08	1.11E-04	1.58E-04	3.21E-08
PDC	MAX	Ruffed_grouse	Chrysene	4.60E-05	2.05E-04	0.00E+00	1.18E-06	2.08E-08	5.68E-08	2.52E-04	3.60E-04	7.30E-08
Project	MAX	Ruffed_grouse	Chrysene	7.77E-07	3.47E-06	0.00E+00	2.00E-08	3.52E-10	9.60E-10	4.27E-06	6.08E-06	1.23E-09
Application	MAX	Snowshoe_hare	Chrysene	4.09E-05	3.00E-04	0.00E+00	0.00E+00	3.36E-08	7.30E-08	3.41E-04	2.43E-04	1.34E-07
Baseline	MAX	Snowshoe_hare	Chrysene	4.09E-05	3.00E-04	0.00E+00	0.00E+00	3.36E-08	7.30E-08	3.41E-04	2.43E-04	1.34E-07
Future	MAX	Snowshoe_hare	Chrysene	3.22E-05	2.35E-04	0.00E+00	0.00E+00	2.64E-08	5.73E-08	2.68E-04	1.91E-04	1.05E-07
PDC	MAX	Snowshoe_hare	Chrysene	7.31E-05	5.35E-04	0.00E+00	0.00E+00	6.00E-08	1.30E-07	6.08E-04	4.35E-04	2.39E-07
Project	MAX	Snowshoe_hare	Chrysene	1.24E-06	9.05E-06	0.00E+00	0.00E+00	1.01E-09	2.20E-09	1.03E-05	7.35E-06	4.04E-09
Application	MAX	Moose	Dibenz(a,h)anthracene	1.44E-04	1.24E-02	3.71E-04	0.00E+00	4.51E-07	5.50E-07	1.30E-02	2.88E-05	3.49E-06
Baseline	MAX	Moose	Dibenz(a,h)anthracene	1.44E-04	1.24E-02	3.70E-04	0.00E+00	4.50E-07	5.49E-07	1.29E-02	2.87E-05	3.48E-06
Future	MAX	Moose	Dibenz(a,h)anthracene	4.38E-05	3.78E-03	1.13E-04	0.00E+00	1.37E-07	1.67E-07	3.94E-03	8.75E-06	1.06E-06
PDC	MAX	Moose	Dibenz(a,h)anthracene	1.06E-04	9.14E-03	2.72E-04	0.00E+00	3.31E-07	4.04E-07	9.51E-03	2.11E-05	2.56E-06
Project	MAX	Moose	Dibenz(a,h)anthracene	5.12E-05	4.42E-03	1.32E-04	0.00E+00	1.60E-07	1.96E-07	4.61E-03	1.02E-05	1.24E-06
Application	MAX	Ruffed_grouse	Dibenz(a,h)anthracene	3.51E-06	6.68E-05	0.00E+00	1.58E-07	8.69E-10	2.37E-09	7.05E-05	1.00E-04	1.40E-08
Baseline	MAX	Ruffed_grouse	Dibenz(a,h)anthracene	3.50E-06	6.66E-05	0.00E+00	1.57E-07	8.66E-10	2.36E-09	7.03E-05	1.00E-04	1.40E-08
Future	MAX	Ruffed_grouse	Dibenz(a,h)anthracene	1.07E-06	2.03E-05	0.00E+00	4.79E-08	2.64E-10	7.19E-10	2.14E-05	3.05E-05	4.25E-09
PDC	MAX	Ruffed_grouse	Dibenz(a,h)anthracene	2.58E-06	4.90E-05	0.00E+00	1.16E-07	6.38E-10	1.74E-09	5.17E-05	7.37E-05	1.03E-08
Project	MAX	Ruffed_grouse	Dibenz(a,h)anthracene	1.25E-06	2.37E-05	0.00E+00	5.60E-08	3.09E-10	8.41E-10	2.50E-05	3.57E-05	4.97E-09
Application	MAX	Snowshoe_hare	Dibenz(a,h)anthracene	5.58E-06	1.74E-04	0.00E+00	0.00E+00	2.50E-09	5.43E-09	1.80E-04	1.28E-04	4.84E-08
Baseline	MAX	Snowshoe_hare	Dibenz(a,h)anthracene	5.56E-06	1.74E-04	0.00E+00	0.00E+00	2.49E-09	5.42E-09	1.79E-04	1.28E-04	4.83E-08

Table E-5 Summary of Predicted Exposures and Game Meat Concentrations

Scenario	Site	Receptor	Chemical	EDI								Game Meat
				Soil	Browse	Aquatic Plant	Invert	Water	Air	Total	Total	
				EDI	EDI	EDI	EDI	EDI	EDI	EDI	EDI	Concentration
				mg/day	mg/day	mg/day	mg/day	mg/day	mg/day	mg/day	mg/kg-BW/day	mg/kg ww
Future	MAX	Snowshoe_hare	Dibenz(a,h)anthracene	1.69E-06	5.29E-05	0.00E+00	0.00E+00	7.60E-10	1.65E-09	5.46E-05	3.90E-05	1.47E-08
PDC	MAX	Snowshoe_hare	Dibenz(a,h)anthracene	4.10E-06	1.28E-04	0.00E+00	0.00E+00	1.84E-09	3.99E-09	1.32E-04	9.43E-05	3.56E-08
Project	MAX	Snowshoe_hare	Dibenz(a,h)anthracene	1.98E-06	6.19E-05	0.00E+00	0.00E+00	8.89E-10	1.93E-09	6.39E-05	4.56E-05	1.72E-08
Application	MAX	Moose	Fluoranthene	7.84E-05	1.08E-03	8.81E-03	0.00E+00	1.07E-05	1.31E-05	9.99E-03	2.22E-05	4.02E-06
Baseline	MAX	Moose	Fluoranthene	7.84E-05	1.08E-03	8.81E-03	0.00E+00	1.07E-05	1.31E-05	9.99E-03	2.22E-05	4.02E-06
Future	MAX	Moose	Fluoranthene	5.91E-05	8.15E-04	6.63E-03	0.00E+00	8.06E-06	9.83E-06	7.52E-03	1.67E-05	3.02E-06
PDC	MAX	Moose	Fluoranthene	1.37E-04	1.90E-03	1.54E-02	0.00E+00	1.88E-05	2.29E-05	1.75E-02	3.89E-05	7.04E-06
Project	MAX	Moose	Fluoranthene	2.69E-06	3.71E-05	3.02E-04	0.00E+00	3.67E-07	4.48E-07	3.43E-04	7.61E-07	1.38E-07
Application	MAX	Ruffed_grouse	Fluoranthene	1.91E-06	5.81E-06	0.00E+00	8.59E-08	2.06E-08	5.62E-08	7.88E-06	1.12E-05	2.33E-09
Baseline	MAX	Ruffed_grouse	Fluoranthene	1.91E-06	5.81E-06	0.00E+00	8.59E-08	2.06E-08	5.62E-08	7.88E-06	1.12E-05	2.33E-09
Future	MAX	Ruffed_grouse	Fluoranthene	1.44E-06	4.37E-06	0.00E+00	6.47E-08	1.55E-08	4.23E-08	5.93E-06	8.45E-06	1.76E-09
PDC	MAX	Ruffed_grouse	Fluoranthene	3.35E-06	1.02E-05	0.00E+00	1.51E-07	3.61E-08	9.85E-08	1.38E-05	1.97E-05	4.09E-09
Project	MAX	Ruffed_grouse	Fluoranthene	6.55E-08	1.99E-07	0.00E+00	2.94E-09	7.07E-10	1.93E-09	2.70E-07	3.85E-07	8.00E-11
Application	MAX	Snowshoe_hare	Fluoranthene	3.04E-06	1.51E-05	0.00E+00	0.00E+00	5.94E-08	1.29E-07	1.84E-05	1.31E-05	7.38E-09
Baseline	MAX	Snowshoe_hare	Fluoranthene	3.04E-06	1.51E-05	0.00E+00	0.00E+00	5.94E-08	1.29E-07	1.84E-05	1.31E-05	7.38E-09
Future	MAX	Snowshoe_hare	Fluoranthene	2.29E-06	1.14E-05	0.00E+00	0.00E+00	4.47E-08	9.70E-08	1.38E-05	9.88E-06	5.56E-09
PDC	MAX	Snowshoe_hare	Fluoranthene	5.33E-06	2.66E-05	0.00E+00	0.00E+00	1.04E-07	2.26E-07	3.22E-05	2.30E-05	1.29E-08
Project	MAX	Snowshoe_hare	Fluoranthene	1.04E-07	5.19E-07	0.00E+00	0.00E+00	2.03E-09	4.42E-09	6.30E-07	4.50E-07	2.53E-10
Application	MAX	Moose	Fluorene	8.60E-03	5.61E-02	1.40E-02	0.00E+00	1.70E-05	2.08E-05	7.88E-02	1.75E-04	2.28E-05
Baseline	MAX	Moose	Fluorene	8.60E-03	5.61E-02	1.40E-02	0.00E+00	1.70E-05	2.08E-05	7.88E-02	1.75E-04	2.28E-05
Future	MAX	Moose	Fluorene	1.43E-06	9.48E-06	8.46E-03	0.00E+00	1.03E-05	1.25E-05	8.49E-03	1.89E-05	2.46E-06
PDC	MAX	Moose	Fluorene	8.60E-03	5.62E-02	2.03E-02	0.00E+00	2.47E-05	3.01E-05	8.51E-02	1.89E-04	2.46E-05
Project	MAX	Moose	Fluorene	7.55E-08	4.99E-07	4.45E-04	0.00E+00	5.41E-07	6.60E-07	4.47E-04	9.93E-07	1.29E-07
Application	MAX	Ruffed_grouse	Fluorene	2.10E-04	3.01E-04	0.00E+00	9.42E-05	3.28E-08	8.93E-08	6.05E-04	8.62E-04	1.29E-07
Baseline	MAX	Ruffed_grouse	Fluorene	2.10E-04	3.01E-04	0.00E+00	9.42E-05	3.28E-08	8.93E-08	6.05E-04	8.62E-04	1.29E-07
Future	MAX	Ruffed_grouse	Fluorene	3.49E-08	5.09E-08	0.00E+00	1.57E-09	1.98E-08	5.39E-08	1.61E-07	2.30E-07	3.44E-11
PDC	MAX	Ruffed_grouse	Fluorene	2.10E-04	3.01E-04	0.00E+00	9.42E-05	4.75E-08	1.29E-07	6.05E-04	8.62E-04	1.29E-07
Project	MAX	Ruffed_grouse	Fluorene	1.84E-09	2.68E-09	0.00E+00	8.26E-11	1.04E-09	2.84E-09	8.48E-09	1.21E-08	1.81E-12
Application	MAX	Snowshoe_hare	Fluorene	3.33E-04	7.86E-04	0.00E+00	0.00E+00	9.44E-08	2.05E-07	1.12E-03	8.00E-04	3.24E-07
Baseline	MAX	Snowshoe_hare	Fluorene	3.33E-04	7.86E-04	0.00E+00	0.00E+00	9.44E-08	2.05E-07	1.12E-03	8.00E-04	3.24E-07
Future	MAX	Snowshoe_hare	Fluorene	5.56E-08	1.33E-07	0.00E+00	0.00E+00	5.70E-08	1.24E-07	3.69E-07	2.64E-07	1.07E-10
PDC	MAX	Snowshoe_hare	Fluorene	3.33E-04	7.86E-04	0.00E+00	0.00E+00	1.37E-07	2.97E-07	1.12E-03	8.00E-04	3.24E-07
Project	MAX	Snowshoe_hare	Fluorene	2.92E-09	6.98E-09	0.00E+00	0.00E+00	3.00E-09	6.51E-09	1.94E-08	1.39E-08	5.62E-12
Application	MAX	Moose	Indeno(1,2,3-cd)pyrene	9.25E-05	4.40E-03	3.10E-04	0.00E+00	3.77E-07	4.60E-07	4.80E-03	1.07E-05	1.33E-06
Baseline	MAX	Moose	Indeno(1,2,3-cd)pyrene	9.21E-05	4.38E-03	3.09E-04	0.00E+00	3.76E-07	4.58E-07	4.78E-03	1.06E-05	1.33E-06
Future	MAX	Moose	Indeno(1,2,3-cd)pyrene	3.40E-05	1.62E-03	1.14E-04	0.00E+00	1.38E-07	1.69E-07	1.76E-03	3.92E-06	4.90E-07
PDC	MAX	Moose	Indeno(1,2,3-cd)pyrene	6.88E-05	3.28E-03	2.31E-04	0.00E+00	2.81E-07	3.42E-07	3.58E-03	7.95E-06	9.93E-07
Project	MAX	Moose	Indeno(1,2,3-cd)pyrene	4.05E-05	1.93E-03	1.36E-04	0.00E+00	1.65E-07	2.01E-07	2.10E-03	4.67E-06	5.84E-07
Application	MAX	Ruffed_grouse	Indeno(1,2,3-cd)pyrene	2.25E-06	2.36E-05	0.00E+00	1.01E-07	7.26E-10	1.98E-09	2.60E-05	3.70E-05	5.31E-09
Baseline	MAX	Ruffed_grouse	Indeno(1,2,3-cd)pyrene	2.24E-06	2.35E-05	0.00E+00	1.01E-07	7.23E-10	1.97E-09	2.59E-05	3.69E-05	5.29E-09
Future	MAX	Ruffed_grouse	Indeno(1,2,3-cd)pyrene	8.27E-07	8.68E-06	0.00E+00	3.72E-08	2.67E-10	7.26E-10	9.54E-06	1.36E-05	1.95E-09
PDC	MAX	Ruffed_grouse	Indeno(1,2,3-cd)pyrene	1.68E-06	1.76E-05	0.00E+00	7.54E-08	5.40E-10	1.47E-09	1.93E-05	2.75E-05	3.96E-09
Project	MAX	Ruffed_grouse	Indeno(1,2,3-cd)pyrene	9.86E-07	1.03E-05	0.00E+00	4.43E-08	3.18E-10	8.66E-10	1.14E-05	1.62E-05	2.33E-09
Application	MAX	Snowshoe_hare	Indeno(1,2,3-cd)pyrene	3.58E-06	6.16E-05	0.00E+00	0.00E+00	2.09E-09	4.54E-09	6.52E-05	4.65E-05	1.81E-08
Baseline	MAX	Snowshoe_hare	Indeno(1,2,3-cd)pyrene	3.57E-06	6.13E-05	0.00E+00	0.00E+00	2.08E-09	4.52E-09	6.49E-05	4.64E-05	1.80E-08
Future	MAX	Snowshoe_hare	Indeno(1,2,3-cd)pyrene	1.32E-06	2.26E-05	0.00E+00	0.00E+00	7.67E-10	1.67E-09	2.39E-05	1.71E-05	6.65E-09
PDC	MAX	Snowshoe_hare	Indeno(1,2,3-cd)pyrene	2.67E-06	4.58E-05	0.00E+00	0.00E+00	1.56E-09	3.38E-09	4.85E-05	3.47E-05	1.35E-08
Project	MAX	Snowshoe_hare	Indeno(1,2,3-cd)pyrene	1.57E-06	2.70E-05	0.00E+00	0.00E+00	9.15E-10	1.99E-09	2.85E-05	2.04E-05	7.92E-09

Table E-5 Summary of Predicted Exposures and Game Meat Concentrations

Scenario	Site	Receptor	Chemical	EDI Soil EDI mg/day	EDI Browse EDI mg/day	EDI Aquatic Plant EDI mg/day	EDI Invert EDI mg/day	EDI Water EDI mg/day	EDI Air EDI mg/day	EDI Total EDI mg/day	EDI Total mg/kg-BW/day	Game Meat Concentration mg/kg ww
Application	MAX	Moose	Phenanthrene	2.37E-02	1.51E+00	3.63E-02	0.00E+00	4.41E-05	5.37E-05	1.57E+00	3.49E-03	5.22E-04
Baseline	MAX	Moose	Phenanthrene	2.37E-02	1.51E+00	3.62E-02	0.00E+00	4.41E-05	5.37E-05	1.57E+00	3.49E-03	5.22E-04
Future	MAX	Moose	Phenanthrene	2.66E-05	2.93E-04	2.70E-02	0.00E+00	3.28E-05	4.00E-05	2.73E-02	6.08E-05	9.09E-06
PDC	MAX	Moose	Phenanthrene	2.37E-02	1.51E+00	6.32E-02	0.00E+00	7.68E-05	9.37E-05	1.60E+00	3.55E-03	5.31E-04
Project	MAX	Moose	Phenanthrene	2.25E-06	2.48E-05	2.29E-03	0.00E+00	2.78E-06	3.39E-06	2.32E-03	5.16E-06	7.72E-07
Application	MAX	Ruffed_grouse	Phenanthrene	5.77E-04	8.11E-03	0.00E+00	2.59E-04	8.48E-08	2.31E-07	8.95E-03	1.28E-02	2.19E-06
Baseline	MAX	Ruffed_grouse	Phenanthrene	5.77E-04	8.11E-03	0.00E+00	2.59E-04	8.48E-08	2.31E-07	8.95E-03	1.28E-02	2.19E-06
Future	MAX	Ruffed_grouse	Phenanthrene	6.47E-07	1.57E-06	0.00E+00	2.91E-08	6.31E-08	1.72E-07	2.48E-06	3.54E-06	6.08E-10
PDC	MAX	Ruffed_grouse	Phenanthrene	5.78E-04	8.12E-03	0.00E+00	2.59E-04	1.48E-07	4.03E-07	8.95E-03	1.28E-02	2.19E-06
Project	MAX	Ruffed_grouse	Phenanthrene	5.49E-08	1.33E-07	0.00E+00	2.47E-09	5.36E-09	1.46E-08	2.11E-07	3.00E-07	5.16E-11
Application	MAX	Snowshoe_hare	Phenanthrene	9.17E-04	2.12E-02	0.00E+00	0.00E+00	2.44E-07	5.30E-07	2.21E-02	1.58E-02	7.34E-06
Baseline	MAX	Snowshoe_hare	Phenanthrene	9.17E-04	2.12E-02	0.00E+00	0.00E+00	2.44E-07	5.30E-07	2.21E-02	1.58E-02	7.34E-06
Future	MAX	Snowshoe_hare	Phenanthrene	1.03E-06	4.10E-06	0.00E+00	0.00E+00	1.82E-07	3.94E-07	5.70E-06	4.07E-06	1.90E-09
PDC	MAX	Snowshoe_hare	Phenanthrene	9.18E-04	2.12E-02	0.00E+00	0.00E+00	4.26E-07	9.25E-07	2.21E-02	1.58E-02	7.34E-06
Project	MAX	Snowshoe_hare	Phenanthrene	8.73E-08	3.48E-07	0.00E+00	0.00E+00	1.54E-08	3.35E-08	4.84E-07	3.46E-07	1.61E-10
Application	MAX	Moose	Pyrene	1.02E-04	4.97E-04	1.04E-02	0.00E+00	1.26E-05	1.54E-05	1.10E-02	2.44E-05	4.20E-06
Baseline	MAX	Moose	Pyrene	1.02E-04	4.97E-04	1.04E-02	0.00E+00	1.26E-05	1.54E-05	1.10E-02	2.44E-05	4.20E-06
Future	MAX	Moose	Pyrene	7.80E-05	3.81E-04	7.94E-03	0.00E+00	9.65E-06	1.18E-05	8.42E-03	1.87E-05	3.22E-06
PDC	MAX	Moose	Pyrene	1.80E-04	8.78E-04	1.83E-02	0.00E+00	2.22E-05	2.71E-05	1.94E-02	4.31E-05	7.42E-06
Project	MAX	Moose	Pyrene	1.47E-06	7.18E-06	1.50E-04	0.00E+00	1.82E-07	2.22E-07	1.59E-04	3.53E-07	6.07E-08
Application	MAX	Ruffed_grouse	Pyrene	2.48E-06	2.67E-06	0.00E+00	1.11E-07	2.42E-08	6.61E-08	5.35E-06	7.62E-06	1.51E-09
Baseline	MAX	Ruffed_grouse	Pyrene	2.48E-06	2.67E-06	0.00E+00	1.11E-07	2.42E-08	6.61E-08	5.35E-06	7.62E-06	1.51E-09
Future	MAX	Ruffed_grouse	Pyrene	1.90E-06	2.04E-06	0.00E+00	8.54E-08	1.86E-08	5.06E-08	4.10E-06	5.84E-06	1.16E-09
PDC	MAX	Ruffed_grouse	Pyrene	4.38E-06	4.71E-06	0.00E+00	1.97E-07	4.28E-08	1.17E-07	9.45E-06	1.35E-05	2.66E-09
Project	MAX	Ruffed_grouse	Pyrene	3.58E-08	3.85E-08	0.00E+00	1.61E-09	3.50E-10	9.54E-10	7.73E-08	1.10E-07	2.18E-11
Application	MAX	Snowshoe_hare	Pyrene	3.94E-06	6.96E-06	0.00E+00	0.00E+00	6.98E-08	1.52E-07	1.11E-05	7.94E-06	4.25E-09
Baseline	MAX	Snowshoe_hare	Pyrene	3.94E-06	6.95E-06	0.00E+00	0.00E+00	6.98E-08	1.52E-07	1.11E-05	7.94E-06	4.25E-09
Future	MAX	Snowshoe_hare	Pyrene	3.02E-06	5.33E-06	0.00E+00	0.00E+00	5.35E-08	1.16E-07	8.52E-06	6.09E-06	3.26E-09
PDC	MAX	Snowshoe_hare	Pyrene	6.97E-06	1.23E-05	0.00E+00	0.00E+00	1.23E-07	2.68E-07	1.96E-05	1.40E-05	7.51E-09
Project	MAX	Snowshoe_hare	Pyrene	5.70E-08	1.00E-07	0.00E+00	0.00E+00	1.01E-09	2.19E-09	1.61E-07	1.15E-07	6.15E-11
Application	MAX	Moose	C9-C18 aromatics	5.40E-04	1.85E-01	1.36E+00	0.00E+00	1.25E-01	1.52E-01	1.83E+00	4.06E-03	3.54E-04
Baseline	MAX	Moose	C9-C18 aromatics	5.40E-04	1.85E-01	1.36E+00	0.00E+00	1.25E-01	1.52E-01	1.83E+00	4.06E-03	3.54E-04
Future	MAX	Moose	C9-C18 aromatics	4.79E-04	1.64E-01	1.21E+00	0.00E+00	1.11E-01	1.35E-01	1.62E+00	3.60E-03	3.14E-04
PDC	MAX	Moose	C9-C18 aromatics	1.02E-03	3.50E-01	2.57E+00	0.00E+00	2.35E-01	2.87E-01	3.45E+00	7.66E-03	6.68E-04
Project	MAX	Moose	C9-C18 aromatics	1.18E-06	4.04E-04	2.97E-03	0.00E+00	2.71E-04	3.31E-04	3.98E-03	8.83E-06	7.71E-07
Application	MAX	Ruffed_grouse	C9-C18 aromatics	1.32E-05	9.96E-04	0.00E+00	5.92E-07	2.40E-04	6.53E-04	1.90E-03	2.71E-03	2.72E-07
Baseline	MAX	Ruffed_grouse	C9-C18 aromatics	1.32E-05	9.96E-04	0.00E+00	5.92E-07	2.40E-04	6.53E-04	1.90E-03	2.71E-03	2.72E-07
Future	MAX	Ruffed_grouse	C9-C18 aromatics	1.17E-05	8.83E-04	0.00E+00	5.25E-07	2.13E-04	5.80E-04	1.69E-03	2.40E-03	2.41E-07
PDC	MAX	Ruffed_grouse	C9-C18 aromatics	2.48E-05	1.88E-03	0.00E+00	1.12E-06	4.52E-04	1.23E-03	3.59E-03	5.11E-03	5.13E-07
Project	MAX	Ruffed_grouse	C9-C18 aromatics	2.86E-08	2.17E-06	0.00E+00	1.29E-09	5.22E-07	1.42E-06	4.14E-06	5.90E-06	5.92E-10
Application	MAX	Snowshoe_hare	C9-C18 aromatics	2.09E-05	2.60E-03	0.00E+00	0.00E+00	6.90E-04	1.50E-03	4.81E-03	3.43E-03	9.32E-07
Baseline	MAX	Snowshoe_hare	C9-C18 aromatics	2.09E-05	2.60E-03	0.00E+00	0.00E+00	6.90E-04	1.50E-03	4.81E-03	3.43E-03	9.32E-07
Future	MAX	Snowshoe_hare	C9-C18 aromatics	1.86E-05	2.30E-03	0.00E+00	0.00E+00	6.12E-04	1.33E-03	4.26E-03	3.04E-03	8.27E-07
PDC	MAX	Snowshoe_hare	C9-C18 aromatics	3.95E-05	4.90E-03	0.00E+00	0.00E+00	1.30E-03	2.83E-03	9.07E-03	6.48E-03	1.76E-06
Project	MAX	Snowshoe_hare	C9-C18 aromatics	4.56E-08	5.65E-06	0.00E+00	0.00E+00	1.50E-06	3.26E-06	1.05E-05	7.47E-06	2.03E-09
Application	MAX	Moose	Formaldehyde	2.74E-08	1.23E-04	1.10E-04	0.00E+00	5.03E-03	7.51E-03	1.28E-02	2.84E-05	1.54E-06
Baseline	MAX	Moose	Formaldehyde	2.73E-08	1.23E-04	1.10E-04	0.00E+00	5.03E-03	7.50E-03	1.28E-02	2.83E-05	1.54E-06
Future	MAX	Moose	Formaldehyde	2.71E-08	1.21E-04	1.09E-04	0.00E+00	4.98E-03	7.42E-03	1.26E-02	2.81E-05	1.52E-06

Table E-5 Summary of Predicted Exposures and Game Meat Concentrations

Scenario	Site	Receptor	Chemical	EDI Soil EDI mg/day	EDI Browse EDI mg/day	EDI Aquatic Plant EDI mg/day	EDI Invert EDI mg/day	EDI Water EDI mg/day	EDI Air EDI mg/day	EDI Total EDI mg/day	EDI Total EDI mg/kg-BW/day	Game Meat Concentration mg/kg ww
PDC	MAX	Moose	Formaldehyde	5.01E-08	2.25E-04	2.02E-04	0.00E+00	9.21E-03	1.37E-02	2.34E-02	5.19E-05	2.82E-06
Project	MAX	Moose	Formaldehyde	9.18E-08	4.11E-04	3.69E-04	0.00E+00	1.69E-02	2.52E-02	4.28E-02	9.51E-05	5.16E-06
Application	MAX	Ruffed_grouse	Formaldehyde	6.67E-10	6.59E-07	0.00E+00	5.99E-11	9.69E-06	3.23E-05	4.26E-05	6.07E-05	3.79E-09
Baseline	MAX	Ruffed_grouse	Formaldehyde	6.66E-10	6.58E-07	0.00E+00	5.99E-11	9.67E-06	3.23E-05	4.26E-05	6.07E-05	3.78E-09
Future	MAX	Ruffed_grouse	Formaldehyde	6.59E-10	6.52E-07	0.00E+00	5.93E-11	9.58E-06	3.19E-05	4.22E-05	6.01E-05	3.75E-09
PDC	MAX	Ruffed_grouse	Formaldehyde	1.22E-09	1.21E-06	0.00E+00	1.10E-10	1.77E-05	5.91E-05	7.80E-05	1.11E-04	6.93E-09
Project	MAX	Ruffed_grouse	Formaldehyde	2.24E-09	2.21E-06	0.00E+00	2.01E-10	3.25E-05	1.08E-04	1.43E-04	2.04E-04	1.27E-08
Application	MAX	Snowshoe_hare	Formaldehyde	1.06E-09	1.72E-06	0.00E+00	0.00E+00	2.79E-05	7.41E-05	1.04E-04	7.41E-05	1.25E-08
Baseline	MAX	Snowshoe_hare	Formaldehyde	1.06E-09	1.72E-06	0.00E+00	0.00E+00	2.79E-05	7.40E-05	1.04E-04	7.40E-05	1.25E-08
Future	MAX	Snowshoe_hare	Formaldehyde	1.05E-09	1.70E-06	0.00E+00	0.00E+00	2.76E-05	7.33E-05	1.03E-04	7.32E-05	1.24E-08
PDC	MAX	Snowshoe_hare	Formaldehyde	1.94E-09	3.14E-06	0.00E+00	0.00E+00	5.10E-05	1.36E-04	1.90E-04	1.36E-04	2.29E-08
Project	MAX	Snowshoe_hare	Formaldehyde	3.55E-09	5.76E-06	0.00E+00	0.00E+00	9.35E-05	2.48E-04	3.48E-04	2.48E-04	4.19E-08

Table E-6 Summary of Media Concentrations

Scenario	Site	Chemical	Soil	Surface Soil	Surface Water	Air	Dust	Deposition Predicted	Environmental Concentrations					
									Browse Deposition	Browse Air	Browse Soil	Browse Total	Aquatic Plant Aquatic	Invert Soil
			mg/kg	mg/kg	mg/L	ug/m3	ug/m3	mg/m2/yr	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw
Baseline	MAX	2-methylnaphthalene	4.00E-02	4.00E-02	2.46E-06	1.00E-03	3.04E-08	7.22E-01	0.00E+00	4.43E-07	1.10E-01	1.10E-01	5.02E-04	1.68E-02
Baseline	MAX	3-methylcholanthrene	1.60E-05	1.60E-04	4.50E-09	1.83E-06	1.22E-10	1.32E-03	9.01E-05	4.20E-06	1.21E-07	9.45E-05	6.92E-05	6.71E-06
Baseline	MAX	7,12-Dimethylbenz(a)anthracene	4.71E-05	4.71E-04	4.05E-08	1.65E-05	3.58E-10	1.19E-02	8.10E-04	3.51E-05	8.11E-07	8.46E-04	6.22E-04	1.98E-05
Baseline	MAX	Acenaphthene	1.27E-07	1.27E-06	2.29E-07	9.32E-05	9.67E-13	6.73E-02	0.00E+00	1.35E-07	2.67E-08	1.61E-07	1.20E-04	1.48E-05
Baseline	MAX	Acenaphthylene	3.20E-06	3.20E-05	4.33E-06	1.77E-03	2.43E-11	1.27E+00	0.00E+00	4.32E-06	6.53E-07	4.97E-06	2.28E-03	3.85E-04
Baseline	MAX	Anthracene	1.89E-06	1.89E-05	2.86E-07	1.20E-04	1.44E-11	8.65E-02	0.00E+00	2.10E-06	1.96E-07	2.29E-06	4.39E-03	7.92E-07
Baseline	MAX	Benzo(a)anthracene	1.53E-04	1.53E-03	4.11E-07	1.67E-04	1.16E-09	1.21E-01	5.87E-03	1.69E-04	2.78E-06	6.04E-03	6.31E-03	2.75E-05
Baseline	MAX	Benzo(a)pyrene	1.44E-04	1.44E-03	8.29E-08	3.38E-05	1.09E-09	2.44E-02	1.66E-03	1.33E-03	1.59E-06	2.99E-03	1.27E-03	6.02E-05
Baseline	MAX	Benzo(b)fluoranthene	1.44E-05	1.44E-04	1.31E-07	5.32E-05	1.10E-10	3.84E-02	0.00E+00	2.06E-03	2.55E-07	2.06E-03	2.00E-03	6.05E-06
Baseline	MAX	Benzo(g,h,i)perylene	1.73E-04	1.73E-03	8.50E-08	3.46E-05	1.31E-09	2.50E-02	1.70E-03	6.41E-03	9.83E-07	8.12E-03	1.31E-03	7.23E-05
Baseline	MAX	Benzo(k)fluoranthene	2.79E-04	2.79E-03	4.16E-08	1.75E-05	2.12E-09	1.26E-02	8.59E-04	5.13E-04	3.18E-06	1.38E-03	6.39E-04	1.34E-04
Baseline	MAX	Chrysene	4.91E-04	4.91E-03	2.51E-07	1.02E-04	3.74E-09	7.37E-02	1.86E-03	3.95E-04	8.34E-06	2.27E-03	3.85E-03	1.18E-04
Baseline	MAX	Dibenz(a,h)anthracene	6.68E-05	6.68E-04	1.86E-08	7.58E-06	5.08E-10	5.47E-03	5.03E-04	8.11E-04	3.25E-07	1.31E-03	2.86E-04	2.80E-05
Baseline	MAX	Fluoranthene	3.65E-05	3.65E-04	4.43E-07	1.80E-04	2.77E-10	1.30E-01	0.00E+00	1.13E-04	1.47E-06	1.15E-04	6.80E-03	1.53E-05
Baseline	MAX	Fluorene	4.00E-02	4.00E-02	7.04E-07	2.87E-04	3.04E-08	2.07E-01	0.00E+00	1.50E-06	5.94E-03	5.94E-03	1.08E-02	1.68E-02
Baseline	MAX	Indeno(1,2,3-cd)pyrene	4.28E-05	4.28E-04	1.55E-08	6.33E-06	3.26E-10	4.57E-03	4.42E-04	2.20E-05	2.22E-07	4.64E-04	2.38E-04	1.80E-05
Baseline	MAX	Phenanthrene	1.10E-01	1.10E-01	1.82E-06	7.42E-04	8.37E-08	5.36E-01	0.00E+00	1.75E-05	1.60E-01	1.60E-01	2.80E-02	4.61E-02
Baseline	MAX	Pyrene	4.74E-05	4.74E-04	5.21E-07	2.12E-04	3.60E-10	1.53E-01	0.00E+00	4.98E-05	2.77E-06	5.26E-05	8.00E-03	1.99E-05
Baseline	MAX	C9-C18 aromatics	2.51E-04	2.51E-03	5.15E-03	2.10E+00	1.91E-09	1.51E+03	0.00E+00	1.96E-02	8.08E-05	1.96E-02	1.05E+00	1.05E-04
Baseline	MAX	Formaldehyde	1.27E-08	1.27E-07	2.08E-04	1.04E-01	9.66E-14	7.48E+01	0.00E+00	1.29E-05	1.07E-07	1.30E-05	8.50E-05	1.07E-08
Application	MAX	2-methylnaphthalene	4.00E-02	4.00E-02	2.46E-06	1.00E-03	3.04E-08	7.22E-01	0.00E+00	4.43E-07	1.10E-01	1.10E-01	5.02E-04	1.68E-02
Application	MAX	3-methylcholanthrene	1.60E-05	1.60E-04	4.51E-09	1.84E-06	1.22E-10	1.33E-03	9.02E-05	4.20E-06	1.21E-07	9.45E-05	6.92E-05	6.71E-06
Application	MAX	7,12-Dimethylbenz(a)anthracene	4.72E-05	4.72E-04	4.05E-08	1.65E-05	3.58E-10	1.19E-02	8.11E-04	3.51E-05	8.11E-07	8.47E-04	6.22E-04	1.98E-05
Application	MAX	Acenaphthene	1.27E-07	1.27E-06	2.29E-07	9.32E-05	9.67E-13	6.73E-02	0.00E+00	1.35E-07	2.67E-08	1.61E-07	1.20E-04	1.48E-05
Application	MAX	Acenaphthylene	3.20E-06	3.20E-05	4.33E-06	1.77E-03	2.43E-11	1.27E+00	0.00E+00	4.32E-06	6.53E-07	4.97E-06	2.28E-03	3.85E-04
Application	MAX	Anthracene	1.89E-06	1.89E-05	2.86E-07	1.20E-04	1.44E-11	8.65E-02	0.00E+00	2.10E-06	1.96E-07	2.29E-06	4.39E-03	7.92E-07
Application	MAX	Benzo(a)anthracene	1.53E-04	1.53E-03	4.11E-07	1.67E-04	1.17E-09	1.21E-01	5.87E-03	1.69E-04	2.78E-06	6.04E-03	6.31E-03	2.75E-05
Application	MAX	Benzo(a)pyrene	1.44E-04	1.44E-03	8.30E-08	3.38E-05	1.09E-09	2.44E-02	1.66E-03	1.33E-03	1.59E-06	2.99E-03	1.27E-03	6.02E-05
Application	MAX	Benzo(b)fluoranthene	1.44E-05	1.44E-04	1.31E-07	5.32E-05	1.10E-10	3.84E-02	0.00E+00	2.06E-03	2.55E-07	2.06E-03	2.00E-03	6.05E-06
Application	MAX	Benzo(g,h,i)perylene	1.73E-04	1.73E-03	8.51E-08	3.46E-05	1.31E-09	2.50E-02	1.70E-03	6.41E-03	9.83E-07	8.12E-03	1.31E-03	7.23E-05
Application	MAX	Benzo(k)fluoranthene	2.80E-04	2.80E-03	4.16E-08	1.75E-05	2.12E-09	1.26E-02	8.60E-04	5.13E-04	3.18E-06	1.38E-03	6.39E-04	1.34E-04
Application	MAX	Chrysene	4.92E-04	4.92E-03	2.51E-07	1.02E-04	3.74E-09	7.37E-02	1.86E-03	3.95E-04	8.34E-06	2.27E-03	3.85E-03	1.18E-04
Application	MAX	Dibenz(a,h)anthracene	6.70E-05	6.70E-04	1.87E-08	7.60E-06	5.09E-10	5.49E-03	5.04E-04	8.13E-04	3.25E-07	1.32E-03	2.87E-04	2.81E-05
Application	MAX	Fluoranthene	3.65E-05	3.65E-04	4.43E-07	1.80E-04	2.77E-10	1.30E-01	0.00E+00	1.13E-04	1.47E-06	1.15E-04	6.80E-03	1.53E-05
Application	MAX	Fluorene	4.00E-02	4.00E-02	7.04E-07	2.87E-04	3.04E-08	2.07E-01	0.00E+00	1.50E-06	5.94E-03	5.94E-03	1.08E-02	1.68E-02
Application	MAX	Indeno(1,2,3-cd)pyrene	4.30E-05	4.30E-04	1.56E-08	6.35E-06	3.27E-10	4.58E-03	4.43E-04	2.21E-05	2.23E-07	4.66E-04	2.39E-04	1.80E-05
Application	MAX	Phenanthrene	1.10E-01	1.10E-01	1.82E-06	7.42E-04	8.37E-08	5.36E-01	0.00E+00	1.75E-05	1.60E-01	1.60E-01	2.80E-02	4.61E-02
Application	MAX	Pyrene	4.74E-05	4.74E-04	5.21E-07	2.12E-04	3.60E-10	1.53E-01	0.00E+00	4.98E-05	2.77E-06	5.26E-05	8.00E-03	1.99E-05
Application	MAX	C9-C18 aromatics	2.51E-04	2.51E-03	5.15E-03	2.10E+00	1.91E-09	1.51E+03	0.00E+00	1.96E-02	8.08E-05	1.96E-02	1.05E+00	1.05E-04
Application	MAX	Formaldehyde	1.27E-08	1.27E-07	2.08E-04	1.04E-01	9.67E-14	7.49E+01	0.00E+00	1.29E-05	1.07E-07	1.30E-05	8.51E-05	1.07E-08
PDC	MAX	2-methylnaphthalene	4.00E-02	4.00E-02	4.40E-06	1.79E-03	3.04E-08	1.29E+00	0.00E+00	7.93E-07	1.10E-01	1.10E-01	8.99E-04	1.68E-02
PDC	MAX	3-methylcholanthrene	1.70E-05	1.70E-04	4.79E-09	1.95E-06	1.29E-10	1.41E-03	9.59E-05	4.47E-06	1.28E-07	1.00E-04	7.36E-05	7.13E-06
PDC	MAX	7,12-Dimethylbenz(a)anthracene	5.01E-05	5.01E-04	4.30E-08	1.75E-05	3.81E-10	1.27E-02	8.61E-04	3.73E-05	8.62E-07	8.99E-04	6.61E-04	2.10E-05
PDC	MAX	Acenaphthene	2.23E-07	2.23E-06	4.02E-07	1.64E-04	1.70E-12	1.18E-01	0.00E+00	2.36E-07	4.69E-08	2.83E-07	2.11E-04	2.59E-05
PDC	MAX	Acenaphthylene	5.74E-06	5.74E-05	7.79E-06	3.17E-03	4.36E-11	2.29E+00	0.00E+00	7.76E-06	1.17E-06	8.93E-06	4.09E-03	6.92E-04
PDC	MAX	Anthracene	3.36E-06	3.36E-05	5.09E-07	2.13E-04	2.55E-11	1.54E-01	0.00E+00	3.73E-06	3.49E-07	4.08E-06	7.82E-03	1.41E-06
PDC	MAX	Benzo(a)anthracene	2.64E-04	2.64E-03	7.07E-07	2.88E-04	2.01E-09	2.08E-01	1.01E-02	2.90E-04	4.79E-06	1.04E-02	1.09E-02	4.74E-05
PDC	MAX	Benzo(a)pyrene	2.58E-04	2.58E-03	1.49E-07	6.06E-05	1.96E-09	4.37E-02	2.98E-03	2.38E-03	2.86E-06	5.36E-03	2.28E-03	1.08E-04
PDC	MAX	Benzo(b)fluoranthene	2.46E-05	2.46E-04	2.23E-07	9.07E-05	1.87E-10	6.55E-02	0.00E+00	3.51E-03	4.35E-07	3.51E-03	3.42E-03	1.03E-05
PDC	MAX	Benzo(g,h,i)perylene	3.07E-04	3.07E-03	1.52E-07	6.17E-05	2.34E-09	4.46E-02	3.03E-03	1.14E-02	1.75E-06	1.45E-02	2.33E-03	1.29E-04
PDC	MAX	Benzo(k)fluoranthene	4.96E-04	4.96E-03	7.39E-08	3.11E-05	3.77E-09	2.24E-02	1.53E-03	9.10E-04	5.65E-06	2.44E-03	1.13E-03	2.38E-04

Table E-6 Summary of Media Concentrations

Scenario	Site	Chemical	Soil	Surface Soil	Surface Water	Air	Dust	Deposition Predicted	Environmental Concentrations					
									Browse Deposition	Browse Air	Browse Soil	Browse Total	Aquatic Plant Aquatic	Invert Soil
			mg/kg	mg/kg	mg/L	ug/m3	ug/m3	mg/m2/yr	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw
PDC	MAX	Chrysene	8.78E-04	8.78E-03	4.48E-07	1.82E-04	6.67E-09	1.32E-01	3.33E-03	7.06E-04	1.49E-05	4.05E-03	6.87E-03	2.10E-04
PDC	MAX	Dibenz(a,h)anthracene	4.92E-05	4.92E-04	1.37E-08	5.58E-06	3.74E-10	4.03E-03	3.70E-04	5.97E-04	2.39E-07	9.67E-04	2.10E-04	2.06E-05
PDC	MAX	Fluoranthene	6.39E-05	6.39E-04	7.76E-07	3.16E-04	4.86E-10	2.28E-01	0.00E+00	1.98E-04	2.58E-06	2.01E-04	1.19E-02	2.68E-05
PDC	MAX	Fluorene	4.00E-02	4.00E-02	1.02E-06	4.15E-04	3.04E-08	3.00E-01	0.00E+00	2.17E-06	5.94E-03	5.95E-03	1.57E-02	1.68E-02
PDC	MAX	Indeno(1,2,3-cd)pyrene	3.20E-05	3.20E-04	1.16E-08	4.73E-06	2.43E-10	3.41E-03	3.30E-04	1.65E-05	1.66E-07	3.47E-04	1.78E-04	1.34E-05
PDC	MAX	Phenanthrene	1.10E-01	1.10E-01	3.18E-06	1.29E-03	8.38E-08	9.34E-01	0.00E+00	3.05E-05	1.60E-01	1.60E-01	4.88E-02	4.61E-02
PDC	MAX	Pyrene	8.36E-05	8.36E-04	9.20E-07	3.75E-04	6.36E-10	2.71E-01	0.00E+00	8.80E-05	4.90E-06	9.29E-05	1.41E-02	3.51E-05
PDC	MAX	C9-C18 aromatics	4.74E-04	4.74E-03	9.72E-03	3.96E+00	3.60E-09	2.86E+03	0.00E+00	3.69E-02	1.52E-04	3.71E-02	1.99E+00	1.99E-04
PDC	MAX	Formaldehyde	2.33E-08	2.33E-07	3.81E-04	1.90E-01	1.77E-13	1.37E+02	0.00E+00	2.36E-05	1.96E-07	2.38E-05	1.56E-04	1.95E-08
Project	MAX	2-methylnaphthalene	5.49E-10	5.49E-09	7.98E-09	3.25E-06	4.17E-15	2.35E-03	0.00E+00	1.44E-09	1.51E-09	2.95E-09	1.63E-06	2.30E-10
Project	MAX	3-methylcholanthrene	2.79E-06	2.79E-05	7.87E-10	3.20E-07	2.12E-11	2.31E-04	1.57E-05	7.33E-07	2.11E-08	1.65E-05	1.21E-05	1.17E-06
Project	MAX	7,12-Dimethylbenz(a)anthracene	8.14E-06	8.14E-05	6.99E-09	2.85E-06	6.19E-11	2.06E-03	1.40E-04	6.07E-06	1.40E-07	1.46E-04	1.07E-04	3.41E-06
Project	MAX	Acenaphthene	3.49E-09	3.49E-08	6.28E-09	2.56E-06	2.65E-14	1.85E-03	0.00E+00	3.69E-09	7.33E-10	4.42E-09	3.30E-06	4.05E-07
Project	MAX	Acenaphthylene	3.26E-09	3.26E-08	4.42E-09	1.80E-06	2.48E-14	1.30E-03	0.00E+00	4.41E-09	6.67E-10	5.07E-09	2.33E-06	3.93E-07
Project	MAX	Anthracene	5.08E-08	5.08E-07	7.69E-09	3.22E-06	3.86E-13	2.32E-03	0.00E+00	5.64E-08	5.27E-09	6.17E-08	1.18E-04	2.13E-08
Project	MAX	Benzo(a)anthracene	4.35E-05	4.35E-04	1.17E-07	4.75E-05	3.30E-10	3.43E-02	1.67E-03	4.78E-05	7.89E-07	1.71E-03	1.79E-03	7.81E-06
Project	MAX	Benzo(a)pyrene	8.06E-06	8.06E-05	4.66E-09	1.90E-06	6.13E-11	1.37E-03	9.32E-05	7.46E-05	8.94E-08	1.68E-04	7.15E-05	3.38E-06
Project	MAX	Benzo(b)fluoranthene	4.10E-07	4.10E-06	3.71E-09	1.51E-06	3.12E-12	1.09E-03	0.00E+00	5.84E-05	7.24E-09	5.85E-05	5.70E-05	1.72E-07
Project	MAX	Benzo(g,h,i)perylene	9.89E-06	9.89E-05	4.88E-09	1.99E-06	7.52E-11	1.43E-03	9.76E-05	3.68E-04	5.64E-08	4.66E-04	7.49E-05	4.15E-06
Project	MAX	Benzo(k)fluoranthene	2.41E-05	2.41E-04	3.60E-09	1.51E-06	1.84E-10	1.09E-03	7.42E-05	4.43E-05	2.75E-07	1.19E-04	5.52E-05	1.16E-05
Project	MAX	Chrysene	1.48E-05	1.48E-04	7.57E-09	3.08E-06	1.13E-10	2.23E-03	5.63E-05	1.19E-05	2.52E-07	6.85E-05	1.16E-04	3.56E-06
Project	MAX	Dibenz(a,h)anthracene	2.38E-05	2.38E-04	6.63E-09	2.70E-06	1.81E-10	1.95E-03	1.79E-04	2.89E-04	1.16E-07	4.68E-04	1.02E-04	9.98E-06
Project	MAX	Fluoranthene	1.25E-06	1.25E-05	1.52E-08	6.18E-06	9.51E-12	4.46E-03	0.00E+00	3.88E-06	5.04E-08	3.93E-06	2.33E-04	5.24E-07
Project	MAX	Fluorene	3.51E-08	3.51E-07	2.24E-08	9.11E-06	2.67E-13	6.58E-03	0.00E+00	4.76E-08	5.22E-09	5.28E-08	3.44E-04	1.47E-08
Project	MAX	Indeno(1,2,3-cd)pyrene	1.88E-05	1.88E-04	6.83E-09	2.78E-06	1.43E-10	2.01E-03	1.94E-04	9.69E-06	9.78E-08	2.04E-04	1.05E-04	7.90E-06
Project	MAX	Phenanthrene	1.05E-06	1.05E-05	1.15E-07	4.69E-05	7.97E-12	3.38E-02	0.00E+00	1.11E-06	1.52E-06	2.63E-06	1.77E-03	4.40E-07
Project	MAX	Pyrene	6.84E-07	6.84E-06	7.52E-09	3.06E-06	5.20E-12	2.21E-03	0.00E+00	7.20E-07	4.00E-08	7.60E-07	1.16E-04	2.87E-07
Project	MAX	C9-C18 aromatics	5.47E-07	5.47E-06	1.12E-05	4.57E-03	4.16E-12	3.30E+00	0.00E+00	4.26E-05	1.76E-07	4.27E-05	2.29E-03	2.29E-07
Project	MAX	Formaldehyde	4.27E-08	4.27E-07	6.98E-04	3.48E-01	3.24E-13	2.51E+02	0.00E+00	4.32E-05	3.60E-07	4.36E-05	2.85E-04	3.58E-08
Future	MAX	2-methylnaphthalene	1.33E-07	1.33E-06	1.94E-06	7.91E-04	1.01E-12	5.71E-01	0.00E+00	3.50E-07	3.67E-07	7.17E-07	3.97E-04	5.60E-08
Future	MAX	3-methylcholanthrene	1.78E-06	1.78E-05	5.01E-10	2.04E-07	1.35E-11	1.47E-04	1.00E-05	4.67E-07	1.34E-08	1.05E-05	7.69E-06	7.46E-07
Future	MAX	7,12-Dimethylbenz(a)anthracene	5.19E-06	5.19E-05	4.45E-09	1.81E-06	3.94E-11	1.31E-03	8.91E-05	3.86E-06	8.92E-08	9.31E-05	6.84E-05	2.17E-06
Future	MAX	Acenaphthene	9.63E-08	9.63E-07	1.73E-07	7.06E-05	7.32E-13	5.10E-02	0.00E+00	1.02E-07	2.02E-08	1.22E-07	9.11E-05	1.12E-05
Future	MAX	Acenaphthylene	2.55E-06	2.55E-05	3.45E-06	1.41E-03	1.94E-11	1.02E+00	0.00E+00	3.44E-06	5.21E-07	3.96E-06	1.82E-03	3.07E-04
Future	MAX	Anthracene	1.47E-06	1.47E-05	2.23E-07	9.34E-05	1.12E-11	6.74E-02	0.00E+00	1.64E-06	1.53E-07	1.79E-06	3.42E-03	6.18E-07
Future	MAX	Benzo(a)anthracene	1.11E-04	1.11E-03	2.96E-07	1.21E-04	8.40E-10	8.72E-02	4.24E-03	1.22E-04	2.01E-06	4.36E-03	4.55E-03	1.99E-05
Future	MAX	Benzo(a)pyrene	1.14E-04	1.14E-03	6.58E-08	2.68E-05	8.66E-10	1.93E-02	1.32E-03	1.05E-03	1.26E-06	2.37E-03	1.01E-03	4.78E-05
Future	MAX	Benzo(b)fluoranthene	1.02E-05	1.02E-04	9.22E-08	3.76E-05	7.74E-11	2.71E-02	0.00E+00	1.45E-03	1.80E-07	1.45E-03	1.42E-03	4.27E-06
Future	MAX	Benzo(g,h,i)perylene	1.35E-04	1.35E-03	6.65E-08	2.71E-05	1.03E-09	1.95E-02	1.33E-03	5.01E-03	7.69E-07	6.35E-03	1.02E-03	5.66E-05
Future	MAX	Benzo(k)fluoranthene	2.17E-04	2.17E-03	3.23E-08	1.36E-05	1.65E-09	9.79E-03	6.66E-04	3.98E-04	2.47E-06	1.07E-03	4.95E-04	1.04E-04
Future	MAX	Chrysene	3.86E-04	3.86E-03	1.97E-07	8.02E-05	2.93E-09	5.79E-02	1.46E-03	3.10E-04	6.55E-06	1.78E-03	3.02E-03	9.25E-05
Future	MAX	Dibenz(a,h)anthracene	2.04E-05	2.04E-04	5.67E-09	2.31E-06	1.55E-10	1.67E-03	1.53E-04	2.47E-04	9.89E-08	4.00E-04	8.70E-05	8.53E-06
Future	MAX	Fluoranthene	2.75E-05	2.75E-04	3.33E-07	1.36E-04	2.09E-10	9.81E-02	0.00E+00	8.52E-05	1.11E-06	8.63E-05	5.12E-03	1.15E-05
Future	MAX	Fluorene	6.67E-07	6.67E-06	4.25E-07	1.73E-04	5.07E-12	1.25E-01	0.00E+00	9.04E-07	9.91E-08	1.00E-06	6.53E-03	2.80E-07
Future	MAX	Indeno(1,2,3-cd)pyrene	1.58E-05	1.58E-04	5.73E-09	2.33E-06	1.20E-10	1.68E-03	1.63E-04	8.13E-06	8.20E-08	1.71E-04	8.79E-05	6.62E-06
Future	MAX	Phenanthrene	1.23E-05	1.23E-04	1.36E-06	5.52E-04	9.39E-11	3.98E-01	0.00E+00	1.30E-05	1.80E-05	3.10E-05	2.08E-02	5.18E-06
Future	MAX	Pyrene	3.63E-05	3.63E-04	3.99E-07	1.63E-04	2.76E-10	1.17E-01	0.00E+00	3.82E-05	2.12E-06	4.03E-05	6.13E-03	1.52E-05
Future	MAX	C9-C18 aromatics	2.23E-04	2.23E-03	4.57E-03	1.86E+00	1.69E-09	1.34E+03	0.00E+00	1.73E-02	7.17E-05	1.74E-02	9.34E-01	9.35E-05
Future	MAX	Formaldehyde	1.26E-08	1.26E-07	2.06E-04	1.03E-01	9.57E-14	7.40E+01	0.00E+00	1.27E-05	1.06E-07	1.29E-05	8.41E-05	1.06E-08

Table E-7 Wildlife Receptor Exposure Variables

Receptor	Variable	Value	Units	Reference
Moose	AIR	7.2E+01	m^3/day	Allometric equation for mammals 3-20; US EPA 1993
Moose	BW	4.50E+02	kg-WW	ASRD 2002
Moose	Per_SIR	2.0%	% of Diet	Actually <2%; Suter et al. 2000
Moose	SIR	2.15E-01	kg-soil/day	Calculated; See estimation of Soil / Sediment Ingestion Rate
Moose	WIR	2.42E+01	L/day	Allometric equation 3-17; US EPA 1993
Ruffed_Grouse	AIR	3.1E-01	m^3/day	Allometric equation for birds 3-19; US EPA 1993
Ruffed_Grouse	BW	7.02E-01	kg-WW	US EPA 1993
Ruffed_Grouse	Per_SIR	9.3%	% of Diet	Assumed similar to wild turkey; Suter et al. 2000
Ruffed_Grouse	SIR	5.24E-03	kg-soil/day	Calculated; See estimation of Soil / Sediment Ingestion Rate
Ruffed_Grouse	WIR	4.65E-02	L/day	Allometric equation 3-15; US EPA 1993
Snowshoe_hare	AIR	7.1E-01	m^3/day	Allometric equation for mammals 3-20; US EPA 1993
Snowshoe_hare	BW	1.40E+00	kg-WW	US EPA 1993
Snowshoe_hare	Per_SIR	6.3%	% of Diet	Assumed similar to jackrabbit; Suter et al. 2000
Snowshoe_hare	SIR	8.33E-03	kg-soil/day	Calculated; See estimation of Soil / Sediment Ingestion Rate
Snowshoe_hare	WIR	1.34E-01	L/day	Allometric equation 3-17; US EPA 1993

NOTES:
AIR = Air inhalation rate
BW = Body Weight
SIR = Soil ingestion rate
Sed_IR = Sediment ingestion rate
WIR = Water ingestion rate

Table E-8 Estimation of Soil Ingestion Rate

Receptor		Percent Soil in Diet		
ruffed_grouse		9.3%		
NFMR	Units			
1.55E+02	kcal/kg/day			
1.09E+02	kcal/day			
1.09E+05	cal/day			
BW	Units			
7.02E-01	kg			
Estimation of Average Metabolizable Energy				
Diet	Portion	GE [kcal/kg-DW]	AE [%]	FIR kg/day
Invert	20%	5400	72%	5.61E-03
Browse	80%	4200	41%	5.07E-02
Aquatic Plant	0%	4300	73%	0.00E+00
			Sum	5.63E-02
Estimation of Total Ingestion Rate [kg-food / day]				5.63E-02
Soil Ingestion Rate [kg-soil / day]				5.24E-03
Estimation of Total Normalized Ingestion Rate [kg-food / kg-BW day]				8.02E-02

Table E-9 Normalized to Body Weight Free-living (Field) Metabolic Rate (NFMR)

Receptor	NFMR [kcal/kg bw/day] A	FMR [kcal/day] B	Body Weight [grams]	a	b	Reference/Comments
Moose	4.52E+01	2.03E+04	4.50E+05	1.52E+00	7.30E-01	US EPA 1993
Ruffed_Grouse	1.55E+02	1.09E+02	7.02E+02	8.51E-01	9.59E-01	Used "Galliformes" (Nagy et al. 1999)
Snowshoe_hare	1.63E+02	2.28E+02	1.40E+03	5.48E+00	7.12E-01	Used "Rodentia" (Nagy et al. 1999)

NOTES:
A) NFMR = Normalized Free Metabolic Rate = FMR / BW; Where BW is in kg
B) FMR = Free Metabolic Rate [kcal/day] = (a x BW^b) / 4.184 Kj/calorie; Where BW is in grams; moose equation already in kcal units

Table E-10 Receptor Dietary Composition [media % of diet]

Receptor	Media	Abbreviation	Value
Moose	Browse	Moose_Browse	80.0%
Moose	Invert	Moose_Invert	0.0%
Moose	Aquatic Plant	Moose_Aquatic Plant	20.0%
Ruffed_grouse	Browse	Ruffed_grouse_Browse	80.0%
Ruffed_grouse	Invert	Ruffed_grouse_Invert	20.0%
Ruffed_grouse	Aquatic Plant	Ruffed_grouse_Aquatic Plant	0.0%
Snowshoe_hare	Browse	Snowshoe_hare_Browse	100.0%
Snowshoe_hare	Invert	Snowshoe_hare_Invert	0.0%
Snowshoe_hare	Aquatic Plant	Snowshoe_hare_Aquatic Plant	0.0%

Table E-11 Metabolizable Energy (ME) of Dietary Items [kcal/kg] A

Receptor	Dietary Item	Abbreviation	Value
Moose	Browse	Moose_Browse	1722
Moose	Invert	Moose_Invert	3888
Moose	Aquatic Plant	Moose_Aquatic Plant	3139
Ruffed_grouse	Browse	Ruffed_grouse_Browse	1722
Ruffed_grouse	Invert	Ruffed_grouse_Invert	3888
Ruffed_grouse	Aquatic Plant	Ruffed_grouse_Aquatic Plant	3139
Snowshoe_hare	Browse	Snowshoe_hare_Browse	1722
Snowshoe_hare	Invert	Snowshoe_hare_Invert	3888
Snowshoe_hare	Aquatic Plant	Snowshoe_hare_Aquatic Plant	3139

NOTES:
A) US EPA 1993; Equation 4-17

Table E-12 Gross Energy (GE) of Dietary Items [kcal/kg dw] A

Receptor	Dietary Item	Value	Reference/Comments
Moose	Browse	4200	monocot young grasses; US EPA 1993
Moose	Invert	5400	grasshopper, crickets; US EPA 1993
Moose	Aquatic Plant	4300	aquatic emergent vegetation; US EPA 1993
Ruffed_grouse	Browse	4200	monocot young grasses; US EPA 1993
Ruffed_grouse	Invert	5400	grasshopper, crickets; US EPA 1993
Ruffed_grouse	Aquatic Plant	4300	aquatic emergent vegetation; US EPA 1993
Snowshoe_hare	Browse	4200	monocot young grasses; US EPA 1993
Snowshoe_hare	Invert	5400	grasshopper, crickets; US EPA 1993
Snowshoe_hare	Aquatic Plant	4300	aquatic emergent vegetation; US EPA 1993

NOTES:
A) US EPA 1993; Tables 4-1 & 4-2

Table E-13 Assimilation Efficiency (AE) of Dietary Items [Percent% Efficiency] A

Receptor	Dietary Item	Value	Reference/Comments
Moose	Aquatic Plant	73%	green forbs; US EPA 1993
Moose	Browse	41%	mature grasses; US EPA 1993
Moose	Invert	72%	terrestrial insects; US EPA 1993
Ruffed_grouse	Aquatic Plant	73%	green forbs; US EPA 1993
Ruffed_grouse	Browse	41%	mature grasses; US EPA 1993
Ruffed_grouse	Invert	72%	terrestrial insects; US EPA 1993
Snowshoe_hare	Aquatic Plant	73%	green forbs; US EPA 1993
Snowshoe_hare	Browse	41%	mature grasses; US EPA 1993
Snowshoe_hare	Invert	72%	terrestrial insects; US EPA 1993

NOTES:
A) US EPA 1993; Table 4-3

Table E-14 Chemicals of Potential Concern

Chemical	Group	Comment
2-methylnaphthalene	PAH	
3-methylcholanthrene	PAH	
7,12-Dimethylbenz(a)anthracene	PAH	
Acenaphthene	PAH	
Acenaphthylene	PAH	
Anthracene	PAH	
Benzo(a)anthracene	PAH	
Benzo(a)pyrene	PAH	
Benzo(b)fluoranthene	PAH	
Benzo(g,h,i)perylene	PAH	
Benzo(k)fluoranthene	PAH	
Chrysene	PAH	
Dibenz(a,h)anthracene	PAH	
Fluoranthene	PAH	
Fluorene	PAH	
Indeno(1,2,3-cd)pyrene	PAH	
Phenanthrene	PAH	
Pyrene	PAH	
C9-C18 aromatics	TPH	
Formaldehyde	VOC	

NOTES:
PAH: Polycyclic aromatic hydrocarbon

Table E-15 Kow

Chemical	Value	Log(Kow)	Reference
2-methylnaphthalene	7.24E+03	3.86E+00	Syracuse Research Corporation 2011
3-methylcholanthrene	2.63E+06	6.42E+00	Syracuse Research Corporation 2011
7,12-Dimethylbenz(a)anthracene	6.31E+05	5.80E+00	Syracuse Research Corporation 2011
Acenaphthene	8.32E+03	3.92E+00	Syracuse Research Corporation 2011
Acenaphthylene	8.71E+03	3.94E+00	Syracuse Research Corporation 2011
Anthracene	2.82E+04	4.45E+00	Syracuse Research Corporation 2011
Benzo(a)anthracene	5.75E+05	5.76E+00	Syracuse Research Corporation 2011
Benzo(a)pyrene	1.35E+06	6.13E+00	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	6.03E+05	5.78E+00	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	4.27E+06	6.63E+00	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	1.29E+06	6.11E+00	Syracuse Research Corporation 2011
Chrysene	6.46E+05	5.81E+00	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	5.62E+06	6.75E+00	Syracuse Research Corporation 2011
Fluoranthene	1.45E+05	5.16E+00	Syracuse Research Corporation 2011
Fluorene	1.51E+04	4.18E+00	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	5.01E+06	6.70E+00	Syracuse Research Corporation 2011
Phenanthrene	2.88E+04	4.46E+00	Syracuse Research Corporation 2011
Pyrene	7.59E+04	4.88E+00	Syracuse Research Corporation 2011
C9-C18 aromatics	3.98E+03	3.60E+00	CCME 2008
Formaldehyde	2.24E+00	3.50E-01	Syracuse Research Corporation 2011

Table E-16 Henry's constant [atm m3 / mol]

Chemical	Value	H [Pa m^3/mol]	H' [Unitless]	Reference
2-methylnaphthalene	5.18E-04	5.25E+01	2.12E-02	Syracuse Research Corporation 2011
3-methylcholanthrene	1.60E-05	1.62E+00	6.56E-04	Syracuse Research Corporation 2011
7,12-Dimethylbenz(a)anthracene	3.76E-06	3.81E-01	1.54E-04	Syracuse Research Corporation 2011
Acenaphthene	1.84E-04	1.86E+01	7.54E-03	Syracuse Research Corporation 2011
Acenaphthylene	0.000114	1.16E+01	4.67E-03	Syracuse Research Corporation 2011
Anthracene	5.56E-05	5.63E+00	2.28E-03	Syracuse Research Corporation 2011
Benzo(a)anthracene	1.20E-05	1.22E+00	4.92E-04	Syracuse Research Corporation 2011
Benzo(a)pyrene	4.57E-07	4.63E-02	1.87E-05	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	6.57E-07	6.66E-02	2.69E-05	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	3.31E-07	3.35E-02	1.36E-05	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	5.84E-07	5.92E-02	2.39E-05	Syracuse Research Corporation 2011
Chrysene	5.23E-06	5.30E-01	2.14E-04	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	1.41E-07	1.43E-02	5.78E-06	Syracuse Research Corporation 2011
Fluoranthene	8.86E-06	8.98E-01	3.63E-04	Syracuse Research Corporation 2011
Fluorene	9.62E-05	9.75E+00	3.94E-03	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	3.48E-07	3.53E-02	1.43E-05	Syracuse Research Corporation 2011
Phenanthrene	4.23E-05	4.29E+00	1.73E-03	Syracuse Research Corporation 2011
Pyrene	1.19E-05	1.21E+00	4.88E-04	Syracuse Research Corporation 2011
C9-C18 aromatics	1.30E-03	1.32E+02	5.33E-02	CCME 2008
Formaldehyde	3.37E-07	3.41E-02	1.38E-05	Syracuse Research Corporation 2011

Table E-17 Vapour pressure [mmHg]

Chemical	Value	VP[atm]	VP[Pa]	VP[kPa]	Reference
2-methylnaphthalene	5.50E-02	7.24E-05	7.33E+00	7.33E-03	Syracuse Research Corporation 2011
3-methylcholanthrene	4.30E-08	5.66E-11	5.73E-06	5.73E-09	Syracuse Research Corporation 2011
7,12-Dimethylbenz(a)anthracene	6.80E-07	8.95E-10	9.07E-05	9.07E-08	Syracuse Research Corporation 2011
Acenaphthene	2.15E-03	2.83E-06	2.87E-01	2.87E-04	Syracuse Research Corporation 2011
Acenaphthylene	6.68E-03	8.79E-06	8.91E-01	8.91E-04	Syracuse Research Corporation 2011
Anthracene	6.53E-06	8.59E-09	8.71E-04	8.71E-07	Syracuse Research Corporation 2011
Benzo(a)anthracene	2.10E-07	2.76E-10	2.80E-05	2.80E-08	Syracuse Research Corporation 2011
Benzo(a)pyrene	5.49E-09	7.22E-12	7.32E-07	7.32E-10	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	5.00E-07	6.58E-10	6.67E-05	6.67E-08	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	1.00E-10	1.32E-13	1.33E-08	1.33E-11	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	9.65E-10	1.27E-12	1.29E-07	1.29E-10	Syracuse Research Corporation 2011
Chrysene	6.23E-09	8.20E-12	8.31E-07	8.31E-10	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	9.55E-10	1.26E-12	1.27E-07	1.27E-10	Syracuse Research Corporation 2011
Fluoranthene	9.22E-06	1.21E-08	1.23E-03	1.23E-06	Syracuse Research Corporation 2011
Fluorene	6.00E-04	7.89E-07	8.00E-02	8.00E-05	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	1.25E-10	1.64E-13	1.67E-08	1.67E-11	Syracuse Research Corporation 2011
Phenanthrene	1.21E-04	1.59E-07	1.61E-02	1.61E-05	Syracuse Research Corporation 2011
Pyrene	4.50E-06	5.92E-09	6.00E-04	6.00E-07	Syracuse Research Corporation 2011
C9-C18 aromatics	3.65E-02	4.80E-05	4.86E+00	4.86E-03	CCME 2008
Formaldehyde	3.89E+03	5.12E+00	5.19E+05	5.19E+02	Syracuse Research Corporation 2011

Table E-18 Solubility [mg/L] or [ppm]

Chemical	Value	S[kg/m3]	Reference
2-methylnaphthalene	2.46E+01	2.46E-02	Syracuse Research Corporation 2011
3-methylcholanthrene	6.60E-03	6.60E-06	CCME 2008
7,12-Dimethylbenz(a)anthracene	6.10E-02	6.10E-05	Syracuse Research Corporation 2011
Acenaphthene	3.90E+00	3.90E-03	Syracuse Research Corporation 2011
Acenaphthylene	1.61E+01	1.61E-02	Syracuse Research Corporation 2011
Anthracene	4.34E-02	4.34E-05	Syracuse Research Corporation 2011
Benzo(a)anthracene	9.40E-03	9.40E-06	Syracuse Research Corporation 2011
Benzo(a)pyrene	1.62E-03	1.62E-06	Syracuse Research Corporation 2011
Benzo(b)fluoranthene	1.50E-03	1.50E-06	Syracuse Research Corporation 2011
Benzo(g,h,i)perylene	2.60E-04	2.60E-07	Syracuse Research Corporation 2011
Benzo(k)fluoranthene	8.00E-04	8.00E-07	Syracuse Research Corporation 2011
Chrysene	2.00E-03	2.00E-06	Syracuse Research Corporation 2011
Dibenz(a,h)anthracene	2.49E-03	2.49E-06	Syracuse Research Corporation 2011
Fluoranthene	2.60E-01	2.60E-04	Syracuse Research Corporation 2011
Fluorene	1.69E+00	1.69E-03	Syracuse Research Corporation 2011
Indeno(1,2,3-cd)pyrene	1.90E-04	1.90E-07	Syracuse Research Corporation 2011
Phenanthrene	1.15E+00	1.15E-03	Syracuse Research Corporation 2011
Pyrene	1.35E-01	1.35E-04	Syracuse Research Corporation 2011
C9-C18 aromatics	5.80E+00	5.80E-03	CCME 2008
Formaldehyde	4.00E+05	4.00E+02	Syracuse Research Corporation 2011

Table E-19 Koc [(mg/g) / (mg/mL)] or [L/kg] or [mL/g]

Chemical	Value	Log(Koc)	Reference
2-methylnaphthalene	2.51E+03	3.40E+00	US EPA 2011 (EPI Suite Database)
3-methylcholanthrene	7.94E+05	5.90E+00	US EPA 2011 (EPI Suite Database)
7,12-Dimethylbenz(a)anthracene	4.93E+05	5.69E+00	US EPA 2011 (EPI Suite Database)
Acenaphthene	5.01E+03	3.70E+00	US EPA 2011 (EPI Suite Database)
Acenaphthylene	5.01E+03	3.70E+00	US EPA 2011 (EPI Suite Database)
Anthracene	1.58E+04	4.20E+00	US EPA 2011 (EPI Suite Database)
Benzo(a)anthracene	1.58E+05	5.20E+00	US EPA 2011 (EPI Suite Database)
Benzo(a)pyrene	6.31E+05	5.80E+00	US EPA 2011 (EPI Suite Database)
Benzo(b)fluoranthene	6.31E+05	5.80E+00	US EPA 2011 (EPI Suite Database)
Benzo(g,h,i)perylene	1.95E+06	6.29E+00	US EPA 2011 (EPI Suite Database)
Benzo(k)fluoranthene	6.31E+05	5.80E+00	US EPA 2011 (EPI Suite Database)
Chrysene	2.00E+05	5.30E+00	US EPA 2011 (EPI Suite Database)
Dibenz(a,h)anthracene	2.00E+06	6.30E+00	US EPA 2011 (EPI Suite Database)
Fluoranthene	5.01E+04	4.70E+00	US EPA 2011 (EPI Suite Database)
Fluorene	9.16E+03	3.96E+00	US EPA 2011 (EPI Suite Database)
Indeno(1,2,3-cd)pyrene	2.00E+06	6.30E+00	US EPA 2011 (EPI Suite Database)
Phenanthrene	1.58E+04	4.20E+00	US EPA 2011 (EPI Suite Database)
Pyrene	5.01E+04	4.70E+00	US EPA 2011 (EPI Suite Database)
C9-C18 aromatics	5.01E+03	3.70E+00	CCME 2008
Formaldehyde	7.94E+00	9.00E-01	US EPA 2011 (EPI Suite Database)

Table E-20 Fraction of Chemical in the Vapour Phase

Chemical	Value	Reference
2-methylnaphthalene	100.0%	US EPA OSW 2005; Assumed similar to naphthalene
3-methylcholanthrene	30.0%	Assumed similar to benzo(a)pyrene
7,12-Dimethylbenz(a)anthracene	30.0%	Assumed similar to benzo(a)pyrene
Acenaphthene	100.0%	US EPA OSW 2005
Acenaphthylene	100.0%	Assumed similar to acenaphthene
Anthracene	100.0%	US EPA OSW 2005
Benzo(a)anthracene	50.0%	US EPA OSW 2005
Benzo(a)pyrene	30.0%	US EPA OSW 2005
Benzo(b)fluoranthene	100.0%	US EPA OSW 2005
Benzo(g,h,i)perylene	30.0%	Assumed similar to benzo(a)pyrene
Benzo(k)fluoranthene	30.0%	US EPA OSW 2005
Chrysene	74.0%	US EPA OSW 2005
Dibenz(a,h)anthracene	5.5%	US EPA OSW 2005
Fluoranthene	100.0%	US EPA OSW 2005
Fluorene	100.0%	US EPA OSW 2005
Indeno(1,2,3-cd)pyrene	0.5%	US EPA OSW 2005
Phenanthrene	100.0%	US EPA OSW 2005
Pyrene	100.0%	US EPA OSW 2005
C9-C18 aromatics	100.0%	US EPA OSW 2005; Assumed similar to naphthalene
Formaldehyde	100.0%	US EPA OSW 2005

Table E-21 Degradation and Volatilization Soil Loss Constant (kt) [yr-1]

Chemical	Kt	Ks(yr-1)	Half-life [Days]	Reference	Kv(yr-1)	Half-life [Days]	Comment/ Reference
2-methylnaphthalene	1.43E+04	1.45E-01	1.75E+03	CCME 2008 (Aromatic C9-C16)	1.43E+04	1.78E-02	Lyman et al. 1990
3-methylcholanthrene	2.76E-01	1.45E-01	1.75E+03	Assumed similar to F2	1.31E-01	1.93E+03	Lyman et al. 1990
7,12-Dimethylbenz(a)anthracene	8.42E-01	4.80E-01	5.27E+02	Assumed similar to B(a)P	3.62E-01	6.99E+02	Lyman et al. 1990
Acenaphthene	1.76E+03	2.48E+00	1.02E+02	US EPA OSW 2005	1.76E+03	1.44E-01	Lyman et al. 1990
Acenaphthylene	1.33E+03	3.48E+00	7.27E+01	US EPA OSW 2005	1.33E+03	1.91E-01	Lyman et al. 1990
Anthracene	1.53E+02	5.50E-01	4.60E+02	US EPA OSW 2005	1.52E+02	1.66E+00	Lyman et al. 1990
Benzo(a)anthracene	2.63E+00	3.70E-01	6.84E+02	US EPA OSW 2005	2.26E+00	1.12E+02	Lyman et al. 1990
Benzo(a)pyrene	5.66E-01	4.80E-01	5.27E+02	US EPA OSW 2005	8.60E-02	2.94E+03	Lyman et al. 1990
Benzo(b)fluoranthene	8.87E+00	4.10E-01	6.17E+02	US EPA OSW 2005	8.46E+00	2.99E+01	Lyman et al. 1990
Benzo(g,h,i)perylene	4.83E-01	4.80E-01	5.27E+02	Assumed similar to B(a)P	3.16E-03	8.01E+04	Lyman et al. 1990
Benzo(k)fluoranthene	1.51E-01	1.20E-01	2.11E+03	US EPA OSW 2005	3.06E-02	8.26E+03	Lyman et al. 1990
Chrysene	5.00E-01	2.50E-01	1.01E+03	US EPA OSW 2005	2.50E-01	1.01E+03	Lyman et al. 1990
Dibenz(a,h)anthracene	2.73E-01	2.70E-01	9.38E+02	US EPA OSW 2005	3.08E-03	8.22E+04	Lyman et al. 1990
Fluoranthene	1.19E+01	5.70E-01	4.44E+02	US EPA OSW 2005	1.13E+01	2.23E+01	Lyman et al. 1990
Fluorene	6.25E+02	4.22E+00	6.00E+01	US EPA OSW 2005	6.20E+02	4.08E-01	Lyman et al. 1990
Indeno(1,2,3-cd)pyrene	3.55E-01	3.50E-01	7.23E+02	US EPA OSW 2005	5.28E-03	4.79E+04	Lyman et al. 1990
Phenanthrene	1.08E+02	1.26E+00	2.01E+02	US EPA OSW 2005	1.06E+02	2.38E+00	Lyman et al. 1990
Pyrene	1.08E+01	1.30E-01	1.95E+03	US EPA OSW 2005	1.06E+01	2.38E+01	Lyman et al. 1990
C9-C18 aromatics	2.01E+04	1.45E-01	1.75E+03	CCME 2008	2.01E+04	1.26E-02	Lyman et al. 1990
Formaldehyde	1.96E+07	3.60E+01	7.03E+00	US EPA OSW 2005	1.96E+07	1.29E-05	Lyman et al. 1990

NOTES:
Volatilization half-life [Days] = (0.0000000158 x Koc x S) / VP

Table E-22 Surface water loss constant (ksw) [yr-1]

Chemical	Value	Half-life [Days]	Reference
2-methylnaphthalene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
3-methylcholanthrene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
7,12-Dimethylbenz(a)anthracene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Acenaphthene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Acenaphthylene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Anthracene	1.10E+01	2.30E+01	Mackay & Hickie 2000
Benzo(a)anthracene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Benzo(a)pyrene	3.57E+00	7.10E+01	Mackay & Hickie 2000
Benzo(b)fluoranthene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Benzo(g,h,i)perylene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Benzo(k)fluoranthene	1.21E+01	2.10E+01	Mackay & Hickie 2000
Chrysene	3.57E+00	7.10E+01	Mackay & Hickie 2000
Dibenz(a,h)anthracene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Fluoranthene	3.57E+00	7.10E+01	Mackay & Hickie 2000
Fluorene	3.57E+00	7.10E+01	Mackay & Hickie 2000
Indeno(1,2,3-cd)pyrene	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Phenanthrene	3.57E+00	7.10E+01	Mackay & Hickie 2000
Pyrene	3.57E+00	7.10E+01	Mackay & Hickie 2000
C9-C18 aromatics	3.57E+00	7.10E+01	Assumed = benzo(a)pyrene
Formaldehyde	6.33E+01	4.00E+00	Mackay et al 1992, midpt of range (96 hrs)

Table E-23 Soil to Pore Water Partition Coefficient (Kd) [L/kg]

Chemical	Value	Reference
2-methylnaphthalene	1.26E+01	Calculated; CCME 2008
3-methylcholanthrene	3.97E+03	Calculated; CCME 2008
7,12-Dimethylbenz(a)anthracene	2.47E+03	Calculated; CCME 2008
Acenaphthene	2.51E+01	Calculated; CCME 2008
Acenaphthylene	2.51E+01	Calculated; CCME 2008
Anthracene	7.92E+01	Calculated; CCME 2008
Benzo(a)anthracene	7.92E+02	Calculated; CCME 2008
Benzo(a)pyrene	3.15E+03	Calculated; CCME 2008
Benzo(b)fluoranthene	3.15E+03	Calculated; CCME 2008
Benzo(g,h,i)perylene	9.75E+03	Calculated; CCME 2008
Benzo(k)fluoranthene	3.15E+03	Calculated; CCME 2008
Chrysene	9.98E+02	Calculated; CCME 2008
Dibenz(a,h)anthracene	9.98E+03	Calculated; CCME 2008
Fluoranthene	2.51E+02	Calculated; CCME 2008
Fluorene	4.58E+01	Calculated; CCME 2008
Indeno(1,2,3-cd)pyrene	9.98E+03	Calculated; CCME 2008
Phenanthrene	7.92E+01	Calculated; CCME 2008
Pyrene	2.51E+02	Calculated; CCME 2008
C9-C18 aromatics	2.51E+01	Calculated; CCME 2008
Formaldehyde	3.97E-02	Calculated; CCME 2008
NOTES: *Calculated Kd = Koc x foc* *foc(g/g) =*	*0.5%*	*AENV 2010*

Table E-24 Deposition velocities [m/s]

Chemical	Wet	Dry	Reference Wet	Reference Dry
2-methylnaphthalene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
3-methylcholanthrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
7,12-Dimethylbenz(a)anthracene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Acenaphthene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Acenaphthylene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Anthracene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(a)anthracene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(a)pyrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(b)fluoranthene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(g,h,i)perylene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Benzo(k)fluoranthene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Chrysene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Cyclopenta(cd)pyrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Dibenz(a,h)anthracene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Fluoranthene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Fluorene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Indeno(1,2,3-cd)pyrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Phenanthrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Pyrene	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
C9-C18 aromatics	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005
Formaldehyde	2.89E-03	2.00E-02	Mackay 1991	Extrapolation from Wesely and Hicks 2000; WESA 2005

NOTES:
Wet deposition velocity based on annual average precipitation of 456mm (Environment Canada 2011)

Table E-25 Percent of Exposure Derived from Impacted Area

Receptor	Value	Comment
Moose	100%	Assumed
Ruffed_Grouse	100%	Assumed
Snowshoe_hare	100%	Assumed

Table E-26 Water Content in Wildlife Food [%]

Receptor	Value	Reference
Aquatic Plant	84%	Suter et al. 2000 (Table 3.5)
Browse	62%	Site-specific data for Alder (from AOSC 2009 and Dover 2010)
Invert	69%	Suter et al. 2000 (Table 3.5)
Moose	74%	WBEA 2009
Ruffed_Grouse	70%	WBEA 2009
Snowshoe_hare	74%	WBEA 2009

Table E-27 Equation Variables Plant Concentration Due to Direct Deposition

Variable	Value	Units	Reference
Empirical Constant - (y)	2.88	Unitless	US EPA OSW 2005
Yield or Standing Biomass for Forage/Browse (Yp)	0.24	kg DW/m^2	US EPA OSW 2005
Plant Surface Loss Coefficient - (kp)	18	yr^{-1}	US EPA OSW 2005
Period of Browse Exposure - (Tp)	0.12	yr	US EPA OSW 2005
Fraction of COPC in Vapour Phase	NA	Chemical Specific	
Deposition Velocity	NA	Chemical Specific	

Table E-28 Time Period of Deposition [years]

Variable	Value	Comment
Time	80	Assumed equal to a lifetime

Table E-29 Soil Properties

Variable	Value	Units	Reference
Surface Soil Mixing Depth = Depth1	0.02	m	US EPA OSW 2005
Soil Mixing Depth for Plants = Depth2	0.2	m	US EPA OSW 2005
Soil Bulk Density	1500	kg/m^3	US EPA OSW 2005

Table E-30 Gas Constants

Variable	Value	Units
Universal Gas Constant (R)	8.21E-05	atm m^3 / mol
Temperature (T)	288	Kelvin
R x T	2.36E-02	Kelvin atm m^3 / mol

Table E-31 Literature Derived Regression Models and Bio-concentration Factors for the ERA [DW basis]

Media	Chemical	UF	Site Specific	Reference/Comment
Aquatic Plant	2-methylnaphthalene	2.04E+02	No	BCFBAF version 3.00 (EPI Suite 2011); Based on naphthalene.
Aquatic Plant	3-methylcholanthrene	1.54E+04	No	Assumed equal to benzo(a)pyrene
Aquatic Plant	7,12-Dimethylbenz(a)anthracene	1.54E+04	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Aquatic Plant	Acenaphthene	5.26E+02	No	BCFBAF version 3.00 (EPI Suite 2011)
Aquatic Plant	Acenaphthylene	5.26E+02	No	BCFBAF version 3.00 (EPI Suite 2011)
Aquatic Plant	Anthracene	1.54E+04	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Aquatic Plant	Benzo(a)anthracene	1.54E+04	No	US EPA OSW 1999 App C, Table C-4 Water-to-Algae BCF
Aquatic Plant	Benzo(a)pyrene	1.54E+04	No	US EPA OSW 1999 App C, Table C-4 Water-to-Algae BCF
Aquatic Plant	Benzo(b)fluoranthene	1.54E+04	No	US EPA OSW 1999 App C, Table C-4 Water-to-Algae BCF
Aquatic Plant	Benzo(g,h,i)perylene	1.54E+04	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Aquatic Plant	Benzo(k)fluoranthene	1.54E+04	No	US EPA OSW 1999 App C, Table C-4 Water-to-Algae BCF
Aquatic Plant	Chrysene	1.54E+04	No	US EPA OSW 1999 App C, Table C-4 Water-to-Algae BCF
Aquatic Plant	Dibenz(a,h)anthracene	1.54E+04	No	US EPA OSW 1999 App C, Table C-4 Water-to-Algae BCF
Aquatic Plant	Fluoranthene	1.54E+04	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Aquatic Plant	Fluorene	1.54E+04	No	Assumed equal to benzo(a)pyrene
Aquatic Plant	Indeno(1,2,3-cd)pyrene	1.54E+04	No	US EPA OSW 1999 App C, Table C-4 Water-to-Algae BCF
Aquatic Plant	Phenanthrene	1.54E+04	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Aquatic Plant	Pyrene	1.54E+04	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Aquatic Plant	C9-C18 aromatics	2.04E+02	No	US EPI Suite BCFBAF version 3.00; Based on naphthalene
Aquatic Plant	Formaldehyde	4.09E-01	No	US EPA OSW 1999 App C, Table C-4 Water-to-Algae BCF
Browse	2-methylnaphthalene	2.75E+00	Yes	site-specific
Browse	3-methylcholanthrene	7.54E-03	No	US EPA OSW 2005
Browse	7,12-Dimethylbenz(a)anthracene	1.72E-02	No	US EPA OSW 2005
Browse	Acenaphthene	2.10E-01	No	US EPA OSW 2005
Browse	Acenaphthylene	2.04E-01	No	US EPA OSW 2005
Browse	Anthracene	1.04E-01	No	US EPA OSW 2005
Browse	Benzo(a)anthracene	1.81E-02	No	US EPA OSW 2005
Browse	Benzo(a)pyrene	1.11E-02	No	US EPA OSW 2005
Browse	Benzo(b)fluoranthene	1.77E-02	No	US EPA OSW 2005
Browse	Benzo(g,h,i)perylene	5.70E-03	No	US EPA OSW 2005
Browse	Benzo(k)fluoranthene	1.14E-02	No	US EPA OSW 2005
Browse	Chrysene	1.70E-02	No	US EPA OSW 2005
Browse	Dibenz(a,h)anthracene	4.86E-03	No	US EPA OSW 2005

Table E-31 Literature Derived Regression Models and Bio-concentration Factors for the ERA [DW basis]

Media	Chemical	UF	Site Specific	Reference/Comment
Browse	Fluoranthene	4.03E-02	No	US EPA OSW 2005
Browse	Fluorene	1.49E-01	No	US EPA OSW 2005
Browse	Indeno(1,2,3-cd)pyrene	5.19E-03	No	US EPA OSW 2005
Browse	Phenanthrene	1.45E+00	Yes	site-specific
Browse	Pyrene	5.85E-02	No	US EPA OSW 2005
Browse	C9-C18 aromatics	3.22E-01	No	US EPA OSW 2005
Browse	Formaldehyde	8.42E+00	No	US EPA OSW 2005
Invert	2-methylnaphthalene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	3-methylcholanthrene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	7,12-Dimethylbenz(a)anthracene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	Acenaphthene	1.16E+02	No	Southworth et al. 1978
Invert	Acenaphthylene	1.20E+02	No	Southworth et al. 1978 (acenaphthene)
Invert	Anthracene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	Benzo(a)anthracene	1.80E-01	No	US EPA OSW 1999 App C, Table C-1 Soil to Invert BCF
Invert	Benzo(a)pyrene	4.19E-01	No	US EPA OSW 1999 App C, Table C-1 Soil to Invert BCF
Invert	Benzo(b)fluoranthene	4.19E-01	No	US EPA OSW 1999 App C, Table C-1 Soil to Invert BCF
Invert	Benzo(g,h,i)perylene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	Benzo(k)fluoranthene	4.79E-01	No	US EPA OSW 1999 App C, Table C-1 Soil to Invert BCF
Invert	Chrysene	2.40E-01	No	US EPA OSW 1999 App C, Table C-1 Soil to Invert BCF
Invert	Dibenz(a,h)anthracene	4.19E-01	No	US EPA OSW 1999 App C, Table C-1 Soil to Invert BCF
Invert	Fluoranthene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	Fluorene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	Indeno(1,2,3-cd)pyrene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	Phenanthrene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	Pyrene	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	C9-C18 aromatics	4.19E-01	No	Assumed = benzo(a)pyrene; US EPA OSW 1999
Invert	Formaldehyde	8.39E-01	No	US EPA OSW 1999 App C, Table C-1 Soil to Invert BCF

NOTES:
Predicted Linear Uptake Factors:
UF Soil - Plant [dry weight] = logBCF = 1.588 - 0.578log(Kow); Travis and Arms 1988
UF Soil - Invertebrate [dry weight] = logBCF = 1.146 - 0.819log(Kow); Southworth et al.1978

Table E-32 Bio transfer factors [day/kg FW]

Media	Chemical	Value	Comment
Moose	2-methylnaphthalene	2.37E-02	US EPA OSW 2005
Moose	3-methylcholanthrene	3.22E-02	US EPA OSW 2005
Moose	7,12-Dimethylbenz(a)anthracene	3.93E-04	US EPA OSW 2005
Moose	Acenaphthene	2.47E-02	US EPA OSW 2005
Moose	Acenaphthylene	2.50E-02	US EPA OSW 2005
Moose	Anthracene	3.31E-04	US EPA OSW 2005
Moose	Benzo(a)anthracene	3.96E-04	US EPA OSW 2005
Moose	Benzo(a)pyrene	3.61E-04	US EPA OSW 2005
Moose	Benzo(b)fluoranthene	3.94E-04	US EPA OSW 2005
Moose	Benzo(g,h,i)perylene	2.89E-04	US EPA OSW 2005
Moose	Benzo(k)fluoranthene	3.64E-04	US EPA OSW 2005
Moose	Chrysene	3.92E-04	US EPA OSW 2005
Moose	Dibenz(a,h)anthracene	2.70E-04	US EPA OSW 2005
Moose	Fluoranthene	4.02E-04	US EPA OSW 2005
Moose	Fluorene	2.89E-04	US EPA OSW 2005
Moose	Indeno(1,2,3-cd)pyrene	2.78E-04	US EPA OSW 2005
Moose	Phenanthrene	3.32E-04	US EPA OSW 2005
Moose	Pyrene	3.83E-04	US EPA OSW 2005
Moose	C9-C18 aromatics	1.94E-04	US EPA OSW 2005
Moose	Formaldehyde	1.21E-04	US EPA OSW 2005
Ruffed_grouse	2-methylnaphthalene	1.74E-02	US EPA OSW 2005
Ruffed_grouse	3-methylcholanthrene	2.37E-02	US EPA OSW 2005
Ruffed_grouse	7,12-Dimethylbenz(a)anthracene	2.90E-04	US EPA OSW 2005
Ruffed_grouse	Acenaphthene	1.82E-02	US EPA OSW 2005
Ruffed_grouse	Acenaphthylene	1.84E-02	US EPA OSW 2005
Ruffed_grouse	Anthracene	2.44E-04	US EPA OSW 2005
Ruffed_grouse	Benzo(a)anthracene	2.92E-04	US EPA OSW 2005
Ruffed_grouse	Benzo(a)pyrene	2.66E-04	US EPA OSW 2005
Ruffed_grouse	Benzo(b)fluoranthene	2.91E-04	US EPA OSW 2005
Ruffed_grouse	Benzo(g,h,i)perylene	2.13E-04	US EPA OSW 2005
Ruffed_grouse	Benzo(k)fluoranthene	2.68E-04	US EPA OSW 2005
Ruffed_grouse	Chrysene	2.89E-04	US EPA OSW 2005
Ruffed_grouse	Dibenz(a,h)anthracene	1.99E-04	US EPA OSW 2005
Ruffed_grouse	Fluoranthene	2.96E-04	US EPA OSW 2005
Ruffed_grouse	Fluorene	2.13E-04	US EPA OSW 2005
Ruffed_grouse	Indeno(1,2,3-cd)pyrene	2.05E-04	US EPA OSW 2005
Ruffed_grouse	Phenanthrene	2.45E-04	US EPA OSW 2005
Ruffed_grouse	Pyrene	2.82E-04	US EPA OSW 2005
Ruffed_grouse	C9-C18 aromatics	1.43E-04	US EPA OSW 2005
Ruffed_grouse	Formaldehyde	8.88E-05	US EPA OSW 2005
Snowshoe_hare	2-methylnaphthalene	2.37E-02	US EPA OSW 2005
Snowshoe_hare	3-methylcholanthrene	3.22E-02	US EPA OSW 2005
Snowshoe_hare	7,12-Dimethylbenz(a)anthracene	3.93E-04	US EPA OSW 2005
Snowshoe_hare	Acenaphthene	2.47E-02	US EPA OSW 2005
Snowshoe_hare	Acenaphthylene	2.50E-02	US EPA OSW 2005
Snowshoe_hare	Anthracene	3.31E-04	US EPA OSW 2005
Snowshoe_hare	Benzo(a)anthracene	3.96E-04	US EPA OSW 2005
Snowshoe_hare	Benzo(a)pyrene	3.61E-04	US EPA OSW 2005
Snowshoe_hare	Benzo(b)fluoranthene	3.94E-04	US EPA OSW 2005
Snowshoe_hare	Benzo(g,h,i)perylene	2.89E-04	US EPA OSW 2005
Snowshoe_hare	Benzo(k)fluoranthene	3.64E-04	US EPA OSW 2005

Table E-32 Bio transfer factors [day/kg FW]

Media	Chemical	Value	Comment
Snowshoe_hare	Chrysene	3.92E-04	US EPA OSW 2005
Snowshoe_hare	Dibenz(a,h)anthracene	2.70E-04	US EPA OSW 2005
Snowshoe_hare	Fluoranthene	4.02E-04	US EPA OSW 2005
Snowshoe_hare	Fluorene	2.89E-04	US EPA OSW 2005
Snowshoe_hare	Indeno(1,2,3-cd)pyrene	2.78E-04	US EPA OSW 2005
Snowshoe_hare	Phenanthrene	3.32E-04	US EPA OSW 2005
Snowshoe_hare	Pyrene	3.83E-04	US EPA OSW 2005
Snowshoe_hare	C9-C18 aromatics	1.94E-04	US EPA OSW 2005
Snowshoe_hare	Formaldehyde	1.21E-04	US EPA OSW 2005

NOTES:
Equation: 10^(-0.099*LOG(Kow)^2+1.07*LOG(Kow)-3.56*FC*MF

Table E-33 Fat content

Receptor	%	Reference/Comment
Moose	0.19	US EPA OSW 2005; assumed equal to beef
Ruffed_Grouse	0.14	US EPA OSW 2005; assumed equal to chicken
Snowshoe_Hare	0.19	US EPA OSW 2005; assumed equal to beef

Table E-34 Metabolism factor

Chemical	Value	Reference
2-methylnaphthalene	1	Assumed most conservative value
3-methylcholanthrene	1	Assumed most conservative value
7,12-Dimethylbenz(a)anthracene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Acenaphthene	1	Assumed most conservative value
Acenaphthylene	1	Assumed most conservative value
Anthracene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Benzo(a)anthracene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Benzo(a)pyrene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Benzo(b)fluoranthene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Benzo(g,h,i)perylene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Benzo(k)fluoranthene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Chrysene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Cyclopenta(cd)pyrene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Dibenz(a,h)anthracene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Fluoranthene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Fluorene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Indeno(1,2,3-cd)pyrene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Phenanthrene	0.01	Hofelt et al. 2001; US EPA OSW 2005
Pyrene	0.01	Hofelt et al. 2001; US EPA OSW 2005
C9-C18 aromatics	0.01	Assumed similar to PAHs
Formaldehyde	1.00	Assumed most conservative value

Table E-35 Pond Parameters for Pond SP16

Pond	Parameter	Value	Units	Comment/Reference
Pond	PA	2,250	m^2	the larger beaver pond of the two ponds provided (SP16)
Pond	PD	1.1	m	average depth of larger pond (SP16)
Pond	PV	2,475	m^3	area x depth
Pond	FR	652,795	m^3/year	flow rate for SP17
Pond	FWC	100%	%	Assumed entire water column available for mixing

Notes
PA: Pond area
PD: Pond depth
PV: Pond volume
FR: Flow rate
FWC: Fraction of water column

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APPENDIX F

Screening Level Wildlife Risk Assessment (SLWRA)

APPENDIX F: SCREENING LEVEL WILDLIFE RISK ASSESSMENT (SLWRA)

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APPENDIX F: SCREENING LEVEL WILDLIFE RISK ASSESSMENT (SLWRA)

F1.0 INTRODUCTION

The primary objective of the Screening Level Wildlife Risk Assessment (SLWRA) is to describe the nature and significance of potential adverse population-level effects to terrestrial wildlife that might be associated with chemical emissions from the proposed Southern Pacific Resource Corp. (STP) McKay Thermal Project – Phase 2 (the Project). A population-level effect can be best-described as a decline or change in abundance or distribution of a wildlife population over time, such that natural recruitment is unable to re-establish the population to its original level (Suter II et al. 2000).

According to the Wildlife Assessment (MEMS 2011a), the Project area provides habitat for a variety of mammals, birds and amphibians. The Project area is situated in a habitat of mature boreal forest which consists of trees, shrubs, bogs, and fens that make up the landscape. In addition, the study area borders the Wabasca-Dunkirk Caribou Management Zone. The wildlife assessment focussed on seven species of concern in the region: Canadian toad, Cape May warbler, beaver, fisher, Canada lynx, moose, and woodland caribou (MEMS 2011a). The SLWRA will assess potential risks to wildlife not for individual species, but instead, the predicted concentrations of chemicals of potential concern (COPCs) were compared to toxicity data and generic soil and water quality guidelines considered protective of all wildlife species.

The SLWRA examines both short-term (acute) and long-term (chronic) health risks to wildlife that may be attributable to the Project, combined with existing or approved developments, as well as with other proposed or planned regional developments. The SLWRA evaluates potential risks to wildlife associated with COPCs emitted from the Project into the air and potentially deposited on soil and/or surface water within the Air Quality study area (MEMS 2011b). To assess potential risks to terrestrial wildlife, predicted chemical exposures will be compared with Toxicity Reference Values (TRVs) and soil and surface water quality guidelines protective of the health of terrestrial wildlife populations.

F2.0 SCOPE OF ASSESSMENT

The scope of the assessment was principally dictated by the Terms of Reference (TOR) issued by Alberta Environment (AENV 2011b). Specifically, TOR Section 3.7.2 [A] e) requires STP to describe and assess the potential impacts of the Project to wildlife and wildlife habitat, specifically addressing the "potential effects on wildlife as a result of changes to air and water quality including both acute and chronic effects on animal health."

The possible need for further study and/or mitigation measures will be determined based on the findings of the SLWRA.

F2.1 Spatial Boundaries

The study area for the SLWRA is consistent with the Human Health Risk Assessment (HHRA) study area, as well as those described for the Air Quality assessment (MEMS 2011b) and Wildlife Assessment (MEMS 2011a). The SLWRA focused on two study areas, the Local Study Area (LSA) and the Regional Study Area (RSA) where the potential health risks associated with chemical emissions from the Project are assessed. The LSA consists of a 50 km × 50 km area,

with approximately a radius of 25 km centered on the Project, while the RSA consists of a 270 × 305 km area surrounding the Project. Consistent with the HHRA and Wildlife assessment, the SLWRA focused on risks to terrestrial wildlife within the LSA. The local maximum point of impingement (MPOI) was evaluated on an acute and chronic basis as wildlife species (e.g., small mammals) could stay in any one location or small area for long durations.

F2.2 Temporal Boundaries

Although the estimated operating life of the project is 25 years, it was conservatively assumed that project emissions would occur for 80 years, as in the HHRA. This was conservatively assumed in consideration of potential cumulative impacts.

The SLWRA assessed potential acute and chronic health risks to wildlife associated with the COPCs emitted or released from the Project. Acute exposures generally extend over a period ranging from hours to days. In contrast, chronic exposures occur continuously over extended periods ranging from months to years (i.e., throughout an animal's lifetime).

In accordance with the TOR, potential health risks to wildlife were assessed for the following three assessment cases:

- Baseline Case: includes existing environmental conditions, along with existing and approved projects or activities.
- Application Case: includes the Baseline Case with the effects of the Project added.
- Planned Development Case (PDC): includes the Application Case plus other planned projects or activities reasonably expected to occur.

F2.3 Issues and Assessment Criteria

To focus the SLWRA on the wildlife risks of primary concern, specific assessment and measurement endpoints were identified. An assessment endpoint is defined as "the characteristic of the ecological system that is the focus of the risk assessment" and that needs to be protected. A measurement endpoint is defined as "the effect on an ecological component that can be measured and described in some quantitative fashion" (Gaudet et al. 1994; CCME 1996).

For the purpose of the SLWRA, the assessment endpoint was identified as potential effects on wildlife populations. The associated measurement endpoints included the following:

- Ratios between maximum predicted chemical concentrations in air and corresponding inhalation TRVs.
- Comparison between predicted chemical concentrations in soil and corresponding soil quality guidelines (SQGs).
- Comparison between predicted chemical concentrations in surface water and corresponding surface water quality guidelines (SWQGs).

The inhalation toxicity data and the soil and water quality guidelines identified for the SLWRA are intended to be protective of wildlife populations.

F3.0 METHODS

The current assessment is a SLWRA conducted according to principals provided by Environment Canada and the Canadian Council of Ministers of the Environment protocols (Gaudet et al. 1994; CCME 1996). The three tiers in an Ecological Risk Assessment (ERA) include:

- Screening-Level Wildlife Risk Assessment (SLWRA)
- Preliminary Quantitative Risk Assessment (PQRA)
- Detailed Quantitative Risk Assessment (DQRA)

The scope for SLWRA in the initial tier employs conservative assumptions and readily available data. Using conservative assumptions regarding both chemical exposure and chemical toxicity to wildlife receptors provides a relatively high degree of conservatism into the assessment. As such, further study is considered unnecessary when a screening-level assessment does not identify an impact.

The steps of the SLWRA methodology are as follows:

- Problem Formulation: identification of the COPCs associated with the Project emissions, characterization of wildlife receptors potentially 'at risk', and determination of the relevant exposure pathways.
- Exposure Assessment: quantification of the potential amount or dose of each COPC received by wildlife receptors through all relevant exposure pathways.
- Toxicity or Hazard Assessment: determination of levels of exposure associated with minimal impact to wildlife populations following exposure for a prescribed period (i.e., acute or chronic exposure).
- Risk Characterization: comparison of estimated exposures (determined in the exposure assessment) with maximum safe dose levels (established in the toxicity assessment) to identify potential health risks for the different assessment cases, as well as discussion of sources of uncertainty and how any uncertainty was addressed in the risk assessment.

F3.1 Problem Formulation

The purpose of the problem formulation was to further focus the SLWRA, as described below:

- Identification of COPCs
    - Identification of TRVs for wildlife exposure
    - Toxic potency screening
    - Physical-chemical screening
- Wildlife receptor characterization
- Environmental media identification
- Identification of exposure pathways

F3.1.1 Identification of Chemicals of Potential Concern

The identification of COPCs began with the review of an inventory of chemicals that could be released or emitted from the Project, and to which wildlife might be exposed. COPCs assessed in the SLWRA also took into consideration the availability of sufficient toxicological information to assess potential health risks. Table F-1 lists the air emissions from the Project, the potential COPCs to be assessed in the SLWRA.

Table F-1 Summary of Total Air Emissions of Chemicals from Southern Pacific Phase 2

Chemicals[1]	Total Emissions[2] (t/d)
Polycyclic Aromatic Hydrocarbons (PAHs)	
7,12-Dimethylbenz(a)anthracene	2.81E-04
Acenaphthene	4.48E-04
Acenaphthylene	3.13E-04
Anthracene	5.64E-04
Benzo(a)anthracene	4.89E-04
Benzo(a)pyrene	3.34E-04
Benzo(b)fluoranthene	2.61E-04
Benzo(g,h,i)perylene	3.03E-04
Benzo(k)fluoranthene	2.61E-04
Chrysene	5.43E-04
Dibenzo(a,h)anthracene	4.78E-04
Fluoranthene	1.09E-03
Fluorene	1.61E-03
Indeno(1,2,3-cd)pyrene	4.89E-04
Phenanthrene	8.31E-03
Pyrene	5.21E-04
Reduced Sulphur Compounds (RSCs)	
CS_2	2.32E-06
H_2S	1.35E-03
Mercaptans[3]	2.96E-04
Thiophenes[3]	1.53E-06
Volatile Organic Compounds (VOCs)	
1,3-Butadiene	1.60E-03
2-Methyl Naphthalene	4.43E-04
3-Methylcholanthrene	3.16E-05
Acetaldehyde	3.95E-01
Acrolein	1.09E-01
Benzene	8.18E-02
C_5-C_8 Aliphatic	7.87E+01
C_9-C_{18} Aliphatic	3.85E-05
C_9-C_{18} Aromatic	1.66E-05

Chemicals[1]	Total Emissions[2] (t/d)
Dichlorobenzene	2.11E-02
Ethyl Benzene	1.19E-01
Formaldehyde	3.96E+00
Naphthalene	1.56E-02
n-Hexane	3.16E+01
n-Pentane	4.57E+01
Toluene	5.43E-01
Xylenes	4.89E-01

Notes:
(1) Criteria Air Contaminants (CAC) (i.e., CO, NO_2, and SO_2) were excluded since these chemicals are automatically included as COPCs for the SLWRA.
(2) Emission values presented are the total of emission sources from tank fugitives, plant fugitives, and combustion.
(3) Mercaptans and thiophenes were not included in the toxic potency screening as no exposure limits were identified for these RSCs.
t/d = tonnes per day

The methods for determination of COPC to be included in the inhalation and multiple exposure assessments took the same approach as was used in the HHRA (Appendix A).

In order to focus the SLWRA on chemicals of concern, toxic potency screening was used to narrow the list of chemicals in the emissions inventory to be evaluated in the acute and chronic inhalation assessment and physical-chemical screening was used to determine the chemicals for the multiple exposure assessment. The toxic potency screening would determine which chemicals in the air emissions inventory would most likely pose a potential hazard to wildlife via direct exposure (i.e., inhalation)., and a physical-chemical screening was used to determine which chemicals in the emissions inventory would most likely pose a potential hazard to wildlife via secondary pathways (i.e., ingestion).

The toxic potency screening involves determining which chemicals in the emissions inventory would contribute to the overall 99% toxicity of the suite of chemicals being emitted from the project. The toxic potential of a chemical is the ratio between the estimated emission rate and the exposure limit for that chemical. Therefore, the identification of exposure limits for inhalation exposure (i.e. TRVs) is necessary for a toxic potency screening.

In addition to the toxic potency screening, criteria air contaminants (CO, NO_2, and SO_2) were automatically included in the acute and chronic inhalation assessment if an inhalation TRV was identified. Particulate matter ($PM_{2.5}$) was not assessed in the SLWRA due to lack of available exposure limit data for avian and mammalian wildlife.

F3.1.1.1 Identification of Acute and Chronic Inhalation Exposure Limits for Wildlife

Identification of inhalation exposure limits (i.e., the safe level of exposure, referred to as 'toxicity reference value' (TRV)), is required as part of the toxic potency screening. In the case of the inhalation assessment, both acute and chronic exposure durations were assessed if TRVs were identified for each COPC on an acute or chronic basis.

Inhalation Toxicity Reference Values

Much of the information regarding the wildlife toxicity of the COPC was obtained from the medical and scientific literature related to the exposure of laboratory test animals such as mice, rats, and guinea pigs for mammalian species, and poultry for avian species. Virtually no studies have been identified in which actual wildlife species were exposed to the COPC under controlled conditions. The lack of wildlife toxicity data presents three challenges:

- Health effects data gathered from the laboratory animals must be extrapolated to the wildlife species being assessed. This requires the use of 'uncertainty' factors to account for possible differences in physiology and uncertainty in sensitivity to the chemicals. The use of such uncertainty factors is a common practice in risk assessment.
- The study designs involved exposures of the laboratory test animals to a range of levels, often showing no effect at low exposure but adverse effects at higher exposures. The differences between the concentrations tested in the laboratory and those to which wildlife might be exposed must be considered to fully assess the significance of the information. In many cases, the concentrations tested in the laboratory animals were considerably higher than those that wildlife might be exposed to in the environment.
- The bioaccessibility or bioavailability (i.e., chemical form) in which the compound is introduced to the test organism is designed to maximize uptake into the blood stream. Bioaccessibility is maximized in the lab to maximize toxic effects. The uptake of the highly bioaccessible form often results in very elevated exposures compared to uptake in the environment, where chemicals are often much less bioaccessible for a variety of physical and chemical reasons.

Both acute and chronic inhalation TRVs were identified for the COPC when sufficient toxicity data were available.

Acute Toxicity Reference Values

Very little acute toxicity information for wildlife species is available other than lethal concentration values (LC_{50}) for most of the COPC assessed herein. The LC_{50} is the COPC concentration that is associated with lethality in 50% of the test animals. The acute inhalation TRVs were derived based on the lowest LC_{50} value reported in the literature. The LC_{LO} refers to the 'lowest published lethal concentration' (NTP 2009). Use of the lowest values reduces the likelihood that potential risks are underestimated.

Since the lowest value reported for all species was used to derive the acute TRV, no uncertainty factors were applied to account for possible differences in sensitivity between species. All mammalian wildlife receptors were evaluated under one acute TRV identified based on the lowest LC_{50} value for all mammalian laboratory animals. Similarly, all avian wildlife receptors were evaluated under one acute TRV identified based on the lowest LC_{50} value reported for all bird species.

The literature review for acute TRVs consisted of an online search of the following:

- International Programme on Chemical Safety (IPCS)
- National Toxicity Program Chemical Repository (NTP)
- National Library of Medicine's Hazardous Substances Data Bank (HSDB)

- National Library of Medicine's ChemIDplus
- Agency for Toxic Substances and Disease Registry (ATSDR)

A summary of the TRVs used in the toxic potency screening to determine COPC to be evaluated in the acute inhalation exposure assessment are provided in Table F-2.

Table F-2 Acute Inhalation TRVs Protective of Wildlife Receptors

Chemical Category	COPC	Receptor	Averaging Period	TRV [mg/m³]	Endpoint	Rationale	Reference
Criteria Air Contaminants (CACs)	Carbon monoxide	Avian	1-hour	1,500	Lethality	An LC_{50} of 1,334 ppm (1,500 mg/m³) was identified in wild birds.	NTP 2009
		Mammal	1-hour	2,078	Lethality	An LC_{50} of 2,078 mg/m³ was identified in rats exposed via inhalation to carbon monoxide for 4 hours.	Ramamoorthy et al. 1995
	Nitrogen dioxide	Avian	1-hour	–	–	–	–
		Mammal	1-hour	56	Lethality	An LC_{50} of 56 mg/m³ was identified in guinea pigs exposed via inhalation to nitrogen dioxide for 1 hour.	HSDB 2009
	Sulphur dioxide	Avian	1-hour	2,600	Lethality	An LC_{20} of 1,000 ppm (2,600 mg/m³) was identified in white leghorn poultry continuously exposed to sulphur dioxide vapours of 0 to 5,000 ppm for 1 hour.	Fedde and Kuhlmann 1979
		Mammal	1-hour	2,600	Lethality	An LC_{50} of 2,600 mg/m³ was identified in mice exposed via inhalation to sulphur dioxide for 4 hours.	HSDB 2009
Petroleum Hydrocarbons (PHCs)	Aliphatic C_5-C_8 group	Avian	24-hour	3,500	Growth	LOAEL of 3,500 mg/m³ in leghorn hens exposed for 30 days continuously to n-hexane vapours.	Abou-Donia et al. 1991
		Mammal	24-hour	2,500	Maternal toxicity	A NOAEL of 10,000 mg/m³ was identified in rats and mice exposed via inhalation to commercial hexane for 6 hours/day on days 6-15 of gestation. Due to endpoint, value was adjusted for continuous exposure.	TPHCWG 1997
	Aliphatic C_9-C_{18} group	Avian	–	–	–	–	–
		Mammal	–	–	–	–	–
	Aromatic C_9-C_{18} group	Avian	–	–	–	–	–
		Mammal	1-hour	500	Growth, reproduction	A NOAEL of 500 mg/m³ was identified in mice exposed via inhalation to high flash aromatic naphtha for 6 hours/day on gestational days 6-15.	TPHCWG 1997; MA DEP 2003
VOCs	1,3-Butadiene	Avian	–	–	–	–	–
		Mammal	1-hour	268,000	Lethality	An LC_{50} of 268,000 mg/m³ was provided for mice exposed via inhalation to 1,3-butadiene for 2 hours.	ATSDR 2009
	Acetaldehyde	Avian	–	–	–	–	–

Chemical Category	COPC	Receptor	Averaging Period	TRV [mg/m³]	Endpoint	Rationale	Reference
		Mammal	1-hour	2,700	Lethality	An LC_{50} of 1,500 ppm (2,702.5 mg/m³) was provided for mice exposed via inhalation to acetaldehyde for 4 hours.	HSDB 2009
	Acrolein	Avian	–	–	–	–	–
		Mammal	1-hour	17	Lethality	An LC_{50} of 17 mg/m³ was identified in rats exposed via inhalation to acrolein for 4 hours.	HSDB 2009
	Benzene	Avian	–	–	–	–	–
		Mammal	1-hour	15,000	Lethality	An LC_{50} of 15,000 mg/m³ was identified in mice exposed via inhalation to benzene for 8 hours.	IPCS 1993
	Dichlorobenzene	Avian	–	–	–	–	–
		Mammal	1-hour	12,000	Lethality	An LC_{50} of 12,000 mg/m³ was identified in mammals (species unidentified) exposed via inhalation to 1,4-dichlorobenzene (exposure duration unknown).	ChemIDplus 2009
	Ethylbenzene	Avian	–	–	–	–	–
		Mammal	1-hour	17,200	Lethality	An LC_{50} of 17,200 mg/m³ was identified in rats exposed via inhalation to ethylbenzene for 4 hours.	IPCS 1996
	Formaldehyde	Avian	–	–	–	–	–
		Mammal	1-hour	414	Lethality	An LC_{50} of 414 mg/m³ was identified in mice exposed via inhalation to formaldehyde for 4 hours.	CICAD 2002
	Naphthalene	Avian	–	–	–	–	–
		Mammal	1-hour	340	Lethality	An LC_{50} of 340 mg/m³ was identified in rats exposed via inhalation to naphthalene for 1 hour. The LC_{50} for naphthalene is more conservative than the TRV used for the aromatic C_9-C_{16} group, thus the naphthalene group was assessed both individually and as part of the aromatic C_9-C_{16} group.	NTP 2008
	n-Hexane	Avian	24-hour	3,500	Growth	A LOAEL of 3,500 mg/m³ was identified in Leghorn hens exposed continuously to n-hexane vapours for 30 days.	Abou-Donia et al. 1991
		Mammal	1-hour	169,000	Lethality	An LC_{50} of 48,000 ppm (169,000 mg/m³) was identified in mice and rats exposed via inhalation to hexane for 4	HSDB 2009, Website

Chemical Category	COPC	Receptor	Averaging Period	TRV [mg/m³]	Endpoint	Rationale	Reference
						hours.	
	n-Pentane	Avian	–	–	–	–	–
		Mammal	1-hour	364,000	Lethality	An LC_{50} of 364,000 mg/m^3 was identified in rats exposed via inhalation to n-pentane for 4 hours.	HSDB 2010; ChemIDplus 2010
	Toluene	Avian	–	–	–	–	–
		Mammal	1-hour	100,000	Lethality	An LC_{50} of 100,000 mg/m³ was identified in rats exposed via inhalation to toluene for 1 hour.	HSDB 2009
	Xylenes	Avian	–	–	–	–	–
		Mammal	1-hour	17,000	Lethality	An LC_{50} of 17,000 mg/m³ was identified in mice exposed via inhalation to xylenes for 6 hours.	HSDB 2009
RSCs	Carbon disulphide	Avian	–	–	–	–	–
		Mammal	1-hour	690	Lethality	An LC_{50} of 690 mg/m³ was identified in mice exposed via inhalation to carbon disulphide for 1 hour.	IPCS 2002
	Hydrogen sulphide	Avian	–	–	–	–	–
		Mammal	1-hour	820	Lethality	An LC_{50} of 820 mg/m³ was identified in mice exposed via inhalation to hydrogen sulphide for 2 hours.	ATSDR 2006

– = No appropriate or relevant data was available.

Chronic Toxicity Reference Values

Limited standardized guidance on the derivation of chronic wildlife TRVs is provided in the form of regulatory guidelines, directives, or protocols. In 1998, the British Columbia Ministry of Water, Land and Air Protection (BC MWLAP 1998) recommended an approach for the extrapolation of toxicity data between mammalian species based on an effective concentration (EC_{20}) or concentration that affects 20% of the exposed (i.e., test) organisms. The BC MWLAP (1998) gave preference to reproductive endpoints, but lethality, growth and developmental effects were considered to be acceptable if these were the only endpoints available. According to the BC MWLAP (1998), an uncertainty factor of 10 should be applied to the EC_{20} to account for interspecies differences. If an EC_{20} is not available, then the BC MWLAP (1998) recommends that a concentration curve be generated from the available toxicity data. Otherwise, the use of a lowest-observed-adverse-effect level (LOAEL) is recommended without any application of uncertainty factors.

A summary of the BC MWLAP (1998) recommendations for ecological risk assessments follows:

- Use an EC_{20} as a TRV.
- If an EC_{20} is not available or cannot be calculated, use the LOAEL from the most applicable study.
- If the data are from similar species do not use uncertainty factors.
- If the animals are not closely related or if it is unknown whether or not they are likely to have similar physiological responses, apply an uncertainty factor of 10.

The US EPA OSW (1999) provides guidance for deriving chronic TRVs using no-observed-adverse-effect levels (NOAELs) based on population-level effects for chronic exposure, such as development, reproduction and survivorship, whereas the CCME (2006) recommends using a LOAEL and applying an uncertainty factor of 1 to 5, based on expert judgment, for extrapolation between wildlife species.

For most of the COPCs, EC_{20} values were not identified. For the chronic inhalation TRVs, reliance was placed on NOAELs as opposed to LOAELs to reduce the likelihood of the underestimation of potential risks to sensitive wildlife species. The lowest reported NOAEL value for all species associated with population-level effects was selected. Due to the similarity in respiratory physiology between different species, no adjustments were made to the NOAEL for the individual wildlife receptors. The lowest NOAEL identified for mammalian laboratory animals was used to evaluate potential risks to all the mammalian wildlife receptors and the lowest NOAEL for birds was used to evaluate potential risks to all the avian wildlife receptors.

The literature review for NOAEL values consisted of an online search of the following:

- Agency for Toxic Substances and Disease Registry (ATSDR)
- American Conference of Governmental Industrial Hygienists (ACGIH)
- California's Office of Environmental Health Hazard Assessment (OEHHA)
- Health Canada and Environment Canada

- International Programme on Chemical Safety (IPCS)
- National Toxicology Program Chemical Repository (NTP)
- Netherlands' National Institute of Public Health and the Environment (RIVM)
- Ontario Ministry of the Environment (OMOE)
- National Library of Medicine's Hazardous Substances Data Bank (HSDB)
- National Library of Medicine's Toxicology Literature Online (TOXLINE)
- World Health Organization (WHO)
- United States Environmental Protection Agency (US EPA)

For many of the COPCs, a TRV was derived from the available toxicological data. If a NOAEL was not available, the lowest LOAEL was recommended as the TRV with an uncertainty factor applied to account for the extrapolation of a LOAEL to a NOAEL. The TRVs were based on ecologically relevant endpoints (i.e., growth, reproduction, and survivorship). If sufficient toxicity information was not available for a given receptor and chemical combination then risks were not evaluated in the SLWRA.

A summary of the TRVs used in the toxic potency screening to determine COPCs to be evaluated in the chronic inhalation exposure assessment are provided in Table F-3.

Table F-3 Chronic Inhalation TRV Protective of Wildlife Receptors

Chemical Category	COPC	Receptor	TRV [mg/m³]	Endpoint	Rationale	Reference
CACs	Carbon Monoxide	Avian	–	–	–	–
		Mammal	–	–	–	–
	Nitrogen dioxide	Avian	–	–	–	–
		Mammal	0.025	Developmental effects	A NOAEL of 0.10 mg/m³ was identified in rats exposed to 0, 0.05, 0.10, 1.0 or 10 mg/m³ nitrogen dioxide for 6 hours/day, 7 days/week, through gestation until the offspring were 2 months old. The NOAEL was adjusted to continuous exposure.	Tabacova et al. 1985
	Sulphur dioxide	Avian	–	–	–	–
		Mammal	2.6	Respiratory effects	A NOAEL of 2.6 mg/m³ was identified in guinea pigs exposed continuously to an average sulphur dioxide concentration of 0.34, 2.6, or 15 mg/m³ for 52 weeks.	HSDB 2009
PHCs	Aliphatic C_5-C_8 group	Avian	35	Growth effects	A LOAEL of 3,500 mg/m^3 was identified in Leghorn hens exposed continuously to n-hexane vapours for 30 days. An uncertainty factor of 100 was applied to account for use of a subchronic study and a LOAEL.	Abou-Donia et al. 1991
		Mammal	1,840	Reproductive effects	A NOAEL of 3,000 ppm (10,307 mg/m^3) was identified in rats exposed to 0, 900, 3,000, or 9,000 ppm commercial hexane for 6 hours/day, 5 days/week for 2 generations. The NOAEL was adjusted to continuous exposure.	TPHCWG 1997
	Aliphatic C_9-C_{18} group	Avian	–	–	–	–
		Mammal	35	Growth effects	A NOAEL of 300 ppm (1,970 mg/m^3) was identified in rats exposed via inhalation to dearomatized white spirit vapours for 6 hours/day, 5 days/week for 12 weeks. The NOAEL was adjusted to continuous exposure. An uncertainty factor of 10 was applied to account for use of a subchronic study.	MA DEP 2003
	Aromatic C_9-C_{18} group	Avian	–	–	–	–
		Mammal	123	Developmental/ reproductive effects	A NOAEL of 100 ppm (491 mg/m^3) was identified in mice exposed to 0, 100, 500 or 1,500 ppm high flash aromatic naphtha for 6 hours/day on gestation days 6-15. NOAEL is based upon the incidence of maternal and fetal effects. The NOAEL was adjusted to continuous exposure.	MA DEP 2003

Chemical Category	COPC	Receptor	TRV [mg/m³]	Endpoint	Rationale	Reference
VOCs	1,3-Butadiene	Avian	–	–	–	
		Mammal	0.25	Reproductive	A LOAEL of 6.25 ppm (14 mg/m³) was identified in female mice exposed to 0, 6.25, 20, 62.5, 200 or 625 ppm of 1,3-butadiene for a duration of 6 hours/day, 5 days/week for 103-weeks. This value was adjusted for continuous exposure, and an uncertainty factor of 10 was applied to account for the use of a LOAEL.	ATSDR 2009
	Acetaldehyde	Avian	–	–	–	–
		Mammal	13	Growth effects	A NOAEL of 400 ppm (720 mg/m³) was identified in rats exposed to 400, 1,000, 2,200, or 5,000 ppm acetaldehyde for 6 hours/day, 5 days/week for 4 weeks. The NOAEL was adjusted to continuous exposure. An uncertainty factor of 10 was applied for use of a subchronic study.	CEPA 2000a
	Acrolein	Avian	–	–	–	–
		Mammal	0.16	Growth effects	A NOAEL of 0.4 ppm (0.9 mg/m³) was identified in rats exposed to 0, 0.4, 1.4, or 4.9 ppm acrolein for 6 hours/day, 5 days/week for 13 weeks. The NOAEL was adjusted to continuous exposure.	US EPA 2009
	Benzene	Avian	–	–	–	–
		Mammal	15	Developmental effects	A LOAEL of 47 ppm (150 mg/m³) was identified in rats exposed to 0, 47, 141, 470, or 939 ppm benzene for 24 hours/day on gestation days 7-14. An uncertainty factor of 10 was applied for use of a LOAEL.	CEPA 1993
	Dichlorobenzene	Avian	–	–	–	–
		Mammal	7.5	Growth effects	A NOAEL of 50 ppm (300 mg/m³) was identified in rats exposed to 0, 50, 150, or 450 ppm 1,4-dichlorobenzene for 6 hours/day, 7 days/week, for 10 or 11 weeks. The NOAEL was adjusted to continuous exposure. An uncertainty factor of 10 was applied for use of a subchronic study.	US EPA 2009
	Ethylbenzene	Avian	–	–	–	–
		Mammal	110	Developmental effects	A NOAEL of 100 ppm (434 mg/m³) was identified in New Zealand white rabbits exposed to 0, 100, or 1,000 ppm ethylbenzene for 6-7 hours per day, 7 days per week on gestation days 1-24. The NOAEL was adjusted to continuous exposure.	US EPA 2009

Chemical Category	COPC	Receptor	TRV [mg/m³]	Endpoint	Rationale	Reference
	Formaldehyde	Avian	–	–	–	–
		Mammal	0.45	Survivorship and growth effects	A NOAEL of 2 ppm (2.5 mg/m³) was identified in rats exposed to 0, 2, 5.6, or 14.3 ppm formaldehyde for 6 hours/day, 5 days/week for 24 months. The NOAEL was adjusted to continuous exposure.	US EPA 2009
	Naphthalene	Avian	–	–	–	–
		Mammal	9.4	Growth effects	A NOAEL of 10 ppm (52.4 mg/m³) was identified in rats exposed to 0, 10, 30, or 60 ppm naphthalene vapours for 6 hours/day, 5 days/week for 2 years. The NOAEL was adjusted to continuous exposure.	ATSDR 2005
	n-Hexane	Avian	35	Growth effects	A LOAEL of 3,500 mg/m³ was identified in leghorn hens exposed continuously to n-hexane vapours for 30 days. An uncertainty factor of 100 was applied to account for use of a subchronic study and a LOAEL.	Abou-Donia et al. 1991
		Mammal	580	Developmental effects	A NOAEL of 200 ppm (700 mg/m³) was identified in rats exposed to 0, 200, 1,000 or 5,000 ppm hexane vapours for 20 hours/day on days 6-19 of gestation. The NOAEL was adjusted to continuous exposure.	ATSDR 1999; US EPA 2009
	n-Pentane	Avian	–	–	–	–
		Mammal	73,750	Developmental/reproductive effects	A NOAEL of 10,000 ppm (295,000 mg/m^3) was identified in rats exposed to 0, 1,000, 3,000, or 10,000 ppm of n-pentane via inhalation for 6 hours/day on days 6-15 of gestation. The NOAEL was adjusted to continuous exposure.	HSDB 2010
	Toluene	Avian	–	–	–	–
		Mammal	7.3	Reproductive effects	A LOAEL of 100 ppm (375 mg/m³) was identified in mice exposed to toluene vapours for 6.5 hours/day, 5 days/week for 14 weeks. The LOAEL was adjusted to continuous exposure. An uncertainty factor of 10 was applied for use of a LOAEL.	CEPA 1992; ATSDR 2000
	Xylenes	Avian	–	–	–	–
		Mammal	15	Developmental effects	A LOAEL of 150 mg/m³ was identified in rats exposed continuously to xylenes on gestation days 7-14. An uncertainty factor of 10 was applied for use of a LOAEL.	ATSDR 2007
RSCs	Carbon disulphide	Avian	–	–	–	–
		Mammal	26	Developmental effects	A NOAEL of 40 ppm (125 mg/m³) was identified in rats and rabbits exposed to 0, 20, or 40 ppm carbon	ATSDR 1996; CEPA 2000b;

Chemical Category	COPC	Receptor	TRV [mg/m³]	Endpoint	Rationale	Reference
					disulphide for 7 hours/day, 5 days/week during pre-gestational and/or gestational periods. The NOAEL was adjusted to continuous exposure.	US EPA 2009
	Hydrogen sulphide	Avian	–	–	–	–
		Mammal	0.76	Growth effects	A NOAEL of 30.5 ppm (42.5 mg/m³) was identified in rats and mice exposed to 0, 10.1, 30.5, or 80 ppm hydrogen sulphide for 6 hours/day, 5 days/week for 90 days. The NOAEL was adjusted to continuous exposure and for the use of subchronic data.	US EPA 2009; ATSDR 2006

– = No appropriate or relevant data was available.

F3.1.1.2 Toxic Potency Screening for Identification of COPCs to be Evaluated in the Inhalation Assessment

All chemicals in the emissions inventory were assessed in the toxic potency screening on an acute and chronic basis for mammalian and avian wildlife receptors, depending on whether inhalation TRVs could be identified. Given that avian wildlife TRVs were only identified for the CACs and for two chemicals from the emissions inventory (C_5-C_8 aliphatic and n-hexane), a toxic potency screening was not required for the avian wildlife receptor and thus, the CACs, C_5-C_8 aliphatic and n-hexane were evaluated in the inhalation assessment for avian wildlife. Toxic Potency screening was used to narrow the list of chemicals for the inhalation assessment for mammalian wildlife as many TRVs were identified for the chemicals in the emissions inventory. Tables F-4 and F-5 presents the results of the toxic potency screening for mammalian wildlife on an acute and chronic basis for chemicals in the emissions inventory, respectively.

The toxic potential for each chemical in the emissions inventory is determined by dividing the total emission rate of a chemical by the corresponding acute or chronic TRV. The relative toxic potential for each chemical is determined, and chemicals that make up 99% of the overall toxic potency of emissions from the Project are chosen to be evaluated as COPCs in the acute or chronic inhalation assessment. Chemicals that were identified for inclusion in the acute and chronic inhalation assessment are shaded grey in Tables F-4 and F-5, respectively.

Table F-4 Toxic Potency Screening for Identification of COPCs for the Acute Inhalation Assessment for Mammalian Wildlife

Chemical Category	COPC	Total Emission Rate (t/d)	Acute TRV for Mammals[1]	Toxic Potential[2]	Relative Toxic Potential	Cumulative Toxic Potential
PHC	C_5-C_8 Aliphatics	7.87E+01	2.5E+03	3.1E-02	66%	66%
VOC	Formaldehyde	3.96E+00	4.1E+02	9.6E-03	20%	85%
VOC	Acrolein	1.09E-01	1.7E+01	6.4E-03	13%	99%
VOC	n-Hexane	3.16E+01	1.7E+05	1.9E-04	0.4%	99%
VOC	Acetaldehyde	3.95E-01	2.7E+03	1.5E-04	0.3%	99%
VOC	n-Pentane	4.57E+01	3.6E+05	1.3E-04	0%	100%
VOC	Naphthalene	1.56E-02	3.4E+02	4.6E-05	0%	100%
VOC	Xylenes	4.89E-01	1.7E+04	2.9E-05	0%	100%
PHC	C9-C18 Aromatic group[3]	2.99E-02	5.0E+02	6.0E-05	0%	100%
VOC	Ethyl Benzene	1.19E-01	1.7E+04	6.9E-06	0%	100%
VOC	Benzene	8.18E-02	1.5E+04	5.5E-06	0%	100%
VOC	Toluene	5.43E-01	1.0E+05	5.4E-06	0%	100%
VOC	Dichlorobenzene	2.11E-02	1.2E+04	1.8E-06	0%	100%
RSC	H_2S	1.35E-03	8.2E+02	1.6E-06	0%	100%
VOC	1,3-Butadiene	1.60E-03	2.7E+05	6.0E-09	0%	100%
RSC	CS_2	2.32E-06	6.9E+02	3.4E-09	0%	100%
PHC	C9-C18 Aromatic[4]	1.66E-05	n/a	–	–	–
PHC	C9-C18 Aliphatic	3.85E-05	n/a	–	–	–
VOC	2-Methyl Naphthalene	4.43E-04	n/a	–	–	–
RSC	Thiophenes	1.53E-06	n/a	–	–	–
RSC	Mercaptans	2.96E-04	n/a	–	–	–
VOC	3-Methylcholanthrene	3.16E-05	n/a	–	–	–
PAH	7,12-Dimethylbenz(a) anthracene	2.81E-04	n/a	–	–	–
PAH	Acenaphthene	4.48E-04	n/a	–	–	–
PAH	Acenaphthylene	3.13E-04	n/a	–	–	–
PAH	Anthracene	5.64E-04	n/a	–	–	–

Chemical Category	COPC	Total Emission Rate (t/d)	Acute TRV for Mammals[1]	Toxic Potential[2]	Relative Toxic Potential	Cumulative Toxic Potential
PAH	Benzo(a)anthracene	4.89E-04	n/a	—	—	—
PAH	Benzo(a)pyrene	3.34E-04	n/a	—	—	—
PAH	Benzo(b)fluoranthene	2.61E-04	n/a	—	—	—
PAH	Benzo(g,h,i)perylene	3.03E-04	n/a	—	—	—
PAH	Benzo(k)fluoranthene	2.61E-04	n/a	—	—	—
PAH	Chrysene	5.43E-04	n/a	—	—	—
PAH	Dibenzo(a,h)anthracene	4.78E-04	n/a	—	—	—
PAH	Fluoranthene	1.09E-03	n/a	—	—	—
PAH	Fluorene	1.61E-03	n/a	—	—	—
PAH	Indeno(1,2,3-cd)pyrene	4.89E-04	n/a	—	—	—
PAH	Phenanthrene	8.31E-03	n/a	—	—	—
PAH	Pyrene	5.21E-04	n/a	—	—	—
			Sum of Toxic Potentials	**4.8E-02**		

Notes:
(1) Refer to Table F-2 for details on acute TRVs for mammalian wildlife
(2) Toxic Potential = Total Emission Rate ÷ Acute Exposure Limit
(3) C_9-C_{18} Aromatics group is the sum of the emission rates for the following chemicals: acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, C_9-C_{18} aromatics, chrysene, fluoranthene, fluorene, naphthalene, 2-methylnaphthalene, phenanthrene, and pyrene
(4) C_9-C_{18} Aromatics was added into the C_9-C_{18} Aromatics group along with chemicals listed in the above footnote (3).
n/a = acute TRV for mammals was not identified
— = value not calculated due to lack of TRV
t/d = tonnes per day

Table F-5 Toxic Potency Screening for Identification of COPCs for the Chronic Inhalation Assessment for Mammalian Wildlife

Chemical Category	COPC	Total Emission Rate (t/d)	Chronic TRV for Mammals[1]	Toxic Potential[2]	Relative Toxic Potential	Cumulative Toxic Potential
VOC	Formaldehyde	3.96E+00	4.5E-01	8.8E+00	90.4%	90%
VOC	Acrolein	1.09E-01	1.6E-01	6.8E-01	7.0%	97%
VOC	Toluene	5.43E-01	7.3E+00	7.4E-02	0.8%	98%
VOC	n-Hexane	3.16E+01	5.8E+02	5.5E-02	0.6%	99%
PHC	C_5-C_8 Aliphatics	7.87E+01	1.8E+03	4.3E-02	0.4%	99%
VOC	Xylenes	4.89E-01	1.5E+01	3.3E-02	0.3%	99%
VOC	Acetaldehyde	3.95E-01	1.3E+01	3.0E-02	0.3%	100%
VOC	1,3-Butadiene	1.60E-03	2.5E-01	6.4E-03	0.1%	100%
VOC	Benzene	8.18E-02	1.5E+01	5.5E-03	0.1%	100%
VOC	Dichlorobenzene	2.11E-02	7.5E+00	2.8E-03	0.0%	100%
RSC	H_2S	1.35E-03	7.6E-01	1.8E-03	0.0%	100%
VOC	Naphthalene	1.56E-02	9.4E+00	1.7E-03	0.0%	100%
VOC	Ethyl Benzene	1.19E-01	1.1E+02	1.1E-03	0.0%	100%
VOC	n-Pentane	4.57E+01	7.4E+04	6.2E-04	0.0%	100%
PHC	C_9-C_{18} Aromatic group[3]	2.99E-02	1.2E+02	2.4E-04	0.0%	100%
PHC	C_9-C_{18} Aliphatics	3.85E-05	3.5E+01	1.1E-06	0.0%	100%
RSC	CS_2	2.32E-06	2.6E+01	8.9E-08	0.0%	100%
PAH	7,12-Dimethylbenz(a) anthracene	2.81E-04	n/a	–	–	–
PAH	Dibenzo(a,h)anthracene	4.78E-04	n/a	–	–	–
PAH	Benzo(a)pyrene	3.34E-04	n/a	–	–	–
PAH	Benzo(a)anthracene	4.89E-04	n/a	–	–	–
PAH	Indeno(1,2,3-cd)pyrene	4.89E-04	n/a	–	–	–
PAH	Benzo(b)fluoranthene	2.61E-04	n/a	–	–	–
PAH	Benzo(k)fluoranthene	2.61E-04	n/a	–	–	–
PAH	Phenanthrene	8.31E-03	n/a	–	–	–
PAH	Chrysene	5.43E-04	n/a	–	–	–

Chemical Category	COPC	Total Emission Rate (t/d)	Chronic TRV for Mammals[1]	Toxic Potential[2]	Relative Toxic Potential	Cumulative Toxic Potential
PAH	Benzo(g,h,i)perylene	3.03E-04	n/a	—	—	—
PAH	Fluoranthene	1.09E-03	n/a	—	—	—
PHC	Aromatic C_9-C_{18}[4]	1.66E-05	n/a	—	—	—
VOC	2-Methyl Naphthalene	4.43E-04	n/a	—	—	—
RSC	Thiophenes	1.53E-06	n/a	—	—	—
RSC	Mercaptans	2.96E-04	n/a	—	—	—
VOC	3-Methylcholanthrene	3.16E-05	n/a	—	—	—
PAH	Acenaphthene	4.48E-04	n/a	—	—	—
PAH	Acenaphthylene	3.13E-04	n/a	—	—	—
PAH	Anthracene	5.64E-04	n/a	—	—	—
PAH	Fluorene	1.61E-03	n/a	—	—	—
PAH	Pyrene	5.21E-04	n/a	—	—	—
			Sum of Toxic Potential	**9.7E+00**		

Notes:
(1) Refer to Table F-3 for details on chronic TRVs for mammalian wildlife
(2) Toxic Potential = Total Emission Rate ÷ Chronic Exposure Limit
(3) C_9-C_{18} Aromatics group is the sum of the emission rates for the following chemicals: acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, C_9-C_{18} aromatics, chrysene, fluoranthene, fluorene, naphthalene, 2-methylnaphthalene, phenanthrene, and pyrene
(4) C_9-C_{18} Aromatics was added into the C_9-C_{18} Aromatics group along with chemicals listed in the above footnote (3).
n/a = chronic TRV for mammals was not identified
— = value not calculated due to lack of TRV
t/d = tonnes per day

Results of the acute inhalation toxic potency screening for mammalian wildlife (Table F-4) identified five COPCs that make up 99% of the total toxic potential of the air emissions from the Project, as follows:

- C_5-C_8 Aliphatic
- Formaldehyde
- Acrolein
- n-Hexane
- Acetaldehyde

Results of the chronic toxic potency screening for mammalian wildlife (Table F-5) identified six COPCs that constitute 99% of the total toxic potential of the chemicals emitted into air from the Project, as follows.

- Formaldehyde
- Acrolein
- Toluene
- n-Hexane
- C_5-C_8 Aliphatic
- Xylenes

F3.1.1.3 Physical-Chemical Screening to Determine COPCs for the Multiple Exposure Pathway Assessment

The purpose of the physical-chemical screening was to assess the potential health risks associated with exposure via deposition of persistent chemicals to the local environment. As part of the physical-chemical screening, chemicals from the emissions inventory were evaluated based on the chemical's volatility and potential for accumulation and persistence in the terrestrial environment. The methods of the physical-chemical screening process are provided in Appendix A of the HHRA report.

Results of the physical-chemical screening process revealed that 20 COPCs are eligible for inclusion in the multiple pathway assessment, provided that defensible exposure limits are available. The final list of COPCs to be evaluated in the multiple pathway assessment is as follows:

- 2-methylnaphthalene
- 3-methylcholanthrene
- 7,12-dimethylbenz(a)anthracene
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene

- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- C_9-C_{18} aromatics
- Chrysene
- Dibenzo(a,h)anthracene
- Fluoranthene
- Fluorene
- Formaldehyde
- Indeno(1,2,3-cd)pyrene
- Phenanthrene
- Pyrene

The final outcome of the toxic potency screening and physical-chemical screening provided a focused list of COPCs to be evaluated in the acute and chronic inhalation assessments, and multiple pathway assessments provided that TRVs, SQGs or SWQGs were identified. Table F-6 presents the COPCs for the SLWRA.

Table F-6 Summary of COPCs Identified from the Toxic Potency Screening and the Physical-Chemical Screening in the SLWRA(1)

Emission Constituent	COPC Based on Toxic Potency Screening		COPC Based on Physical and Chemical Screening
	Acute Inhalation	Chronic Inhalation	Multiple Pathway
PAHs			
7,12-Dimethylbenz(a)anthracene	NA	NA	COPC
Acenaphthene	NA	NA	COPC
Acenaphthylene	NA	NA	COPC
Anthracene	NA	NA	COPC
Benzo(a)anthracene	NA	NA	COPC
Benzo(a)pyrene	NA	NA	COPC
Benzo(b)fluoranthene	NA	NA	COPC
Benzo(g,h,i)perylene	NA	NA	COPC
Benzo(k)fluoranthene	NA	NA	COPC
Chrysene	NA	NA	COPC
Dibenzo(a,h)anthracene	NA	NA	COPC
Fluoranthene	NA	NA	COPC
Fluorene	NA	NA	COPC
Indeno(1,2,3-cd)pyrene	NA	NA	COPC
Phenanthrene	NA	NA	COPC

Emission Constituent	COPC Based on Toxic Potency Screening		COPC Based on Physical and Chemical Screening
	Acute Inhalation	Chronic Inhalation	Multiple Pathway
Pyrene	NA	NA	COPC
PHCs			
C5-C8 Aliphatic	COPC	COPC	NA
C9-C18 Aliphatic	NA	NA	NA
C9-C18 Aromatic	NA	NA	COPC
RSCs			
CS_2	NA	NA	NA
H_2S	NA	NA	NA
Mercaptans	NA	NA	NA
Thiophenes	NA	NA	NA
VOCs			
1,3-Butadiene	NA	NA	NA
2-Methyl Naphthalene	NA	NA	COPC
3-Methylcholanthrene	NA	NA	COPC
Acetaldehyde	COPC	NA	NA
Acrolein	COPC	COPC	NA
Benzene	NA	NA	NA
Dichlorobenzene	NA	NA	NA
Ethyl Benzene	NA	NA	NA
Formaldehyde	COPC	COPC	COPC
Naphthalene	NA	NA	NA
n-Hexane	COPC	COPC	NA
n-Pentane	NA	NA	NA
Toluene	NA	COPC	NA
Xylenes	NA	COPC	NA
CACs[(2)]			
Carbon Monoxide (CO)	COPC	COPC	NA
Nitrogen dioxide (NO_2)	COPC	COPC	NA
Sulphur dioxide (SO_2)	COPC	COPC	NA

Notes:
(1) COPCs were assessed for mammalian or avian wildlife receptors provided that TRVs for inhalation exposure or SQGs or SWQGs for secondary pathway exposure. Therefore, the majority of COPCs were assessed for mammalian wildlife and limited COPCs were assessed for avian wildlife due to lack of exposure limits.
(2) Criteria air contaminants were not included as part of toxic potency screening, but automatically included in the inhalation assessment of the HHRA and excluded from the multiple pathway assessment (see Appendix A for details). $PM_{2.5}$ was not assessed in the SLWRA as TRVs for wildlife exposure was not identified.
NA: Not assessed because chemical did not pass toxic potency screening and/or physical and chemical screening (see Appendix A for details).

The COPCs were assessed either as individual chemicals (e.g., formaldehyde) or as chemical constituent within a group. Some COPCs were included both as individual chemicals (e.g., n-hexane) and as part of a chemical group (e.g., in this case, the C_5-C_{18} aliphatic).

Table F-7 provides the final list of COPCs and surrogate groups to be assessed in the inhalation, soil and water assessments along with appropriate groups.

Table F-7 COPCs in the SLWRA

Chemical Category	Chemical Inventory	COPCs			
		Inhalation Assessment		Multiple Pathway	
		Acute	Chronic	Soil Assessment	Water Assessment
CACs	Carbon monoxide	Carbon monoxide	NA	NA	NA
	Nitrogen dioxide	Nitrogen dioxide	Nitrogen dioxide	NA	NA
	Sulphur dioxide	Sulphur dioxide	Sulphur dioxide	NA	NA
PAHs	2-Methylnaphthalene	NA	NA	F2 Fraction	F2 Fraction
	3-Methylcholanthrene	NA	NA	F3 Fraction	F3 Fraction
	7,12-Dimethylbenz(a) anthracene	NA	NA	F3 Fraction HMW PAH group	F3 Fraction
	Acenaphthene	NA	NA	Acenaphthene F2 Fraction LMW PAH group	F2 Fraction
	Acenaphthylene	NA	NA	F2 Fraction LMW PAH group	F2 Fraction
	Anthracene	NA	NA	Anthracene F2 Fraction LMW PAH group	F2 Fraction
	Benz(a)anthracene	NA	NA	Benz(a)anthracene F3 Fraction HMW PAH group	F3 Fraction
	Benzo(a)pyrene	NA	NA	Benzo(a)pyrene F3 Fraction HMW PAH group	F3 Fraction
	Benzo(b)fluoranthene	NA	NA	F3 Fraction HMW PAH group	F3 Fraction
	Benzo(g,h,i)perylene	NA	NA	F3 Fraction HMW PAH group	F3 Fraction
	Benzo(k)fluoranthene	NA	NA	Benzo(k)fluoranthene F3 Fraction HMW PAH group	F3 Fraction
	Chrysene	NA	NA	Chrysene F3 Fraction HMW PAH group	F3 Fraction
	Dibenz(a,h)anthracene	NA	NA	F3 Fraction HMW PAH group	F3 Fraction
	Fluoranthene	NA	NA	Fluoranthene F2 Fraction LMW PAH group	F2 Fraction

Chemical Category	Chemical Inventory	COPCs			
		Inhalation Assessment		Multiple Pathway	
		Acute	Chronic	Soil Assessment	Water Assessment
	Fluorene	NA	NA	Fluorene F2 Fraction LMW PAH group	F2 Fraction
	Indeno(1,2,3-cd)pyrene	NA	NA	F3 Fraction HMW PAH group	F3 Fraction
	Naphthalene	NA	NA	NA	NA
	Phenanthrene	NA	NA	Phenanthrene F2 Fraction LMW PAH group	F2 Fraction
	Pyrene	NA	NA	Pyrene F2 Fraction HMW PAH group	F2 Fraction
PHCs	C_5-C_8 Aliphatic	C_5-C_8 Aliphatic	C_5-C_8 Aliphatic	NA	NA
	C_9-C_{18} Aliphatic	—	NA	NA	NA
	C_9-C_{18} Aromatic	NA	NA	C_9-C_{18} Aromatic	C_9-C_{18} Aromatic
VOCs	1,3-Butadiene	NA	NA	NA	NA
	Acetaldehyde	Acetaldehyde	NA	NA	NA
	Acrolein	Acrolein	Acrolein	NA	NA
	Benzene	NA	NA	NA	NA
	Dichlorobenzene	NA	NA	NA	NA
	Formaldehyde	Formaldehyde	Formaldehyde	—	—
	n-Hexane	n-Hexane C_5-C_8 aliphatic	n-Hexane C_5-C_8 aliphatic	NA	NA
	n-Pentane	C_5-C_8 aliphatic	C_5-C_8 aliphatic	NA	NA
	Toluene	NA	Toluene	NA	NA
	Xylenes	NA	Xylenes	NA	NA
RSCs	Carbon disulphide	NA	NA	NA	NA
	Hydrogen sulphide	NA	NA	NA	NA

Notes:
NA = Not assessed. In the case for CACs and H_2S, chemicals were strictly related to inhalation exposure and therefore were not included in the soil or surface water assessment. For other chemicals (e.g., VOCs and PHC fractions) these chemicals did not screen-on in the multiple pathway screening process, and therefore were not assessed in the soil or surface water assessments.
— = No data available. A TRV, SQG or SWQG was not available.
F2 fraction includes sub fractions: aliphatic and aromatic C_{11}-C_{16} (CCME 2008)
F3 fraction includes sub fractions: aliphatic and aromatic C_{17}-C_{34} (CCME 2008)
LMW PAH group = Low Molecular Weight PAH includes all 2 and 3 ring PAHs (CCME 2008; US EPA 2007).
HMW PAH group = High Molecular Weight PAH includes all 4 or more ring PAHs (CCME 2008; US EPA 2007).

F3.1.2 Wildlife Receptor Identification

Wildlife species that frequent the area, including resident and migratory populations, could potentially be exposed to chemicals emitted from the Project. The Wildlife assessment (MEMS 2011a) identified many small (e.g., beaver) and large (e.g., moose) mammalian species as well as avian species (e.g., Cape May warbler) that use the LSA for habitat. For this SLWRA,

potential risks to wildlife species were not assessed for individual species, but instead, predicted concentrations of COPCs were compared to toxicity data and generic soil and water quality guidelines considered protective of all wildlife species.

F3.1.3 Environmental Media Identification

In order to assess potential risks to wildlife through multiple exposure pathways, potential changes in soil quality and surface water quality as a result of atmospheric deposition from air emissions were estimated in the SLWRA. COPCs were screened against soil quality guidelines and surface water quality guidelines for the protection of wildlife mammalian and avian species.

F3.1.4 Identification of Exposure Pathways

Although inhalation is generally considered to be a minor wildlife pathway (Environment Canada 1994; Suter II et al. 2000; US EPA OSW 2005), it was included in the SLWRA for the following reasons:

- The emissions from the Project will be emitted into the atmosphere
- Most emitted COPCs will be volatile, so the inhalation pathway would likely predominate over oral or dermal pathways for those chemicals.

For the inhalation assessment, the toxic potency screening was used to identify COPCs and the maximum predicted COPC concentrations in air for those COPCs were compared with the corresponding available inhalation mammalian and avian TRVs. It was assumed that if predicted COPC concentrations in air were below the available TRVs, air emissions associated with the Project would not pose a threat to local wildlife populations.

For the multiple pathway assessment, physical-chemical screening of the chemicals in the emissions inventory was used to identify COPCs. Ingestion was assumed to be the principal exposure pathway for the non-volatile COPCs that have the potential to accumulate in the terrestrial environment. After chemicals are deposited onto soils, they become incorporated into the upper profile of the soils and taken up by vegetation, remain deposited on vegetation, or sequestered into soils and soil dwelling organisms (i.e., potentially accumulate in wildlife foods). Ingestion exposures also included surface water consumption by wildlife for those chemicals that may potentially be deposited onto surface waters.

For the SLWRA, predicted soil concentrations were compared to AENV (2010) SQGs and to US EPA (2007) Ecological Soil Screening Levels (Eco-SSLs) for PAHs protective of ecological receptors. It was assumed that if predicted COPC concentrations in soil met the AENV SQGs and Eco-SSLs, corresponding wildlife food chain concentrations would not pose a risk to local wildlife populations.

Predicted surface water concentrations were compared to AENV (2010) SWQGs protective of wildlife species that ingest surface waters. It was assumed that if predicted COPC concentrations in surface water met the AENV SWQGs, risk to local wildlife populations would be minimal.

Wildlife receptors could potentially be exposed to COPCs through direct contact with environmental media. However, dermal exposure was not considered, as it is likely insignificant

relative to exposure received through food, soil and water ingestion (Suter II et al. 2000; US EPA OSW 2005).

F3.2 Exposure Assessment

Determination of potential exposures via inhalation and ingestion of COPCs relied on predictive exposure modelling with the exception of some concentrations of measured PAHs in the sample data for soil. The Project did not collect any baseline sample data and alternatively, soil data used in the SLWRA to characterize ambient concentrations of PAHs for the Project was based on the AOSC MacKay River Commercial (AOSC 2009) and Dover Commercial Project (DOC 2010) sampling programs. The MacKay River Commercial Project collected 36 soil samples and the Dover Commercial Project collected 24 soil samples for a total of 60 soil samples. Concentrations in soil were mostly non-detect at <0.01 to <1 mg/kg for soil. When available, the maximum measured concentration of a chemical in soil was used (refer to Table D.5-3-10 in the HHRA report for maximum measured concentrations). Measured data for COPCs in surface water were not available, and concentrations were predicted based on predicted air concentrations and deposition. Air concentrations were obtained for the largest pond near the Project site (pond SP16).

F3.2.1 Maximum Predicted Air, Soil, and Surface Water Concentrations

Inhalation exposure estimates were based on the results of air dispersion modelling described in the Air Quality assessment (MEMS 2011b). Maximum predicted 1-hour and annual average concentrations of COPCs were used for the assessment of acute and chronic inhalation assessment, respectively. Predicted chemical group air concentrations were estimated by summing the maximum predicted air concentrations for each of the constituent COPCs included in the chemical group.

The concentrations of COPCs in soil and surface water were predicted for the three assessment cases (Baseline Case, Application Case, and PDC). The soil and surface water concentrations were predicted using models that estimate the movement of the COPCs from the Project onto soil and surface water. Description of the model used for estimating soil and surface water concentrations are provided in Hatfield 2011.

F3.3 Toxicity Assessment

The toxicity assessment of the SLWRA resulted in identification of safe levels of COPC exposure for wildlife species. In the case of the inhalation assessment, both acute and chronic exposure durations were assessed and the safe level of exposure is referred to as a TRV for each COPC.

In the soil assessment, AENV SQGs and US EPA Eco-SSLs were considered protective of local wildlife populations exposed to the COPCs through the food chain. Similarly, AENV SWQGs were assumed to protect terrestrial and avian wildlife from health risks associated with the ingestion of surface waters.

F3.3.1 Inhalation Toxicity Reference Values

For the inhalation assessment, TRVs were required for the toxic potency screening in order to determine the toxic potential of the chemicals in the emissions inventory. The results of the

toxic potency screening narrowed the list of chemicals in the emissions inventory for a focused assessment of COPCs. The maximum predicted ground-level air concentrations for the COPCs determined from the toxic potency screening were compared to the TRVs for each of the COPC for all three assessment cases (i.e. Baseline, Application, and PDC). If maximum predicted ground-level air concentrations were equal to or lower than the TRVs, it was assumed that all wildlife receptors would be protected from adverse health effects associated with inhalation of the COPC.

Please see Table F-2 for acute inhalation TRVs and Table F-3 for chronic inhalation TRVs.

F3.3.2 Soil Quality Guidelines and Eco-SSLs for Wildlife

The AENV Tier 1 SQGs selected for the SLWRA were developed to be protective of wildlife for soil and food ingestion for the most stringent land use (i.e., agricultural or natural land use) (AENV 2010). The soil guidelines developed by AENV (2010) were calculated using models consistent with those developed for CCME (2006) protocols.

The US EPA Eco-SSLs refer to the concentration of a contaminant in soil that is considered protective of ecological receptors that come in contact with and/or consume biota that live in or on the soil (US EPA 2005). The US EPA uses a two-step approach to derive the Eco-SSLs. In the first step, TRVs were developed for a mammalian and avian receptor. In deriving the TRVs for the Eco-SSLs, the US EPA used a 'weight-of-evidence' approach and conducted comprehensive literature reviews of available toxicity data for avian or mammalian species.

The Eco-SSL approach calculated the geometric mean NOAEL of the growth and reproduction effect data to derive a TRV (US EPA 2005). The US EPA (2005) examined the geometric mean NOAEL in relationship with the lowest bounded LOAEL for reproduction, growth, and survival. If the geometric mean was higher than the lowest bounded LOAEL, then the highest bounded NOAEL below the lowest bounded LOAEL was selected as the TRV (US EPA 2005). In developing the mammal and avian TRVs, the US EPA OSW (1999) gave preference to the lowest chronic or subchronic NOAEL, followed by chronic or subchronic LOAEL. If neither was available, then acute median lethality point estimates or single dose toxicity values were used.

In the second step of the Eco-SSL approach, the US EPA back-calculated the Eco-SSLs (soil concentrations) for three surrogate mammalian or avian species based on the TRV derived in the first step and a wildlife exposure model. For the SLWRA, the lowest Eco-SSL provided of the three surrogate species was selected.

Eco-SSLs were only used for COPCs when Provincial or Federal guidelines were not available.

Table F-8 summarizes the SQGs used for the selected chemicals assessed in the soil assessment.

Table F-8 SQGs Protective of Wildlife

Chemical Category	COPC	SQG for Wildlife (mg/kg)		
		SQG[1]	Eco-SSL[2]	
			Avian	Mammalian
PAHs	3-Methylcholanthrene	–	–	–
	7,12-Dimethylbenz(a)anthracene	–	–	–

Chemical Category	COPC	SQG for Wildlife (mg/kg)		
		SQG[1]	Eco-SSL[2]	
			Avian	Mammalian
	Anthracene	61.5	—	—
	Benz(a)anthracene	6.2	—	—
	Benzo(a)pyrene	0.6	—	—
	Benzo(k)fluoranthene	6.2	—	—
	Chrysene	6.2	—	—
	Fluoranthene	15.4	—	—
	Fluorene	15.4	—	—
	Indeno(1,2,3-cd)pyrene	—	—	—
	Phenanthrene	43	—	—
	Pyrene	7.7	—	—
	HMW PAH group	—	—	1.1
	LMW PAH group	—	—	100
PHC	F1 Fraction	11,000	—	—
	F2 Fraction	9,800	—	—
	F3 Fraction	16,000	—	—
VOCs	Formaldehyde	—	—	—

Notes:
— = No SQG or Eco-SSL available
(1) Source: AENV 2010.
(2) Source: US EPA 2007.

F3.3.3 Surface Water Quality Guidelines for Wildlife

The AENV SWQGs selected for the SLWRA were developed to be protective of wildlife ingestion of surface water (AENV 2010). The surface water guidelines developed by AENV (2010) were calculated from published daily threshold exposure doses and ecological exposure parameters provided by AENV.

Table F-9 summarizes the SWQGs used for the C assessed in the water assessment.

Table F-9 SWQG Protective of Wildlife

Chemical Category	COPC	SWQG for Wildlife[1] (mg/L)
PAHs	3-Methylcholanthrene	—
	7,12-Dimethylbenz(a)anthracene	—
	Anthracene	—
	Benz(a)anthracene	—
	Benzo(a)pyrene	—
	Benzo(k)fluoranthene	—
	Chrysene	—
	Fluoranthene	—
	Fluorene	—
	Indeno(1,2,3-cd)pyrene	—
	Phenanthrene	—
	Pyrene	—

	HMW PAH group	–
	LMW PAH group	–
PHC	F1 Fraction	46.4
	F2 Fraction	42.6
	F3 Fraction	69.0
VOCs	Formaldehyde	–

Notes:
(1) Source: AENV 2010.

F3.4 Risk Characterization

F3.4.1 Inhalation Exposure Assessment

The risk characterization step of the SLWRA for inhalation exposure involved comparing maximum predicted COPC air concentrations for each of the assessment cases to wildlife inhalation TRVs.

Hazard quotient (HQ) values were calculated by dividing the predicted contaminant concentration in air by the available TRV, as indicated in the following equation:

$$\text{Inhalation Pathway HQ} = \frac{\text{Maximum Predicted Air Concentration } (\mu g/m^3)}{\text{TRV } (\mu g/m^3)}$$

Interpretation of the predicted HQ values was as follows:

- HQ ≤ 1: estimated maximum exposure is less than the associated TRV, indicating that risks to wildlife are negligible for the COPC.
- HQ >1: estimated maximum exposure is greater than the associated TRV, indicating that potential wildlife health effects may exist.

HQ values based on acute and chronic inhalation for the three assessment cases are presented in Table F-10 and Table F-11, respectively.

F3.4.2 Soil Assessment

A comparison of maximum predicted COPC soil concentrations to SQGs (AENV SQGs or EPA Eco-SSLs) is summarized in Table F-13.

Where maximum predicted soil concentrations did not exceed SQGs, it was assumed that potential risks to wildlife would be negligible. Where maximum predicted COPC concentrations exceed SQGs, it was assumed that potential wildlife health effects may exist and the potential health risks were discussed further.

F3.4.3 Water Assessment

A comparison of maximum predicted surface water COPC concentrations to SWQGs is presented in Table F-14.

It was assumed that potential risks to wildlife would be negligible where maximum predicted surface water COPC concentrations did not exceed SQGs. Where maximum predicted COPC concentrations exceed surface water quality guidelines, it was assumed that potential wildlife health effects may exist and the potential health risks were discussed further.

F4.0 RESULTS OF THE SCREENING LEVEL WILDLIFE RISK ASSESSMENT

Separate assessments were completed for the acute and chronic exposure estimates. In the chronic assessment, distinction was made between inhalation and soil/water ingestion exposures, as previously described.

In recognition of the influence of duration and pathway of exposure, results were segregated into:

- acute inhalation pathway
- chronic inhalation pathway
- chronic soil pathway
- chronic surface water pathway

The acute and chronic results are presented in scientific notation as many of the calculated numerical values were well below 1. For instance, the acute risk estimate for the mammalian receptor associated with exposure to the Baseline carbon monoxide air concentration is 1.3E-03, which is equivalent to an HQ of 0.0013 (see Table F-10). An explanation of the acute and chronic inhalation, as well as the soil and surface water assessments are provided in the following sections.

F4.1 Acute Inhalation Assessment

Acute inhalation risk estimates, expressed as HQ values, are based on an assumed exposure period that lasts from hours to days. The maximum predicted acute inhalation HQ values for all the receptor locations are provided in Table F-10 for the mammalian and avian wildlife receptors.

Table F-10 Maximum Acute Inhalation HQs for Wildlife

Chemical Category	COPC	HQ[1]		
		Baseline Case	Application Case	PDC
Mammalian[2]				
CACs	Carbon monoxide	1.3E-03	1.3E-03	1.4E-03
	Nitrogen dioxide	4.1E-03	4.1E-03	3.3E-03
	Sulphur dioxide	2.2E-04	2.2E-04	2.2E-04
PHCs	C_5-C_8 Aliphatic	2.4E-04	2.4E-04	4.4E-04
VOCs	Acetaldehyde	6.7E-06	6.7E-06	7.1E-06
	Acrolein	8.8E-05	8.8E-05	1.1E-04
	Formaldehyde	2.4E-05	2.4E-05	3.2E-05
	n-Hexane	2.6E-06	2.6E-06	2.6E-06
Avian[3]				
CACs	Carbon monoxide	1.8E-03	1.8E-03	1.9E-03

Chemical Category	COPC	HQ[1]		
		Baseline Case	Application Case	PDC
	Sulphur dioxide	2.2E-04	2.2E-04	2.2E-04
PHCs	C_5-C_8 Aliphatic	1.7E-04	1.7E-04	3.2E-04
VOCs	n-Hexane	1.3E-05	1.3E-05	1.1E-05

Notes:
(1) An HQ equal to or less than 1 signifies that the estimated exposure is equal to or less than the TRV and no health effects are expected. With scientific notation, any value expressed to the negative power (i.e., E-x) shows that predicted exposures were less than the TRV; whereas, a value expressed to the positive power (i.e., E+x) shows exposure estimates exceeded the TRV.
(2) Based on maximum predicted 1-hour or 24-hour ground-level air concentrations and acute mammalian TRVs (Table F-2).
(3) Based on maximum predicted 1-hour or 24-hour ground-level air concentrations and acute avian TRVs (Table F-2). Acute avian TRVs were only available for carbon monoxide, sulphur dioxide, C_5-C_8 aliphatic, and n-hexane.

All predicted acute HQ values for all cases were well below 1 (i.e., predicted exposures were much less than the assumed TRVs) for both mammalian and avian receptors. Thus, it was concluded that predicted acute exposures would not have an adverse effect on either avian or mammalian wildlife in the region.

F4.2 Chronic Inhalation Assessment

The chronic inhalation assessment evaluates the potential health risks associated with continuous exposure to predicted maximum annual average air concentrations. The maximum predicted chronic inhalation HQ values are provided in Table F-11 for the mammalian and avian wildlife receptors.

Table F-11 Chronic Inhalation HQs for Wildlife

Chemical Category	COPC	HQ[1]		
		Baseline Case	Application Case	PDC
Mammalian[2]				
CACs	Nitrogen dioxide	**1.2E+00**	**1.2E+00**	**1.2E+00**
	Sulphur dioxide	2.4E-03	2.4E-03	2.9E-03
PHCs	C_5-C_8 Aliphatic	3.6E-05	3.6E-05	4.5E-05
VOCs	Acrolein	9.1E-05	9.1E-05	1.6E-04
	Formaldehyde	2.3E-04	2.3E-04	4.2E-04
	n-Hexane	7.6E-06	7.6E-06	5.6E-06
	Toluene	1.0E-04	1.0E-04	3.1E-04
	Xylenes	3.5E-05	3.5E-05	1.6E-04
Avian[3]				
PHCs	C_5-C_8 Aliphatic	1.9E-03	1.9E-03	2.4E-03
VOCs	n-Hexane	1.3E-04	1.3E-04	9.4E-05

(1) An HQ equal to or less than 1 signifies that the estimated exposure is equal to or less than the TRV and no health effects are expected. With scientific notation, any value expressed to the negative power (i.e., E-x) shows that predicted exposures were less than the TRV; whereas, a value expressed to the positive power (i.e., E+x) shows exposure estimates exceeded the TRV
(2) Based on maximum predicted annual ground-level air concentrations and chronic mammalian TRVs (Table F-3)
(3) Based on maximum predicted annual ground-level air concentrations and chronic inhalation avian TRVs (Table F-3)
Bold values represent exceedances

With the exception of NO_2 for mammalian wildlife, predicted chronic inhalation HQ values did not exceed 1 (i.e., predicted exposures were less than the exposure limits) for all of the assessment cases (i.e., Baseline Case, Application Case and PDC) for mammalian and avian wildlife receptors. Table F-12 presents the maximum predicted NO_2 HQ values for the receptor locations in each assessment case.

Table F-12 NO_2 HQs Predicted for the Mammalian Wildlife Receptor on a Chronic Inhalation Basis for all Receptor Locations

Receptor ID	Baseline Case	Application Case	PDC
FL-MPOI	5.4E-01	6.0E-01	6.4E-01
L-MPOI	**1.1E+00**	**1.1E+00**	**1.1E+00**
R1	4.3E-01	4.3E-01	5.2E-01
R2	6.4E-01	6.4E-01	7.2E-01
R3	6.3E-01	6.3E-01	7.0E-01
R4	5.8E-01	5.8E-01	6.4E-01
R5	4.5E-01	4.8E-01	5.4E-01
R6	6.8E-01	6.9E-01	7.3E-01
R7	7.4E-01	7.4E-01	7.8E-01
R8	6.6E-01	6.6E-01	7.0E-01
R9	8.8E-01	8.8E-01	9.8E-01
R10	**1.2E+00**	**1.2E+00**	**1.2E+00**

HQ values for chronic inhalation exposure to NO_2 in mammals were predicted to be greater than 1 under all assessment cases (i.e., Baseline Case, Application Case, and PDC) at the local maximum point of impact (L-MPOI) and at R10 (Fort McKay). The resulting HQ value predicted for the local MPOI was 1.1 and for R10, 1.2 under all assessment cases for both locations. All other locations predicted HQs of less than 1.0.

The lack of increase between the Baseline Case and the Application Case for the local MPOI and for R10, indicates that the Project is not a significant contributor to the annual NO_2 concentrations.

Interpretation of the exceedances should consider the following factors:

- The use of a NOAEL of 0.10 mg/m³ to derive the TRV used for NO_2 is highly conservative. A LOAEL of 1 mg/m³ (is 10 times higher than the NOAEL) was also identified from the same study (Tabacova et al. 1985). Comparison of the highest NO_2 concentration predicted, occurring at R10, of 31 µg/m³ to the LOAEL based TRV of 250 µg/m³ indicates that adverse effects are not likely, as the predicted maximum concentration is well below the LOAEL based TRV.
- The exceedances of the NO_2 HQ were predicted in the Baseline Case, indicating that NO_2 concentrations may be occurring in the ambient air. The predicted maximum Baseline Case NO_2 concentration occurring at R10 (31 µg/m³) is within the range of measured concentrations in the oil sands region. Measured ambient NO_2 concentrations within the oil sands region between the years 2000 to 2009 show annual averages between 10 µg/m³ and 35 µg/m³ (CASA 2011). The NO_2 ambient air data were characterized using continuously

monitored and measured hourly NO_2 air concentrations from air monitoring stations in the oil sands region (CASA 2011). The air monitoring stations (AMS) used to characterize the ambient NO_2 air concentrations include: AMS 1, AMS 6, AMS 7, AMS 12, AMS 13, and AMS 15. The highest annual average concentration of 35 µg/m³ was observed at AMS 12, which is situated close to a mine operation where mine processes in the vicinity are likely to be significant sources of NO_2 emissions. The 2009 annual average concentration for AMS 1 (Fort McKay) is 15 µg/m³.

- The exceedances of NO_2 are not expected to represent a true risk to wildlife in the Project area, since the HQ values were conservatively based on the predicted maximum annual NO_2 concentrations. Actual inhalation exposure to wildlife in the region would be expected to be lower than the maximum predicted values as animals move around within their home range.
- Alberta's Ambient Air Quality Objective (AAAQO) for NO_2 is 45 µg/m³ (AENV 2011a). The TRV used for NO_2 in the SLWRA was 25 µg/m³, which is a conservative value compared to the AAAQO. The maximum predicted NO_2 concentration for the region was 31 µg/m³. This maximum predicted concentration of NO_2 does not exceed the AAAQO of 45 µg/m³.

The overall conclusion of the chronic inhalation assessment is that the predicted maximum annual average air concentrations for all COPCs would pose negligible to low inhalation health risks to mammalian and avian wildlife in the region.

F4.3 Chronic Soil Assessment

Chronic risk estimates associated with ingestion exposure pathways were based on comparison of predicted maximum soil concentrations to relevant SQGs, as identified previously. All predicted soil concentrations were below their respective SQGs for all COPCs, and therefore it was concluded that predicted long-term soil concentrations would not adversely impact terrestrial wildlife populations in the study area.

A comparison of maximum predicted soil concentrations and SQGs is provided in Table F-13 for mammalian and avian wildlife receptors.

Table F-13 Comparison of Predicted Soil Concentrations with SQG Protective of Wildlife [mg/kg]

COPCs	Baseline	Application	PDC	AENV SQG[1]	US EPA Eco-SSL[2]	
				Wildlife	Mammalian	Avian
PAHs						
7,12-Dimethylbenz(a)anthracene	4.7E-05	4.7E-05	5.0E-05	—	—	—
Acenaphthene	1.3E-07	1.3E-07	2.2E-07	2.2E+01	—	—
Acenaphthylene	3.2E-06	3.2E-06	5.7E-06	—	—	—
Anthracene	1.9E-06	1.9E-06	3.4E-06	6.2E+01	—	—
Benzo(a)anthracene	1.5E-04	1.5E-04	2.6E-04	6.2E+00	—	—
Benzo(a)pyrene	1.4E-04	1.4E-04	2.6E-04	6.0E-01	—	—
Benzo(b)fluoranthene	1.4E-05	1.4E-05	2.5E-05	—	—	—
Benzo(g,h,i)perylene	1.7E-04	1.7E-04	3.1E-04	—	—	—
Benzo(k)fluoranthene	2.8E-04	2.8E-04	5.0E-04	6.2E+00	—	—
Chrysene	4.9E-04	4.9E-04	8.8E-04	6.2E+00	—	—
Dibenz(a,h)anthracene	6.7E-05	6.7E-05	4.9E-05	—	—	—
Fluoranthene	3.6E-05	3.6E-05	6.4E-05	1.5E+01	—	—
Fluorene	4.0E-02	4.0E-02	4.0E-02	1.5E+01	—	—
Indeno(1,2,3-cd)pyrene	4.3E-05	4.3E-05	3.2E-05	—	—	—
Phenanthrene	1.1E-01	1.1E-01	1.1E-01	4.3E+01	—	—
Pyrene	4.7E-05	4.7E-05	8.4E-05	7.7E+00	—	—
LMW PAH group[3]	1.5E-01	1.5E-01	1.5E-01	—	1.0E+02	—
HMW PAH group[4]	1.2E-03	1.2E-03	2.0E-03	—	1.1E+00	—
PHCs						
C9-C18 aromatics	2.5E-04	2.5E-04	4.7E-04	—	—	—
F2 Fraction[5]	1.9E-01	1.9E-01	1.9E-01	9.8E+03	—	—
F3 Fraction[6]	1.4E-03	1.4E-03	2.4E-03	1.6E+04	—	—
VOCs						
2-methylnaphthalene	4.0E-02	4.0E-02	4.0E-02	—	—	—
3-methylcholanthrene	1.6E-05	1.6E-05	1.7E-05	—	—	—
Formaldehyde	1.3E-08	1.3E-08	2.3E-08	—	—	—

Notes:
— = soil quality guideline not available
(1) AENV SQGs are referenced from AENV (2010) Surface Soil Remediation Guideline Values for Natural Area Land Use - Wildlife Soil and Food Ingestion (Table A-1)
(2) US EPA Eco-SSLs are referenced from US EPA (2007) PAH Eco-SSLs (Table 2.1)
(3) LMW PAH includes all 2 and 3 ring PAHs (CCME 2008; US EPA 2007)
(4) HMW PAH includes all PAHs with 4 or more rings (CCME 2008; US EPA 2007)
(5) F2 Fraction is composed of C_{11}-C_{16} aromatics and aliphatics (CCME 2008). Chemical constituents of this group consists of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, phenanthrene, and pyrene
(6) F3 Fraction is composed of C_{17}-C_{34} aromatics and aliphatics (CCME 2008). Chemical constituents of this group consists of 3-methylcholanthrene, 7,12-dimethylbenz(a)anthracene,benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene

F4.4 Chronic Surface Water Assessment

Chronic risk estimates associated with surface water ingestion exposure pathways were based on comparison of predicted maximum surface water concentrations to relevant SWQGs, as identified previously. All predicted surface water concentrations were below their respective guidelines for Baseline, Application, and PDC, therefore, it was concluded that predicted long-term surface water concentrations would not adversely impact terrestrial wildlife populations in the region.

A comparison of maximum predicted surface water concentrations and SWQGs for wildlife is provided in Table F-14 for wildlife receptors.

Table F-14 Comparison of Predicted Surface Water Concentrations with Water Quality Guidelines Protective of Wildlife [mg/L]

Chemical	Baseline	Application	PDC	AENV SWQG for Wildlife[(1)]
PAHs				
7,12-Dimethylbenz(a)anthracene	4.0E-08	4.1E-08	4.3E-08	–
Acenaphthene	2.3E-07	2.3E-07	4.0E-07	–
Acenaphthylene	4.3E-06	4.3E-06	7.8E-06	–
Anthracene	2.9E-07	2.9E-07	5.1E-07	–
Benzo(a)anthracene	4.1E-07	4.1E-07	7.1E-07	–
Benzo(a)pyrene	8.3E-08	8.3E-08	1.5E-07	–
Benzo(b)fluoranthene	1.3E-07	1.3E-07	2.2E-07	–
Benzo(g,h,i)perylene	8.5E-08	8.5E-08	1.5E-07	–
Benzo(k)fluoranthene	4.2E-08	4.2E-08	7.4E-08	–
Chrysene	2.5E-07	2.5E-07	4.5E-07	–
Dibenz(a,h)anthracene	1.9E-08	1.9E-08	1.4E-08	–
Fluoranthene	4.4E-07	4.4E-07	7.8E-07	–
Fluorene	7.0E-07	7.0E-07	1.0E-06	–
Indeno(1,2,3-cd)pyrene	1.6E-08	1.6E-08	1.2E-08	–
Phenanthrene	1.8E-06	1.8E-06	3.2E-06	–
Pyrene	5.2E-07	5.2E-07	9.2E-07	–
PHCs				
C_9-C_{18} aromatics	5.2E-03	5.2E-03	9.7E-03	42.6
F2 Fraction[(2)]	1.1E-05	1.1E-05	1.9E-05	42.6
F3 Fraction[(3)]	1.1E-06	1.1E-06	1.8E-06	69
VOCs				
2-methylnaphthalene	2.5E-06	2.5E-06	4.4E-06	–
3-methylcholanthrene	4.5E-09	4.5E-09	4.8E-09	–
Formaldehyde	2.1E-04	2.1E-04	3.8E-04	–

Notes:
- = Surface water quality guideline not available

(1) AENV SWQGs are referenced from AENV (2010) Surface Water Quality Guidelines for Wildlife Water (Table C-11)
(2) F2 Fraction is composed of C11-C16 aromatics and aliphatics (CCME 2008).
(3) F3 Fraction is composed of C17-C34 aromatics and aliphatics (CCME 2008).

F4.5 Conservative Assumptions in the SLWRA

- Conservative assumptions applied to the SLWRA include:
- Wildlife receptors were assumed to be exposed to maximum predicted 1-hour or 24-hour (acute) air concentrations and continuously exposed to maximum predicted annual average (chronic) air concentrations for the region.
- Wildlife receptors were assumed to be exposed to maximum predicted air concentrations for the entire duration of their lifetime; in actuality, most wildlife species move around within their home ranges or migrate, etc., meaning that they will not be continuously exposed to maximum predicted air concentrations over their entire lifetimes.
- Soil concentration calculations did not include certain known chemical loss mechanisms (i.e., soil erosion and leaching).
- The operating life of the Project is not expected to extend beyond 30 years, but 80 years of deposition was assumed (as was done in the HHRA in consideration of potential cumulative impacts).
- Acute inhalation TRVs were developed using the lowest LC_{50} values available.
- Chronic inhalation TRVs were developed using NOAELs selected for the most sensitive species and through the application of uncertainty factors.

F4.6 Conclusions

On both an acute and chronic basis, maximum predicted air concentrations did not exceed TRVs protective of avian and mammalian wildlife with the exception of NO_2 on a chronic basis for mammals.

Chronic inhalation HQs of 1.2 were predicted for NO_2 for Baseline, Application, and PDC. The predicted exceedances are attributable to the conservative assumptions incorporated in the SLWRA, including the use of a conservative TRV and the maximum predicted annual NO_2 air concentrations. It was concluded that potential inhalation health risks are negligible to low under these circumstances.

Maximum predicted long-term soil concentrations did not exceed regulatory-based SQGs and Eco-SSLs protective of wildlife.

Similarly, maximum predicted long-term surface water concentrations did not exceed regulatory-based SWQGs protective of wildlife. Thus, predicted surface water concentrations are not anticipated to result in adverse effects to terrestrial wildlife populations in the region.

The results of the SLWRA indicate that the overall risks posed to wildlife health will be negligible. Therefore, no impacts to wildlife populations are expected based on estimated wildlife exposures to predicted maximum acute and chronic air concentrations and predicted maximum soil and surface water concentrations. The confidence in the prediction is high since highly conservative assumptions were applied in the SLWRA.

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F6.0 ABBREVIATIONS FOR SLWRA

µg ..... microgram
AAAQO ..... Alberta's Ambient Air Quality Objective
ACGIH ..... American Conference of Governmental Industrial Hygienists
AENV ..... Alberta Environment
AOSC ..... Athabasca Oil Sands Corportation
ATSDR ..... Agency for Toxic Substances and Disease Registry
BC MWLAP ..... British Columbia Ministry of Water, Land and Air Protection
CAC ..... criteria air contaminants
CASA ..... Clean Air Strategic Alliance
CCME ..... Canadian Council of Ministers of the Environment
CICAD ..... Concise International Chemical Assessment Document
CO ..... carbon monoxide
COPC or COPCs ..... chemical(s) of potential concern
CS_2 ..... carbon disulphide
DOC ..... Dover Operating Corporation
DQRA ..... detailed quantitative risk assessment
e.g. ..... Latin, for example
EC, EC_{20} ..... effective concentration (i.e. 20% of the population is effected)
Eco-SSL ..... ecological soil screening level
EIA ..... environmental impact assessment
ERA ..... ecological risk assessment
etc. ..... Latin, and others
H_2S ..... hydrogen sulphide
HHRA ..... human health risk assessment
HMW ..... high molecular weight
HQ ..... hazard quotient
HSDB ..... Hazardous Substances Data Bank
i.e. ..... Latin, such as (that is)
IPCS ..... International Programme on Chemical Safety
kg ..... kilogram
km ..... kilometre
LC, LC_{20}, LC_{50} ..... lethal concentration (i.e. where 20, 50% of the population is effected)
LC_{LO} ..... lowest published lethal concentration
LMW ..... low molecular weight
LOAEL ..... lowest-observed-adverse-effect level
LSA ..... local study area
m^3 ..... metres cubed
MA DEP ..... Massachusetts Department of Environmental Protection
MEMS ..... Millennium EMS Solutions Ltd.
mg ..... milligram
MPOI ..... maximum point of impingement
NA ..... not assessed
NO_2 ..... nitrogen dioxide
NOAEL ..... no-observed-adverse-effect level
NTP ..... National Toxicity Program
OEHHA ..... California Office of Environmental Health Hazard Assessment
OMOE ..... Ontario Ministry of the Environment
PAH ..... polycyclic aromatic hydrocarbons
PDC ..... planned development case

PHC ..... Petroleum Hydrocarbon
$PM_{2.5}$ ..... particulate matter less than 2.5 µm in diameter
ppm ..... parts per million
PQRA ..... preliminary quantitative risk assessment
RIVM ..... Netherlands National Institute of Public Health and the Environment
RSA ..... regional study area
RSC ..... reduced sulphur compounds
SLWRA ..... screening level wildlife risk assessment
SO_2 ..... sulphur dioxide
SQG ..... soil quality guideline
STP ..... Southern Pacific Resource Corp. McKay Thermal Project
SWQG ..... surface water quality guideline
t/d ..... tonnes per day
TOR ..... terms of reference
TOXLINE ..... National Library of Medicine's Toxicology Literature Online
TPHCWG ..... Total Petroleum Hydrocarbon Criteria Working Group
TRV ..... toxicological reference values
US EPA OSW ..... United States Environmental Protection Agency Office of Solid Waste
US EPA ..... United States Environmental Protection Agency
VOCs ..... volatile organic compounds
WHO ..... World Health Organization

APPENDIX G

STP McKay Thermal Project - Phase 2
Focused Human Health Risk Assessment Work Plan

SCIENCE INTEGRITY KNOWLEDGE

SOUTHERN PACIFIC RESOURCE CORP.
STP MCKAY THERMAL PROJECT – PHASE 2
FOCUSED HUMAN HEALTH RISK ASSESSMENT
WORK PLAN

FINAL REPORT

June 2011

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SOUTHERN PACIFIC MCKAY THERMAL PROJECT FOCUSED HUMAN HEALTH RISK ASSESSMENT WORK PLAN

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Attachment B Study Area Figures and Receptors for Historical EIAs

Attachment C Chemicals of Potential Concern (COPC) Identified for the Historical Human Health Risk Assessments

SOUTHERN PACIFIC MCKAY THERMAL PROJECT FOCUSED HUMAN HEALTH RISK ASSESSMENT WORK PLAN

1.0 INTRODUCTION

The primary objective of the human health risk assessment (HHRA) will be to describe the nature and significance of potential health risks to humans from chemical emissions originating from the proposed Southern Pacific Resource Corp. (STP) McKay Thermal Project – Phase 2. In addition, the HHRA will examine potential health risks associated with the environmental conditions that would exist prior to development of the Project, as well as the environmental conditions that would exist as a result of the Project in combination with other planned activities for the region.

STP currently has approval to construct and operate a 12,000 bpd facility known as the STP McKay Thermal Project – Phase 1 which is located approximately 45 km north west of Fort McMurray, Alberta. By the end of 2011, STP intends to file an application for a 24,000 bpd facility located immediately east of the Phase 1 facility (Figure 1). The STP McKay Thermal Project – Phase 2 is located in close proximity to the following three steam assisted gravity drainage (SAGD) projects:

- Petro-Canada or Suncor MacKay River Expansion Project (Petro-Canada 2007);
- Proposed AOSC MacKay River Commercial Project (AOSC 2009); and
- Proposed Dover Commercial Project (DOC 2010).

The STP McKay Thermal Project will utilize similar well-established in situ technology currently proposed for the Dover and AOSC commercial facilities, and approved for the Suncor MacKay River Expansion facility.

As part of the regulatory approval process for the MacKay and Dover projects, a comprehensive HHRA examining the potential human health risks associated with chemical emissions from each of the projects was completed. The approach used in the assessments was consistent with those developed by Health Canada, the U.S. National Research Council (US NRC), and the U.S. Environmental Protection Agency (US EPA). This approach has been endorsed by Alberta Environment (AENV), Alberta Health and Wellness (AHW), and the Energy Resources Conservation Board (ERCB).

The guidance document for scoping a focused HHRA is provided in Attachment A. In order to determine if the STP McKay Thermal Project is suitable for a focused HHRA (i.e., reduced scope of work) a number of criteria or conditions must be met:

- First, a historical Environmental Impact Assessment (EIA) that is “relevant” to the STP McKay Thermal Project must be available. The suitability of the historical EIA would be determined, in part, through consultation with AHW. It is important to note that AHW refers to historical EIAs as those that have been deemed complete within the last five years, indicating that AHW has no outstanding concerns associated with the planned project. However, EIAs not yet deemed complete, such as the AOSC MacKay River or Dover Commercial Projects, may still be utilized pending AHW approval.

- Second, the historical EIA must contain a Baseline Case, Application Case and Planned Development Case (PDC) that encompass a similar regional study area (RSA) and/or air quality modelling domain to that of the STP McKay Thermal Project.
- Third, the historical EIA must contain an HHRA for an in situ project with similar design characteristics that can be used as a "framework" for the focused HHRA.
- Fourth, "adequate" environmental baseline data for the region must be available and relevant to the STP McKay Thermal Project. Environmental data may be obtained from either within or outside an EIA; however, the relevance of any environmental baseline data obtained from outside an EIA to the STP McKay Thermal Project must be justified in order to receive the endorsement of AHW to proceed to a focused HHRA.

Intrinsik and Southern Pacific Resource Corp believe that the STP McKay Thermal Project meets the conditions and criteria to proceed to a focused HHRA. This work plan recommends the scope of work for the focused HHRA and provides the necessary information based on the pre-screening exercise to determine that the STP McKay Thermal Project would qualify for a focused HHRA.

2.0 PROPOSED WORPLAN FOR THE STP MCKAY THERMAL PROJECT HHRA

The work plan for the STP McKay Thermal Project HHRA was submitted to Alberta Health and Wellness (AHW) on May 13th 2011 and a meeting was held on June 2nd 2011 with AHW to discuss the approach. This work plan incorporates comments from AHW and the changes are highlighted in "yellow" for clarification and transparency.

The work plan for the STP McKay Thermal Project HHRA proposes to follow the methods prescribed in the HHRA for the Dover and AOSC commercial project, including the approved for the Suncor MacKay River Expansion facility. The HHRA for the STP McKay Thermal Project will not be based on the air quality results of the historical EIAs, rather the HHRA will be based on the air quality assessment conducted for the EIA as defined in the projects terms of reference supplied by Alberta Environment. The historical EIAs and their supplemental information will, however, be reviewed to ensure that all necessary data has been presented in the STP McKay Thermal Project HHRA. The following modifications are proposed for the focused HHRA:

- Study area for the HHRA will be reduced to a LSA/RSA that is approximately 50 by 50 km (approximate radius of 25 km) centred on the STP McKay Thermal Project;
- HHRA will include receptors identified in the LSA only; and
- COPC list included in the HHRA will be reduced based on toxic potency screening for the inhalation assessment and physical/chemical screening for the multiple pathway exposure assessment.
- Findings and conclusions of the historical EIAs and known First Nation concerns in the area will be used to focus the HHRA.

2.1 Study Area

Alberta Environment suggests that the study area includes measurable effects of the Project alone and in combination with other activities. At and beyond the project study area boundary, the anticipated environmental conditions should be similar with and without the Project. The predicted ground-level concentrations (from the project) need to be about 10% of the ambient air quality objectives or equal to a background value, whichever is higher, at the boundary of the model domain (AENV 2009). For this project, it is anticipated that an area of 50 by 50 km is sufficient to capture more than 90% of the ground level concentrations predicted from the STP McKay Thermal Project. However, the actual dimensions of the LSA will be defined by Air Quality modelling based on predicted concentrations of Project Alone surrogate COPCs. For example, NO_2 could provide a surrogate for criteria air contaminants (CAC), benzene for volatile organic compounds (VOC) and particulate matter for polycyclic aromatic hydrocarbons (PAH). In all circumstances the air quality assessment will determine the potential radius of impact for COPC in the emission profile.

The emission profile for the STP McKay Thermal Project will primarily consist of COPC derived from natural gas combustion and fugitive emissions. The emission profile is typical of a SAGD operation with COPC from various chemical groups; such as, CAC, VOC and PAH. Mine fleet emissions will not be considered as part of defining the study area for the HHRA since there is no mine fleet associated with the Project.

2.2 Receptors of Concern

Table 2-1 below provides a summary of the proposed receptor locations within the LSA for the STP McKay Thermal Project. These receptor locations were derived from the AOSC MacKay River Commercial Project since no other receptor locations between the Suncor MacKay River Expansion and Dover Commercial Project are found with a 25 km radius of the STP McKay Thermal Project. A comprehensive traditional land use assessment will be conducted as part of the STP McKay Thermal Project EIA to determine if receptor locations should be added or refined within the LSA. In addition, to the list of receptor locations provided in Table 2-1, the HHRA will include a maximum point of impingement (MPOI) for each COPC and assessment case. Finally, recent HHRAs for SAGD applications have also considered worker camps as receptors of concern. This receptor group will also be considered as part of the focused HHRA.

Outside the LSA the HHRA does not anticipate that other communities (i.e., Fort McKay and Fort McMurray) or recreational areas will be identified as receptor locations since the receptors are too far away from the proposed STP McKay Thermal Project to be materially influenced by the Project emissions. However; additional receptor locations (e.g., communities or recreational areas) will be addressed accordingly in the HHRA if they are identified through the public consultation process.

Table 2-1 Proposed Receptor Locations within the LSA for the STP McKay Thermal Project

Receptor ID	*UTM East (km)*	*UTM North (km)*	*Description*
1	428.998	6286.480	Kelley McNeilly Cabin
2	454.523	6293.667	Damon and Sharon Wright
3	450.384	6294.595	Pliska Cabin A
4	444.471	6293.169	Pliska Cabin B
5	422.046	6300.401	Pliska Cabin C
6	441.048	6316.020	Powder Cabin A
7	447.034	6316.045	MacDonald Cabin B
8	441.243	6313.727	Powder Cabin B

2.3 COPC Screening

All of the COPC emitted to air from the Project will be evaluated with toxic potency screening to determine which COPC would most likely pose a potential health hazard and contribute the majority of the total toxic potential of the air emissions. A number of screening methods can be used to narrow a list of chemicals for further analysis. These include:

- relative toxic potency determinations using emission rates and exposure limits;
- identifying COPC viewed as a concern by regulatory authorities for the oil sands region; and
- identifying COPC that have been identified as a potential concern in previous HHRAs.

The screening will primarily be based on relative toxic potency determinations using emission rates and exposure limits. Subsequent to this quantitative method of screening (described below), the more qualitative screening methods listed above were considered to ensure that a complete list of COPC are obtained.

The quantitative screening process was based on two primary considerations:

- the potential toxicity of each chemical on an acute and chronic basis; and,
- the potential for exposure to each chemical.

Potential exposure was based on the estimated emission rates for each chemical from the proposed STP McKay Thermal project. The potential toxicity of each chemical will be represented by acute and chronic exposure limits developed by recognized regulatory agencies such as Health Canada and the US EPA (U.S. Environmental Protection Agency). The relative toxic potency of each chemical is calculated by dividing the emission rate by its chronic exposure limit and determining the relative contribution of each chemical to the total toxic potential (sum of individual toxic potentials). When combined, those chemicals that contributed 99% to the overall toxic potency will be included as COPC to be evaluated in the HHRA. COPC can be defined as the chemicals likely to contribute to the majority of the total toxic potential of the air emissions.

Certain COPC that may deposit to the surrounding terrestrial environment and possibly persist or accumulate in the environment will be identified. Humans may be exposed to these COPC via secondary pathways - soil, food and water.

For this purpose, the list of COPC will be divided into two groups as follow:

- Gaseous COPC (e.g., CO, H_2S, NO_2 and SO_2), are not likely to contribute to human exposure via non-inhalation pathways. In addition, the health effects of these gaseous COPC are strictly related to inhalation (i.e., at the point of contact).
- Non-gaseous COPC (e.g., polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and some petroleum hydrocarbon fractions) may deposit in the vicinity of the STP McKay Thermal Project and persist or accumulate in the environment in sufficient quantities for humans to be exposed via soil, food and water pathways.

To identify non-gaseous COPC that could persist or accumulate in the terrestrial environment, consideration was given to the inherent physical/chemical properties of each COPC that would influence its fate and persistence in the environment, and subsequently its potential presence in secondary pathways of exposure. This was accomplished by comparing the physical/chemical properties of the chemicals (i.e., molecular weight, vapour pressure, and Henry's Law constant) against pre-established criteria to identify those substances that could deposit from the air onto nearby lands and/or surface waters.

The screening criteria used to define whether a chemical is non-volatile, and therefore exhibits the potential to persist in environmental media other than air, are defined by the US EPA and California EPA (US EPA 2003).

The US EPA defines a non-volatile chemical as one that meets both of the following criteria:

- Molecular weight > 200 g/mol,
- Henry's Law Constant $<1.0 \times 10^{-5}$ atm-m^3/mol.

The California EPA defines a non volatile chemical as one that has both the following properties:

- Vapour pressure $< 1.0 \times 10^{-3}$ mm Hg,
- Henry's Law Constant $<1.0 \times 10^{-5}$ atm-m^3/mol.

In addition to the above physical/chemical screening criteria, US EPA (2003) also indicates that chemicals with log K_{ow} values greater than 3.5 are more likely to be taken up and bioaccumulated in plant and animal tissues. However, no specific guidance is provided to indicate if K_{ow} should or should not be used to define whether a chemical is non-volatile. Therefore, in addition to using K_{ow} for COPC screening, the focused HHRA will use fugacity modelling to identify which COPC with log K_{ow} values greater than 3.5 should be considered in the multiple pathway exposure assessment.

Fugacity modelling can be used identify and prioritize environmental compartments that are expected to contain most of the substance of interest. Compartments considered relevant are those for which more than 5% by mass is forecast by modelling (Boethling et al. 2009). Therefore, a COPC will be considered in the multiple pathway assessment if the following are identified:

- Log K_{ow} > 3.5 and
- Fugacity modelling show <95% of COPC in the air compartment. In other words, >5% of the COPC partitions to soil, water and or sediment.

The focused HHRA will use toxic potency screening to determine which chemicals in the emission inventory would most likely pose a potential health hazard via direct exposure (i.e., inhalation) and use physical/chemical screening to determine which chemicals in the emission inventory would most likely pose a potential health hazard via secondary pathways (i.e., ingestion).

3.0 HISTORICAL PROJECTS

Petro-Canada (currently Suncor) - MacKay River Expansion Project
Petro-Canada (currently Suncor) applied to the Alberta Energy and Utilities Board (EUB) and Alberta Environment (AENV) for approval to expand the MacKay River Expansion Project on its Oil Sands Development Leases located in Townships 92 and 93, Range 12 W4M, in the area southwest of Fort MacKay, Alberta and northwest of Fort McMurray, Alberta (Figure 1 and Attachment B). The project site is located about 10 km north of the MacKay River and 25 km southwest of Fort MacKay. This project is based on steam assisted gravity drainage (SAGD) thermal technology. The MacKay River Expansion would include:

- construction, operation and reclamation of a new central processing facility consisting of steam generation, cogeneration, water treatment and bitumen handling facilities,
- production of an additional 6,360 cubic metres per day (m^3/d) (40,000 barrels per day (bpd)) of bitumen for a project total of 11,600 m^3/d (73,000 bpd), and
- relocation of 17 approved pads and the addition of four new pads.

The EIA submitted to the ERCB and AENV in support of the application for approval of the MacKay River Expansion Project is a suitable candidate for the historical EIA supporting the focused HHRA for the STP McKay Thermal Project (Figure 1 and Attachment B), as it meets both the timeline and completion requirements outlined by AHW. The MacKay River Expansion was filed on November, 2005 and deemed complete in 2008.

Athabasca Oil Sands Corporation (AOSC) - MacKay River Commercial Project
In December 2009, Athabasca Oil Sands Corporation (AOSC) submitted a regulatory application for the MacKay River Commercial Project to the ERCB and AENV (Figure 1 and Attachment B). This project is based on steam assisted gravity drainage (SAGD) thermal technology. The Project will be constructed in phases to reach an ultimate design capacity of 23,847 m^3/d (150,000 bpd) of bitumen production on a calendar day basis. The MacKay River Commercial Project EIA has not been deemed complete by the ERCB to date and the Project EIA may only be used for the historical EIA pending AHW approval.

Athabasca Oil Sands Corporation (AOSC) - Dover Commercial Project
In December 2010, Dover Operating Corporation submitted a regulatory application for the Dover Commercial Project to the ERCB and AENV. The Project is located approximately 95 km northwest of Fort McMurray within the Regional Municipality of Wood Buffalo (Figure 1 and Attachment B). The Dover Commercial Project leases are located within Townships 92, 93, 94, 95 and 96, Ranges 15, 16, 17 and 18 W4M. The Project will be developed with a phased construction strategy with an ultimate design capacity of 39,750 m^3/d (250,000 bpd) of bitumen production. The Project will use SAGD thermal technology. The Dover Commercial Project EIA has not been deemed complete by the ERCB to date and the Project EIA may only be used for the historical EIA pending AHW approval.

Careful consideration was given to the suitability of the principal components in the Project EIAs that would support the focused HHRA for the STP McKay Thermal Project. These include:

- Air Quality
- Surface Water Quality
- Hydrogeology

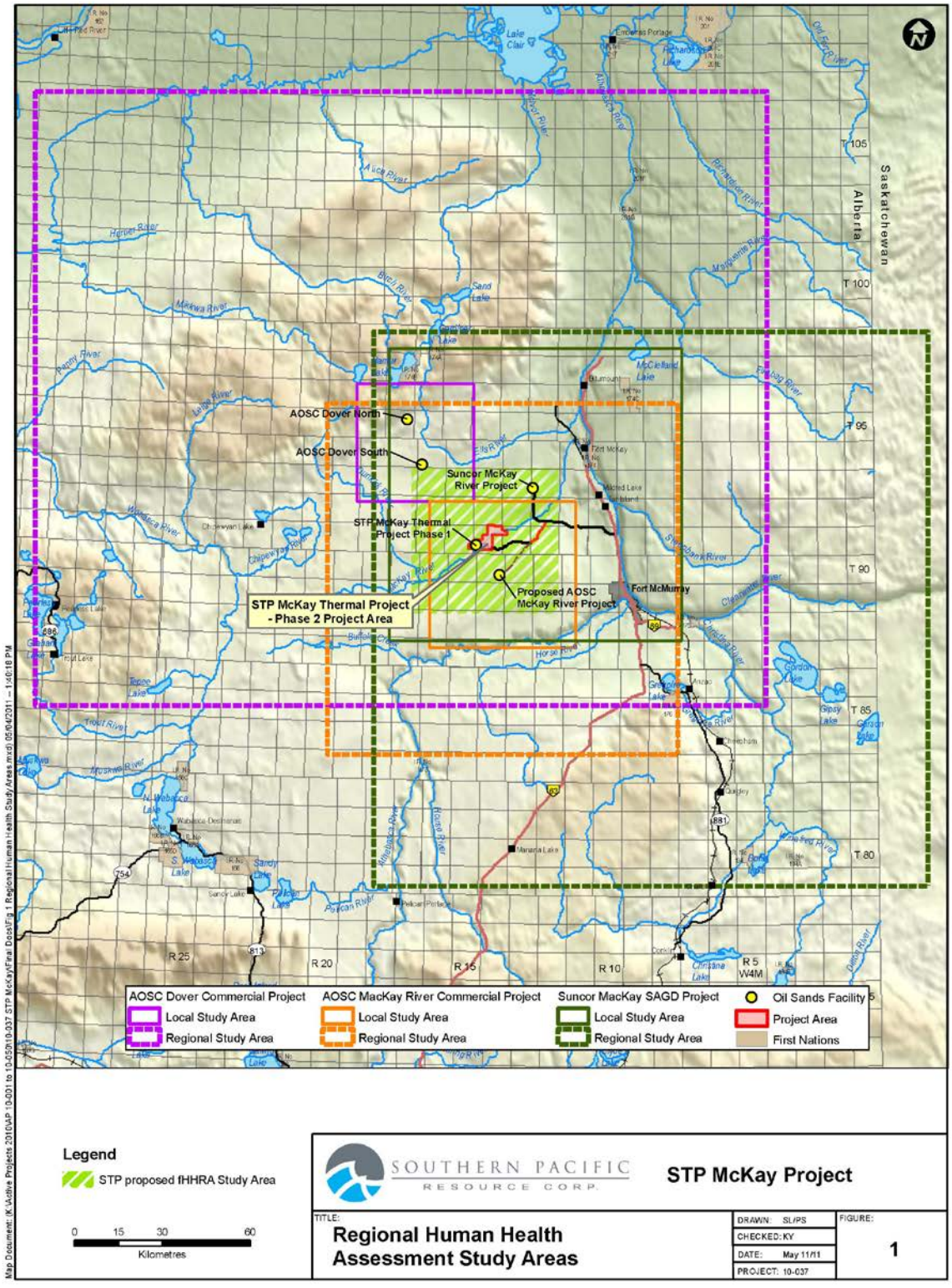

Figure 1 Air quality study areas for Environmental Impact Assessments

3.1 Air Quality

In general, Air Quality Assessments provide an understanding of the magnitude and the spatial variation of potential air quality changes associated with project emissions in consideration with other projects. Air Quality Assessments consider each of these sources in isolation and in combination, because project emissions will overlap with emissions from other sources.

3.1.1 Historical Projects and Assessment Areas

The Suncor MacKay River Expansion, AOSC MacKay River Commercial and Dover Commercial Projects, as well as the STP McKay Thermal Project, are all located in the area west of Fort McMurray and Fort MacKay in the Lower Athabasca Region (Figure 1).

The Air Quality Assessment for the Suncor MacKay River Expansion Project EIA examined two assessment areas (Attachment B):

- Local Study Area (LSA): The air LSA represents a 15 by 15 km area centred on the MacKay River Expansion Project.
- Regional Study Area (RSA): The air RSA represents a 190 by 190 km area centred on the MacKay River Expansion Project. Major developments located outside of the air RSA also were included; therefore, the air quality modelling domain was set to an area bounded by 460 by 190 km.

The Air Quality Assessment for the AOSC MacKay River Commercial Project EIA examined two assessment areas (Attachment B):

- Local Study Area (LSA): The air LSA represents a 50 by 50 km area centred on the MacKay River Central Plant.
- Regional Study Area (RSA): The air RSA represents a 120 by 120 km area centred on the MacKay River Central Plant. However, there are a number of operating, approved and planned oil sands developments in north eastern Alberta, to the north in the Athabasca oil sands area and to the south in the Christina Lake area. Major developments located outside of the air RSA may affect areas within the air RSA. Therefore, the air quality modelling domain was set to an area bounded by 300 by 450 km.

Finally, the Air Quality Assessment for the more recent Dover Commercial Project EIA examined two assessment areas (Attachment B):

- Local Study Area (LSA): The LSA is a 40 km by 40 km square centred approximately at the midpoint between the Dover North Plant (DNP) and Dover South Plant (DSP).
- Regional Study Area (RSA): The RSA is about 210 km by 250 km and includes the mining areas in the Oil Sands Region.

As shown above in Figure 1, the LSA and RSA evaluated in the historical projects overlap the STP McKay Thermal Project. As such, these assessment areas should be considered relevant to the STP McKay Thermal Project. The model domain for each of the historical projects encloses the STP McKay Thermal Project. Overall, the AOSC MacKay River Commercial Project and Dover Commercial Project model domains represent the more comprehensive, relevant assessment area with respect to the regional emission sources that could influence air quality within the STP McKay Thermal Project lease area. On the basis of assessment areas,

the AOSC MacKay River Commercial Project EIA and Dover Commercial Project EIA would be the stronger candidates for the historical EIA.

The HHRA for the STP McKay Thermal Project will not be based on Air Quality data from the historical projects, because a comprehensive Air Quality Assessment will be completed as part of the STP McKay Thermal Project EIA. Therefore, the HHRA will use the most current and comprehensive information that is available from the Air Quality Assessment for the Project.

3.1.2 COPC and Emission Sources

Additional consideration was extended to the project design including the in situ technology that Southern Pacific plans to utilize for the STP McKay Thermal Project. As a result of similar technologies, the sources of chemical emissions from the STP McKay Thermal Project would be similar to those presented in the Suncor MacKay River Expansion Project, AOSC MacKay River Commercial Project and Dover Commercial Project EIA. These include well pads, steam boilers, heaters, generators, flares, and storage tanks. The main sources of air emissions associated with all three of the projects will be the boiler and heater stacks located at the central processing facility (CPF). Fugitive emissions from storage tanks, valves, flanges, rotating seals, and drains located in the process areas are also possible and were included as part of the emissions inventory for the AOSC MacKay River Commercial Project EIA and Dover Commercial Project EIA. The HHRA will provide sufficient information to demonstrate that the STP McKay Thermal Project uses similar technology to the AOSC MacKay River Commercial Project and Dover Commercial Project EIA.

The historical EIA projects were identified as a potential source of sulphur dioxide (SO_2), oxides of nitrogen (NO_X), particulate matter less than 2.5 µm in diameter ($PM_{2.5}$), carbon monoxide (CO), volatile organic compounds (VOC) and polycyclic aromatic hydrocarbons (PAH) emissions that result from the various combustion processes. Secondary formation of particulate matter from combustion products, such as, oxides of sulphur and nitrogen were included as part of the air quality assessments. As an example, Attachment C provides a summary of the chemicals of potential concern (COPC) that were evaluated for each of the historical EIA projects; however, the COPC for the STP McKay Thermal Project will be based on the Project-specific emission profile derived in the Air Quality Assessment. In addition, none of the historical projects considered metals as is anticipated with the STP McKay Thermal Project. A rational with adequate scientific evidence will be provided to support this decision.

The AOSC MacKay River Commercial Project and Dover Commercial Project EIA also considered emissions from the construction phase of the project. Sources of the emissions considered during construction included on-road and off-road vehicle traffic, heavy equipment, heaters, and temporary power generation. This demonstrates that although the Suncor MacKay River Expansion Project and STP McKay Thermal Project share similar design characteristics, including the same SAGD process, the AOSC MacKay River Commercial Project and Dover Commercial Project EIA represent the more recent, comprehensive EIA for this type of design and would again be the stronger candidate for the historical EIA.

3.2 Surface Water Quality

Each of the historical EIA Surface Water Quality Assessments examined existing or baseline surface water quality, as well as the potential impact of the projects on surface water quality.

3.2.1 Assessment Areas

The boundaries of the LSA defined in the Surface Water Quality Assessments for the MacKay River Expansion Project, MacKay River Commercial Project and Dover Commercial Project EIAs were similar. In addition, the study areas for the three historical surface water assessments overlap the STP McKay Thermal Project. The Surface Water Quality LSA for each project encompassed the lease area, source wells and Project components including pads, roads, pipelines, utilities, plant facilities and disposal wells; which all have the potential to cause changes to water flows, water quantity and water chemistry. In general, the LSA for the Suncor MacKay River Expansion Project and AOSC MacKay River Commercial Project is located entirely in the MacKay River basin on the west side of the Athabasca River. The drainage streams of the LSA flow in a predominately easterly direction before entering the MacKay River. The Dover Commercial Project did not contain a LSA but the Aquatics Regional Study Area (RSA) did include the Ells River and MacKay River drainage basins.

The STP McKay Thermal Project is located in between the AOSC MacKay River Commercial Project and Dover Commercial Project EIAs and approximately 15 km upstream of the Suncor MacKay River Expansion Project. As such, AHW may conclude that the STP McKay Thermal Project is adequately addressed by any one of these historical surface water quality assessments.

3.2.2 Impact Assessment

Based on the planned mitigation measures and the conclusions in the Surface Water Quality Assessments contained in the MacKay River Expansion Project, MacKay River Commercial Project and Dover Commercial Project EIAs, chemical releases to surface water bodies from the Projects are not expected as a result of direct disturbance, changes in overland flow, spills or acidifying effects. Overall, the Surface water quality assessments indicate that water quality parameters are influenced by natural factors such as temperature and seasonal variation, precipitation, surface runoff, chemical and biotic components of the aquatic environment, sediments and groundwater. Generally, impact assessment ratings under the Application Case for each of the historical projects were predicted to be “no impact”.

The EIA for the STP McKay Thermal Project will complete a comprehensive Surface Water Quality Assessment as defined by the terms of reference finalized by Alberta Environment. Therefore, the HHRA does not plan on using any of the historical projects for surface water quality. However, the historical projects could serve useful for filling in data gaps where necessary for the HHRA (e.g., Baseline concentrations of COPC in surface water).

3.3 Hydrogeology

3.3.1 Assessment Areas

The boundary of the Hydrogeology RSA was relatively consistent between the MacKay River Expansion Project, MacKay River Commercial Project and Dover Commercial Projects. Only the Hydrogeology LSA for the AOSC MacKay River Commercial Project includes the STP McKay Thermal Project. The Hydrogeology LSA for the AOSC MacKay River Commercial Project includes most of the MacKay River watershed. The Hydrogeology RSA for the MacKay River Commercial Project was defined primarily on the basis of interpreted regional geology and groundwater flow patterns. The spatial extent of the Hydrogeology RSA was:

- *North* – The height of land along the Birch Mountains;

- *East* – The height of land defining the Ells River watershed and the Athabasca River;
- *South* – Buffalo Creek; and,
- *West* – The height of land defining the Chipewyan River watershed.

Both the Hydrogeology LSA and RSA for the AOSC MacKay River Commercial Project encompass the STP McKay Thermal Project lease area. As a result, the Hydrogeology assessment area described in the AOSC MacKay River Commercial Project EIA should be considered the most "relevant" to the STP McKay Thermal Project.

3.3.2 Impact Assessment

Based on the planned mitigation measures and the conclusions in the Hydrogeology Assessments contained in the MacKay River Expansion Project, MacKay River Commercial Project and Dover Commercial Project EIAs, chemical releases to groundwater from these Projects are not expected to impact human health.

Accidental releases from the pipelines, tanks, buildings and well casings associated with the operations of the project surface facilities are not expected to negatively affect groundwater quality based on the implementation of mitigation measures, monitoring and previous experience at similar facilities throughout Alberta.

Consistent with the historical projects, the STP McKay Thermal project plans to obtain process water from similar groundwater sources which can also impact groundwater on a regional basis. However, a comprehensive Hydrogeology assessment will be completed by Southern Pacific Resource Corporation for the EIA and an adaptive management groundwater response plan will be developed in consultation with AENV if necessary. The Hydrogeology assessment will also evaluate the potential for impacts to any of the overlying aquifers, including those of potential concern to human health.

Bitumen thermal-recovery increases the temperature of sediments and groundwater in the formations surrounding the steam injection and production wells. This increase in temperature has been associated with an increase in the solubility of various minerals and metals, including arsenic. As a result, arsenic concentrations have been observed to increase in groundwater at several bitumen recovery facilities in Alberta. An assessment of heat propagation from the steam injection and production wells will be completed as part of the STP McKay Thermal Project to determine the potential enhancement of mineral dissolution or precipitation reactions which may occur.

The EIA for the STP McKay Thermal Project will complete a comprehensive Groundwater Quality Assessment as defined by the terms of reference finalized by Alberta Environment. Therefore, the HHRA does not plan on using any of the historical projects for groundwater quality. However, the historical projects could serve useful for filling in data gaps where necessary for the HHRA (e.g., Baseline concentrations of COPC in groundwater).

4.0 HISTORICAL BASELINE CASE, APPLICATION CASE AND PLANNED DEVELOPMENT CASE

The second criterion or condition of the pre-screening exercise is that the historical EIA must contain a Baseline Case, Application Case and PDC that encompass a similar RSA and/or air quality model domain to that of the STP McKay Thermal Project.

Consistent with the terms of reference for the projects, Air Quality evaluated the following three assessment cases in both the MacKay River Commercial Project and Dover Commercial Project EIAs:

- Baseline Case – including existing and approved emission sources within the RSA of the MacKay River Commercial Project EIA and the Dover Commercial Project EIA. The approved developments included facilities that have regulatory approval by any federal, provincial or municipal regulatory authority but that are not yet in operation;
- Application Case – including existing and approved emission sources, as well as emissions from the project (i.e., Baseline Case plus project); and,
- Planned Development Case (PDC) – including existing, approved and planned future emission sources within the RSA of the MacKay River Commercial Project EIA and the Dover Commercial Project EIA, including emissions originating from the project (i.e., Application Case plus planned future emission sources).

Each of the historical project EIAs contains a Baseline Case, Application Case and PDC that is relevant to the STP McKay Thermal Project. In addition, the AOSC MacKay River Commercial Project EIA includes the Suncor MacKay River Expansion Project in the Baseline Case and the Dover Commercial Project in the PDC (as well as other planned future emission sources that had not been proposed at the time of the MacKay River Expansion Project application for approval). On this basis, the Baseline Case, Application Case and PDC contained within the MacKay River Commercial Project EIA represent the more relevant assessment cases to the STP McKay Thermal Project on both a spatial and temporal basis.

The HHRA for the STP McKay Thermal Project will not be based on assessment cases from the historical projects, because a comprehensive Air Quality Assessment will be completed as part of the STP McKay Thermal Project EIA. Therefore, the HHRA will use the most current and comprehensive assessment case information that is available from the Air Quality Assessment. Finally, the HHRA will address predicted risks for each assessment case separately and in relation to the Baseline case.

5.0 HISTORICAL HUMAN HEALTH RISK ASSESSMENT

The third criterion or condition of the pre-screening exercise is that the historical EIA must contain an HHRA for an in situ project with similar design characteristics that can be used as a "framework" for the focused HHRA.

As already indicated, comprehensive HHRAs examining the potential human health risks associated with chemical emissions from the MacKay River Expansion, MacKay River Commercial project and Dover Commercial Projects were completed as part of the regulatory approval process. The approach used in each of the assessments was consistent with those developed by Health Canada, the US NRC, and the US EPA, and has been endorsed by AENV, AHW, and the ERCB.

The problem formulation was the initial step of each of the assessments. In this step, practical boundaries are placed on the overall scope of work and the key areas of concern are identified. It is likely that this step would primarily serve as the "framework" for the focused HHRA. As such, discussion of the historical HHRA focused on this initial step of the MacKay River Commercial and Dover Commercial Project HHRAs.

The three major tasks of the problem formulation are described as:

- identification of the chemicals emitted or released from the project that might contribute to potential human health risks;
- characterization of people who might be exposed to project emissions or releases; and,
- identification of all relevant exposure pathways for people who might be exposed to emissions or releases from the project.

5.1 Chemical Emissions Inventory

In each of the assessments, a comprehensive inventory of chemicals that could be emitted or released from the MacKay River Expansion, MacKay River Commercial and Dover Commercial Projects, and to which people might be exposed, was developed. Development of the chemical inventory considered both possible air emissions and releases to water attributable to the projects.

The MacKay River Commercial and Dover Commercial Projects share similar design characteristics, 36 chemicals were evaluated in the HHRA for the Dover Commercial Project, while 48 chemicals were evaluated for the MacKay River Commercial Project. Attachment C provides a comprehensive list of the COPC that were evaluated in each of the historical HHRAs. Additional chemicals (i.e., >90) were identified in the MacKay River Commercial Project emissions due to the inclusion of a comprehensive fugitive emissions assessment from the central processing facility and infrastructure.

The chemical emissions inventory used in the MacKay River Commercial Project HHRA represents the more current and comprehensive inventory of the historical Project HHRAs; thus, the MacKay River Commercial Project HHRA would be the stronger candidate for the historical HHRA.

5.2 Characterization of People Potentially at Risk

People potentially at risk include sensitive or susceptible individuals who receive the highest exposures to the project emissions. In this regard, consideration is generally given to:

- the people who are known or anticipated to spend time near the project;
- the lifestyles (e.g., consumption patterns) and physical characteristics of the individuals in the health study area; and,
- the sensitivity or susceptibility of individuals in the region (e.g., infants and young children, the elderly, individuals with compromised health).

5.2.1 Locations at Which People Reside or Visit

To identify and permit understanding of the potential health risks that might be presented to people from exposure to the chemical emissions originating from the project, emphasis is given to examining the potential health risks to the people living in the local study area. However, for added completeness, coverage is generally extended to include people who might visit or frequent the area for work, recreation or other purposes.

The historical projects identified receptor locations where people are known or anticipated to spend time within the RSA. These included:

- neighbouring communities;
- cabins;
- lodges located on lakes;
- commercial operations; and,
- areas used for recreational or traditional purposes, such as campsites, grave sites, plant and berry gathering areas, and lakes potentially used for swimming and fishing.

The MacKay River Expansion Project, MacKay River Commercial Project and Dover Commercial Project EIAs identified 13, 62 and 11 receptor locations, respectively. Recognizing that people theoretically could be active anywhere within the LSA, the historical Project HHRAs were expanded to include an assessment of potential health risks to people at the location where the maximum ground-level air concentrations specifically associated with the historical projects were predicted to occur, as well as the location within the RSA where the overall maximum concentrations were predicted to occur.

In general, maximum project-related concentrations were predicted to occur in close proximity to the central processing facility emission sources and predicted to decrease with increasing distance from these sources.

5.2.2 Lifestyles and Physical Characteristics

Lifestyle categories are established to represent groups of people within the health study area that share common behavioural characteristics such as time spent at the specific location and similar dietary consumption patterns, and thus receive a similar level of exposure to the chemicals emitted from the project.

All three historical HHRAs assumed similar physical characteristics, including the consumption rates, of residents, workers and people who might visit or frequent the area were consistent with Health Canada's guidance on human health preliminary quantitative risk assessment (PQRA).

Given the close proximity of the MacKay River Commercial Project and Dover Commercial Project, the physical characteristics of the people within these project areas should be representative of people within the STP McKay Thermal Project HHRA. Because the physical

characteristics assumed as part of the AOSC MacKay River Commercial Project HHRA reflect the most recent Health Canada guidance (Health Canada 2009), the MacKay River Commercial Project HHRA is the stronger candidate for the focused HHRA.

5.2.3 Exposure Pathway Identification

Since emissions from the projects will be released directly into air from various sources, the Suncor MacKay River Expansion Project, AOSC MacKay River Commercial Project and Dover Commercial Project HHRAs evaluated the potential health risks associated with the direct inhalation of air (i.e., primary pathway of exposure); however, consideration was also extended to possible secondary pathways (e.g., inhalation of dust, food and water ingestion, and dermal contact). The STP McKay Thermal Project plans to follow the same project design as the AOSC MacKay River Commercial Project and Dover Commercial Projects. On this basis, both primary and secondary pathways of exposure will require consideration for the STP McKay Thermal Project as well.

A complete listing of the exposure pathways included in the historical Project HHRAs is provided in Table 5-1.

Table 5-1 Exposure Pathways Considered in the Project HHRAs

Exposure Pathway	*AOSC Dover Commercial Project*	*AOSC MacKay River Commercial Project*	*Suncor MacKay River Expansion*
Inhalation			
Inhalation of air	√	√	√
Inhalation of dust	√	√	√
Ingestion			
Ingestion of soil (inadvertent)	√	√	√
Ingestion of treated groundwater as drinking water	x	x	x
Ingestion of local surface water as drinking water	√	√	x
Ingestion of local surface water while swimming (inadvertent)	x	√	x
Ingestion of local wild game	√	√	√
Ingestion of local fish	√	√	x
Ingestion of local, natural foods (i.e., berries, cattail roots and tea leaves)	√	√	√
Dermal Contact			
Dermal contact with soil	√	√	√
Dermal contact with surface water while swimming	x	√	x

√ Exposure pathway was assessed in the HHRA.

x Exposure pathway was not assessed in the HHRA.

Water-related exposure pathways (i.e., ingestion of drinking water, inadvertent ingestion and dermal contact while swimming, ingestion of fish) were not incorporated into the HHRA submitted as part of the Suncor MacKay River Expansion Project EIA since the potential impacts to surface water and groundwater quality as a result of the Project were considered negligible. However, exposure pathways involving surface water and groundwater were considered relevant to the AOSC MacKay River Commercial and Dover Commercial Project HHRA. These additional pathways of exposure should be included in the STP McKay Thermal Project.

6.0 REGIONAL ENVIRONMENTAL BASELINE DATA

The historical projects and the Southern Pacific Project are located within the Central Mixedwood Subregion of Alberta's Boreal Forest Natural Region. Soil and terrain features of this region are characterized by extensive areas of bogs and fens, with jack pine and aspen tree cover. Ground moraine and glacial outwash features are common within the Central Mixedwood Subregion.

Based on the above considerations, the soil and vegetation data used to characterize baseline or ambient concentrations of PAHs and metals in the AOSC MacKay River Commercial and Dover Commercial Project HHRAs should be considered representative of the environmental conditions within the STP McKay Thermal Project area. Sample data were not collected as part of the Suncor MacKay River Expansion.

As part of the MacKay River Commercial and Dover Commercial Project baseline programs, samples of soil and vegetation were collected from their respective lease areas and analyzed for concentrations of PAHs and metals (Table 6-1). The vegetation samples consisted of two types that are known to be consumed traditionally by humans (berries and Labrador tea leaves) and one that represents forage vegetation consumed by wildlife (alder leaves). In total, 60 samples of soil, 20 samples of berries, 22 samples of Labrador tea leaves, 17 samples of cattail roots, and 20 samples of alder leaves have been collected from the area and analyzed for concentrations of PAHs and/or metals. The combined data set would be used for the STP McKay Thermal Project HHRA to provide better characterization of ambient concentrations of COPC in the environment on a regional and local basis.

Table 6-1 Baseline Soil and Vegetation Data Collected

Project	*Sample Size*					*Sample Period*
	Soil	*Berries*	*Labrador Tea Leaves*	*Cattail Roots*	*Alder Leaves*	
AOSC MacKay River Commercial Project	36	12	12	12	12	August 2008
AOSCDover Commercial Project	24	8	10	5	8	August 2010
Total	60	20	22	17	20	

As a result, the baseline soil and vegetation data compiled for the MacKay River Commercial Project and Devon Commercial Project HHRA should be considered sufficient for the characterization of ambient or baseline concentrations of COPC in soil and vegetation in the STP McKay Thermal Project area.

Baseline sample data was not collected for the STP McKay Thermal Project HHRA. The HHRA for the STP McKay Thermal Project will use baseline and vegetation data collected from the historical projects where applicable.

7.0 CONCLUSIONS

In fall 2010, Alberta Health and Wellness (AHW) developed what was intended to be a step-by-step process for undertaking focused human health risk assessments (HHRA) of in situ oil sands developments (Attachment A). The intent was that applicants would be able to make certain modifications to the approach typically adopted for risk assessments in order to reduce the level of complexity and shorten the regulatory review period.

In order for an in situ project to qualify for a focused HHRA, it needs to meet a number of conditions, namely:

- There must be a recent Environmental Impact Assessment (EIA) available that can be used as a partial surrogate for the proposed project;
- This surrogate EIA must contain relevant Baseline, Application and Planned Development assessment cases and contain a comprehensive HHRA applicable to the proposed project; and,
- There must be sufficient and applicable regional environmental (i.e., measured) data available in the region of the proposed project.

Review of the MacKay River Expansion, MacKay River Commercial and Dover Commercial Project EIAs suggests that the STP McKay Thermal Project meets these conditions and therefore qualify for a focused HHRA. The work plan for the focused HHRA recommends that the AOSC MacKay River Commercial Project would serve as the best candidate for the focused HHRA and that the HHRA should focus on risks to receptors in the LSA or an area approximately 50 by 50 km centred on the project. The final decision as to whether or not to proceed to a focused HHRA will not be made prior to receiving written endorsement from AHW.

8.0 REFERENCES

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Attachment A

In Situ Focused Terms of Reference Scoping for a Focused Human Health Risk Assessment. Alberta Health and Wellness. September 20, 2010.

In Situ Focused Terms of Reference
Scoping for a Focused Human Health Risk Assessment
September 20th, 2010

The scope and content of a human health risk assessment (HHRA) may vary according to a number of factors associated with an in situ project. In certain circumstances, modifications to risk assessment methodologies may be applied, which would result in a risk assessment of less complexity and a shorter time requirement for review. However, while these modifications would essentially help to focus the scope of the risk assessment and streamline the process, they do not negate the requirement for an HHRA for in situ projects. It should be noted, the process to focus the scope of the risk assessment is only applicable to in situ projects and under particular circumstances as outlined below.

In order to determine if an in situ project is suitable for an HHRA with a reduced scope, a number of conditions must be met as outlined in Figure 1. Whether a proponent meets the conditions is determined by how the proponent answers the questions in Figure 1 and the evidence provided in support of questions in which they have answered "yes". This includes, but may not be limited to, evidence showing that:

EIA Reports

- The historical[1] EIA is relevant to the in situ project
- The historical HHRA is applicable to the proposed project (e.g., most current exposure limits, in situ HHRA)
- The historical HHRA contains three development scenarios (i.e., Baseline, Application and Planned Development Cases) that are relevant to the proposed in situ project
- Other components of the EIA (e.g., water, air, fish, etc.) that are being used in the historical HHRA are relevant to the proposed in situ project

Regional Environmental Baseline Data

- If regional data are available they are representative of conditions at the proposed project site or study area
- The regional data are of adequate quantity and quality

It is expected that the proponent will clearly outline how the historical EIA and HHRA are relevant to their proposed in-situ project. This might be accomplished by presenting a range of similar characteristics of the proposed project to the previous project presented in the EIA report (e.g., production volume, fuel type, emission profile etc.). With respect to the three development cases in an historical EIA, it is important to consider both the regional study area and the air modeling domain used and its relevance to the proposed in situ project. As well, exceptions and/or known variables should be explicitly noted.

[1] Historical refers to EIAs and/or HHRAs in which AENV's completeness decision has been made within the last five years and AHW has no outstanding concerns with the project. EIAs and/or HHRAs in which a completeness decision has not yet been made may be utilized pending approval by AHW.

Once this is completed the proponent must also ensure that there is regional environmental baseline data available and relevant to their project. Adequacy of the data will be dependent on whether the data collected for the previous HHRA and EIA report are found to be representative of the proposed project location and whether or not any data deficiencies have been identified. It will be up to the proponent to provide evidence to support the use of a previously completed HHRA and associated regional environmental data from the EIA report for their proposed in situ project. Environmental data may also be obtained from outside of an EIA report; however, justification will need to be provided regarding its relevance to the proposed project. If regional data are not available the proponent must collect their own environmental data to be used in the focused HHRA (FHHRA).

Providing the conditions in Figure 1 have been met, the proponent will then undertake a FHHRA. Meeting the conditions in Figure 1 is the initial step in reducing the scope of the risk assessment. As part of the FHHRA, a screening step should be undertaken to better understand what modifications need to be applied to further focus the evaluation. The complexity and, consequently, the required level of effort will vary between projects depending on the site characteristics, sources of emissions, types of emissions (i.e., chemicals in air or water), exposure pathways, and receptor combinations. As part of the screening, a series of questions should be asked to help focus the HHRA as outlined in Table 1. If the proponent has followed the aforementioned steps, it is expected that in most cases, the scope of the risk assessment will be considerably reduced.

The FHHRA provides a general indication, using conservative assumptions, of the potential for human health risk (or lack thereof) associated with a project. The outcome of the FHHRA may be the conclusion that potential risks do not exist, and therefore further evaluation may not be required. However, if potential risks are identified, refinement of the assumptions and/or collection of additional data may be required, leading to a more detailed evaluation of certain risks. The need for further quantitative assessment at this stage will depend on the specific project and risk identified.

Timing is an important consideration in this process for the proponent. Therefore, it is recommended that the proponent complete the process outlined in Figure 1 and the screening step of the FHHRA early on in the EIA process (i.e., EIA initiation). This will allow proponent's to understand what is required for the HHRA and to identify data needs to their consultants early on in the process.

When a proponent is deciding what historical EIA to use for its FHHRA, it is recommended that Alberta Health and Wellness (AHW) be consulted. In addition, to ensure that their outcome to the screening and approach to the FHHRA is adequate, the proponents should contact AHW for their endorsement. If evidence presented in support of a proponents responses to the questions outlined in Figure 1 or the screening component of the FHHRA is not sufficiently rigorous, AHW may still require a comprehensive HHRA. Should a proponent decide to not undertake a FHHRA, the option is always available to proceed directly to a comprehensive HHRA.

Figure 1. Process for a Focused Human Health Risk Assessment

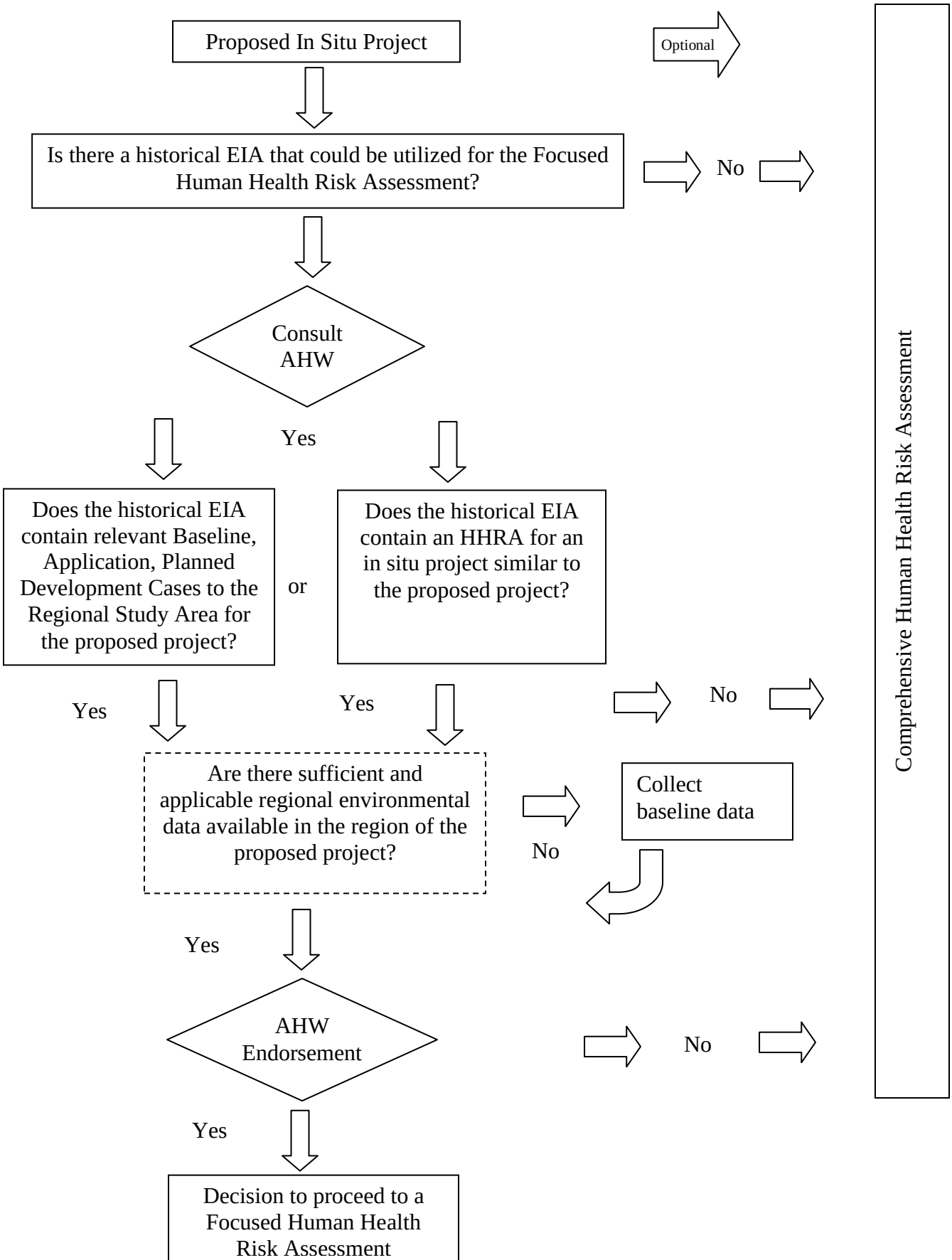
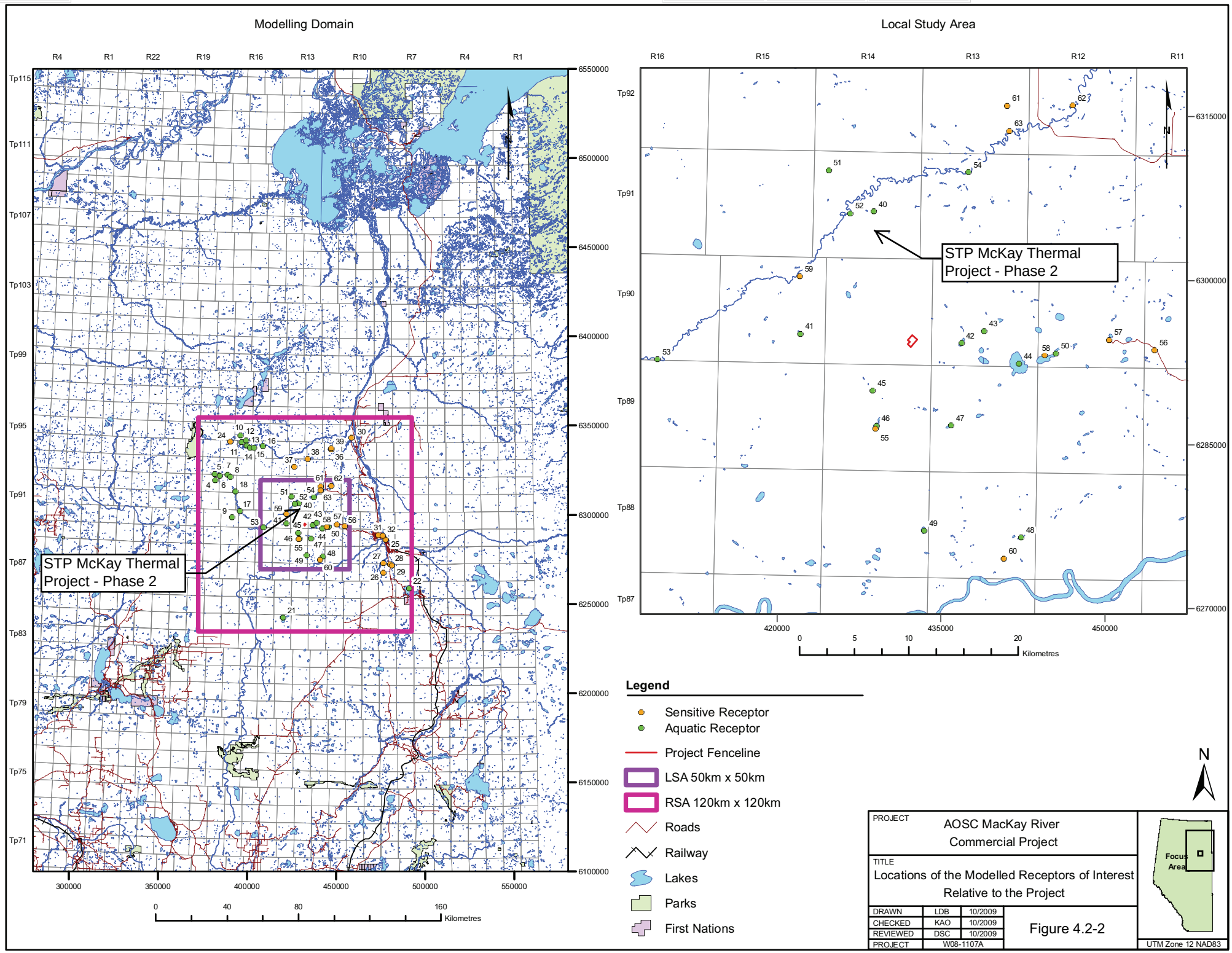


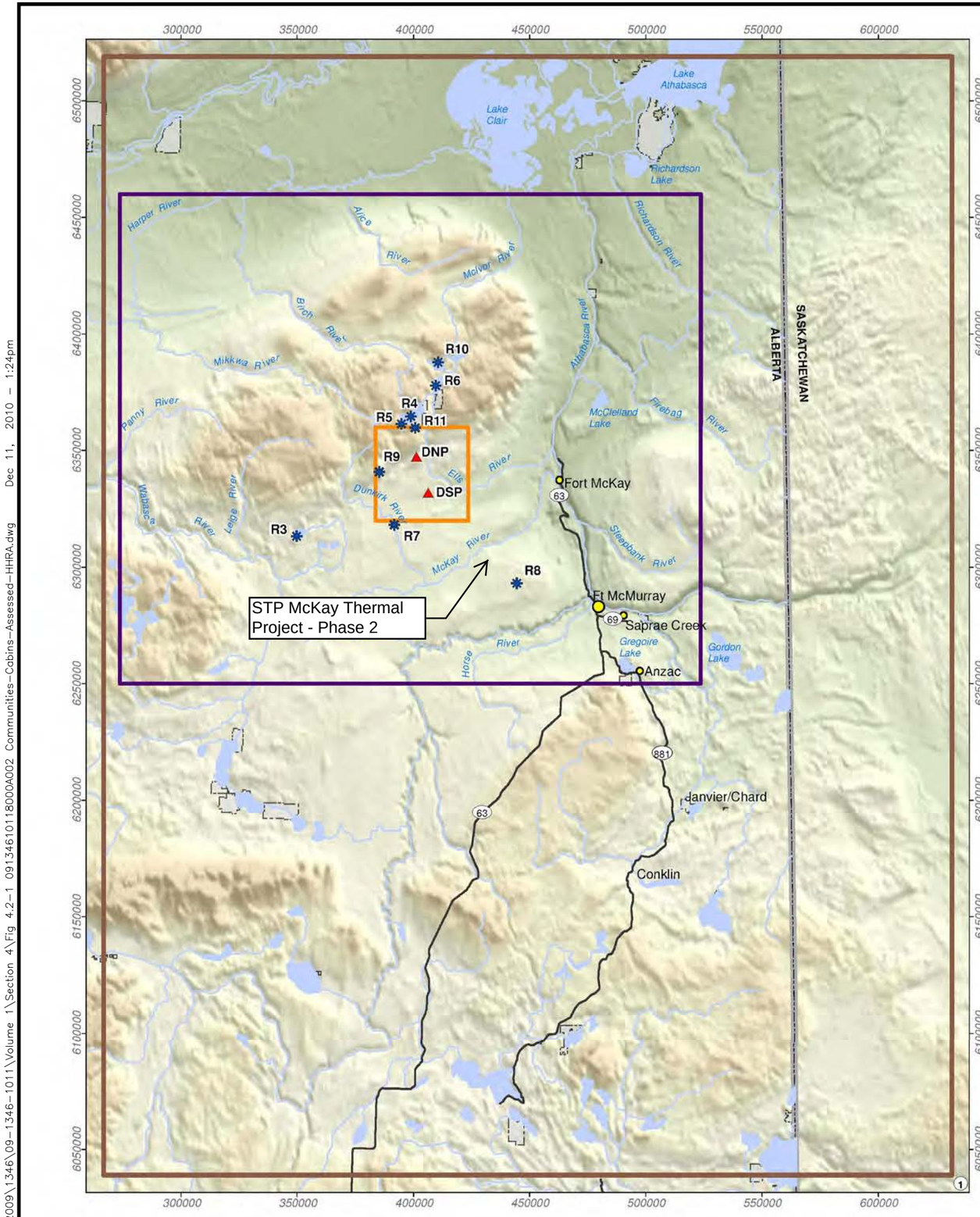
Table 1. Questions Asked to Focus the Human Health Risk Assessment

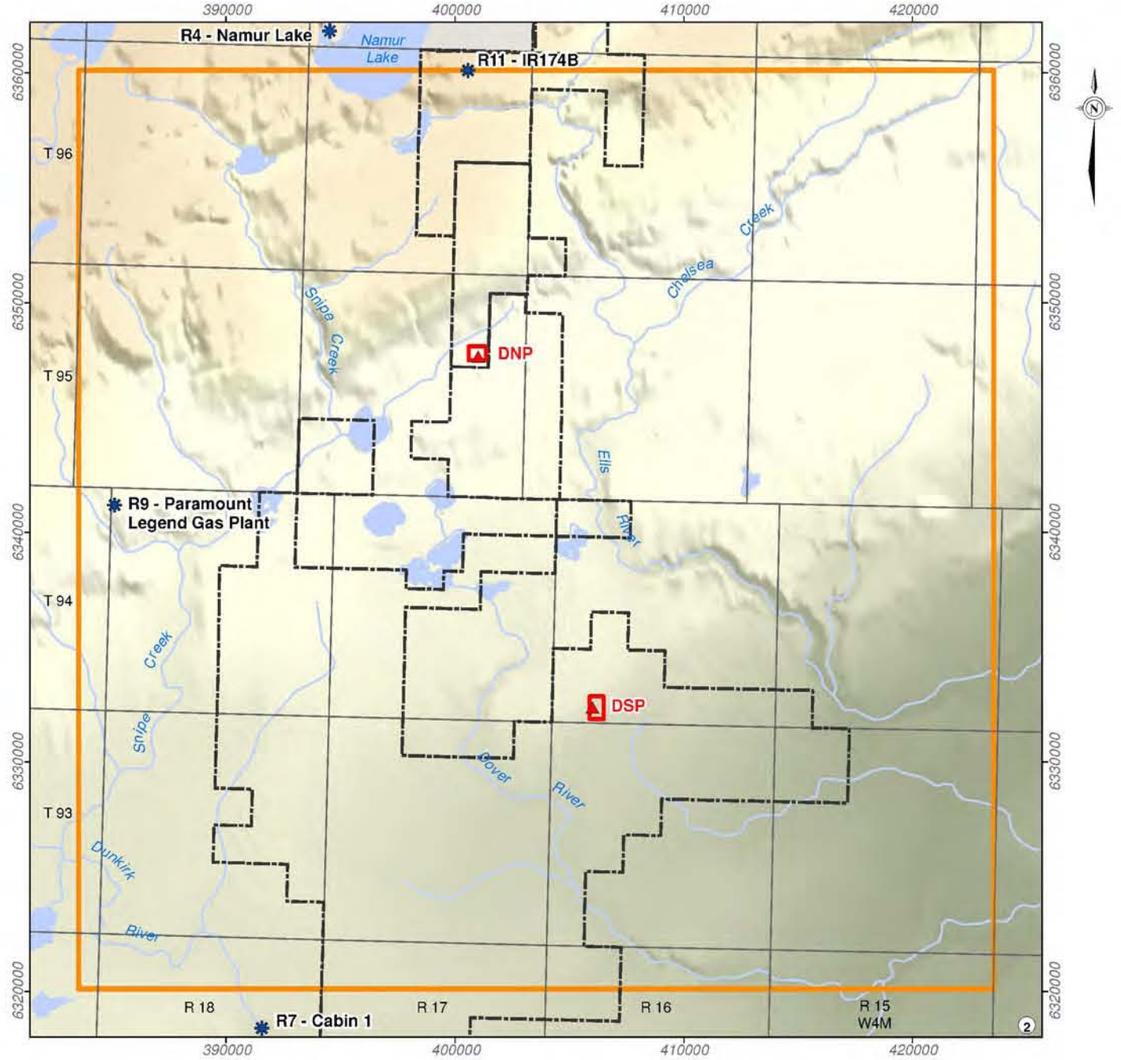
Project Characterization	Where is the project located?
	What are the project emission sources?
	What is the land being used for near the project (e.g., traditional food sources, recreational use, trap lines, cabins etc.)?
Chemicals of Potential Concern	What are the chemicals of potential concern for this project?
	Have any chemicals been identified as an issue by the regulators or communities in the study area?
	What chemicals were identified in previous HHRAs completed in the regional study area? Are they relevant to the proposed project?
Receptors	What is the proximity of the project to communities? Recreation areas? Trap lines? Cabins?
	Identification of receptors locations to be assessed (e.g., maximum point of impingement, reasonable worst-case scenario, city, etc.).
	Identification of receptor types to be assessed (adult, toddler, infant etc).
	What receptors were identified in previous HHRAs in the region? Are they relevant to the project?
Exposure pathways	What are the potential media that could be impacted by the project routes of exposure (e.g., air, water, soil, food etc)?
	What are the potential routes of exposure (e.g., inhalation, ingestion, dermal)?
	What exposure pathways were identified in previous HHRAs completed in the region? Are they relevant to the proposed project?
Other	What are the other emission sources in the area?

Attachment B

Study Area Figures and Receptors for Historical EIAs


Modelling Domain
Local Study Area
STP McKay Thermal Project - Phase 2
STP McKay Thermal Project - Phase 2
Legend
Sensitive Receptor
Aquatic Receptor
Project Fenceline
LSA 50km x 50km
RSA 120km x 120km
Roads
Railway
Lakes
Parks
First Nations
Kilometres
Kilometres
N
PROJECT
AOSC MacKay River Commercial Project
TITLE
Locations of the Modelled Receptors of Interest Relative to the Project
DRAWN LDB 10/2009
CHECKED KAO 10/2009
REVIEWED DSC 10/2009
PROJECT W08-1107A
Figure 4.2-2
Focus Area
UTM Zone 12 NAD83





Legend

- Special Receptor
- Community
- DNP/DSP Project
- DNP/DSP Fence Line
- Topography (masl)
  - High : 800
  - Low : 200
- Lease Boundary
- CALMET
- RSA (250 x 210 km)
- LSA (40 x 40 km)
- Reservation

Label	Name
R1	Fort McKay
R2	Fort McMurray
R3	Chipewyan Lake
R4	Namur Lake
R5	Namur Lake (Lodge)
R6	North Gardiner Lake
R7	Cabin 1
R8	Cabin 2
R9	Paramount Legend Gas Plant
R10	Island Lake Lodge
R11	IR174B

REFERENCE

LSA DEM FROM GEOBASE, 2010. DATUM: NAD83 PROJECTION: UTM ZONE 12

1 SCALE 40 20 0 40 KILOMETRES

2 SCALE 5.2 2.6 0 5.2 KILOMETRES

PROJECT

DOVER COMMERCIAL PROJECT

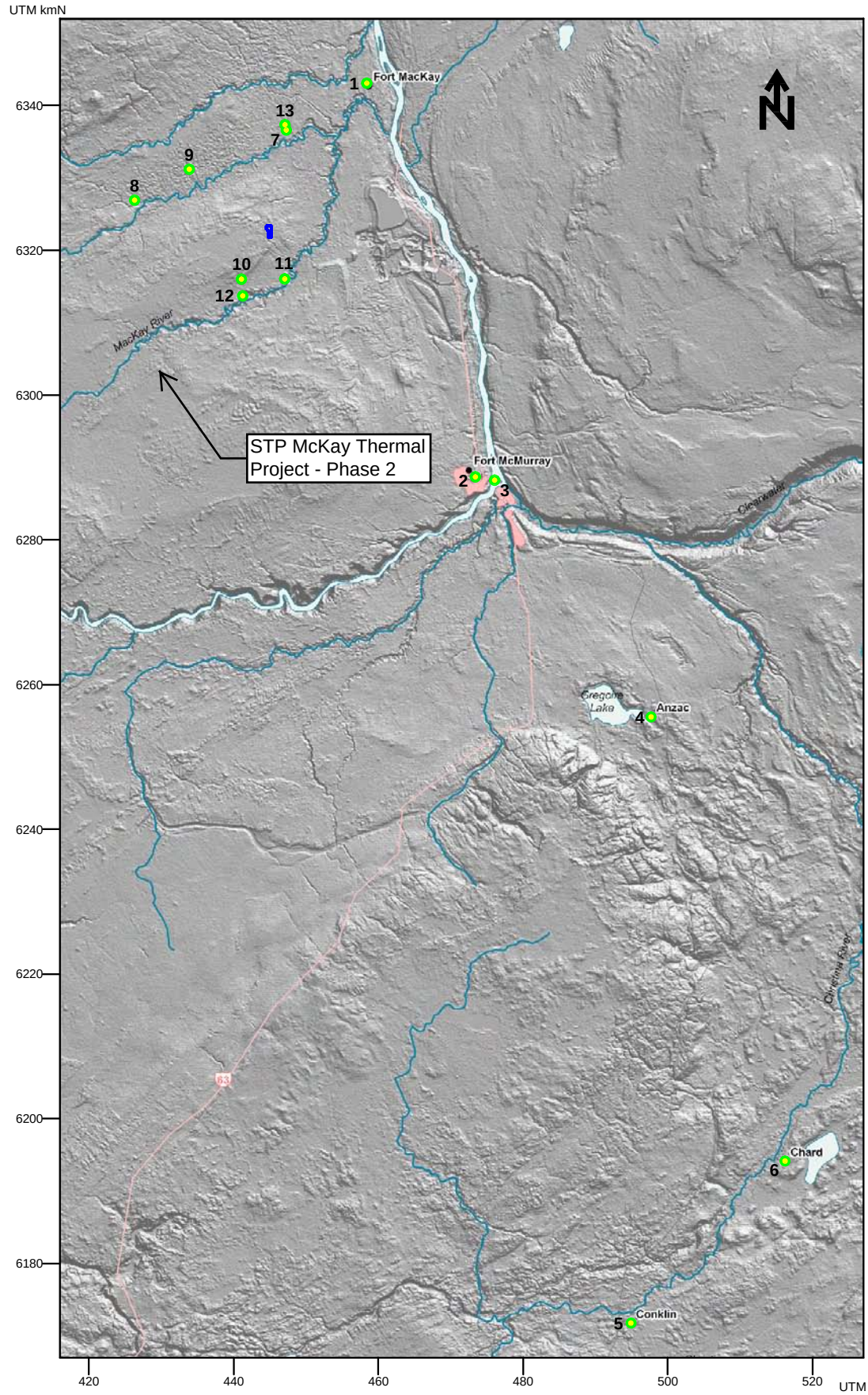
TITLE

LOCATION OF COMMUNITIES, CABINS AND RECREATIONAL AREAS ASSESSED FOR THE HUMAN HEALTH RISK ASSESSMENT

DOVER Operating Corp.

PROJECT	09.1346.1011.9100		FILE No.	09134610119180A001
DESIGN	DC	09/11/10	SCALE	AS SHOWN REV. 0
CADD	PSR	09/11/10	FIGURE:	4.2-1
CHECK	AKW	09/12/10		
REVIEW	TGC	09/12/10		

L:\2009\1346\09-1346-1011\Volume 1\Section 4\Fig 4.2-1 09134610118000A002 Communities-Cabins-Assessed-HHRA.dwg Dec 11, 2010 - 1:24pm



Legend

- Towns
- Railroads
- Road Network
- Rivers / Streams
- Petro-Canada MacKay
- Receptors

Receptors

1 Fort MacKay
2 Fort McMurray, Patricia McInnes Station
3 Fort McMurray, Athabasca Valley
4 Anzac
5 Conklin
6 Janvier/Chard
7 MacDonald Cabin (1)
8 Orr Family (1)
9 Orr Family (2)
10 Powder Cabin (1)
11 MacDonald Cabin (2)
12 Powder Cabin (2)
13 Dolphus Ahyasou

Scale (km)
0 25 50 75

UTM NAD 83 (Zone 12)

PETRO-CANADA
MacKay River

PETRO-CANADA

Figure 5-2

Map Showing Receptor Locations

Attachment C

Chemicals of Potential Concern (COPC) Identified for the Historical Human Health Risk Assessments

Chemical Category	*AOSC Dover Commercial Project*	*AOSC MacKay River Commercial Project*	*Suncor MacKay River Expansion*
CACs	--	Carbon monoxide	Carbon monoxide
	Nitrogen dioxide	Nitrogen dioxide	Nitrogen dioxide
	Particulate matter	Particulate matter	Particulate matter
	Sulphur dioxide	Sulphur dioxide	Sulphur dioxide
PAHs	3-Methylcholanthrene	3-Methylcholanthrene	--
	7,12-Dimethylbenz(a)anthracene	7,12-Dimethylbenz(a)anthracene	--
	Acenaphthene	Acenaphthene (6)	Acenaphthene
	Acenaphthylene	Acenaphthylene (6)	Acenaphthylene
	Anthracene	Anthracene	Anthracene
	Benzo(a)anthracene	Benz(a)anthracene	Benzo(a)anthracene
	Benzo(a)pyrene	Benzo(a)pyrene	Benzo(a)pyrene
	Benzo(b)fluoranthene	Benzo(b)fluoranthene	Benzo(b)fluoranthene
	--	Benzo(e)pyrene	--
	Benzo(g,h,i)perylene	Benzo(g,h,i)perylene	Benzo(g,h,i)perylene
	Benzo(k)fluoranthene	Benzo(k)fluoranthene	Benzo(k)fluoranthene
	Chrysene	Chrysene	Chrysene
	Dibenzo(a,h)anthracene	Dibenz(a,h)anthracene	Dibenz(a,h)anthracene
	Fluoranthene	Fluoranthene	Fluoranthene
	Fluorene	Fluorene	Fluorene
	Indeno(1,2,3-cd)pyrene	Indeno(1,2,3-cd)pyrene	Indeno(1,2,3-cd)pyrene
	--	Perylene	--
	Phenanthrene	Phenanthrene	Phenanthrene
	Pyrene	Pyrene	Pyrene
VOCs		1,1-Biphenyl	
	1,3-Butadiene	1,3-Butadiene	
		2-Chloronaphthalene	
	2-Methyl Naphthalene	2-Methylnaphthalene	2-Methylnaphthalene
		Acenaphthene	
		Acenaphthylene	
		Acetaldehyde	Acetaldehyde
	Acrolein	Acrolein	Acrolein
	Aldehydes (1)		
		Benzaldehyde	
	Benzene	Benzene	Benzene
	Dichlorobenzene	Dichlorobenzene	Dichlorobenzene
		Ethylbenzene	Ethylbenzene
	Formaldehyde	Formaldehyde	Formaldehyde
	n-Hexane	Hexane	Hexane
	Ketones (2)		
		Naphthalene	Naphthalene
		Pentane	Pentane
		Propylene Oxide	
	Toluene (3)	Toluene	Toluene
	Xylenes (4)	Xylene	Xylenes
Reduced Sulphur		Carbon disulphide (6)	
	Hydrogen sulphide	Hydrogen sulphide (6)	
PHC	Aliphatic C_2-C_8	Aliphatic C_5-C_8	Aliphatic C_5-C_8
	Aliphatic C_9-C_{16}	Aliphatic C_9-C_{16}	
	Aliphatic C_{17}-C_{34}		
	Aromatic C_9-C_{16} (5)	Aromatic C_9-C_{16}	
		Aromatic C_{17}-C_{34}	

Notes:

(1) Acetaldehyde is a surrogate for the aldehyde group

(2) The surrogate used for the ketones group was methyl ethyl ketone

(3) Toluene is a surrogate for the aromatic C_6-C_8 group

(4) Xylenes mixture was the surrogate for the xylenes group

(5) Ethylbenzene is a surrogate for the aromatic C_9-C_{16} group

(6) Acenaphthene, acenaphthylene, carbon disulphide and hydrogen sulphide were classified as VOCs in the HHRA