

Technical Memorandum No. 1

Occidental Chemical Corporation Property – Human Health Risk Assessment Work Plan Addendum

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Subject: Human Health Risk Assessment Work Plan Addendum

Enclosures: Tables 1 through 8

The U.S. Army Corps of Engineers, Baltimore District (USACE–Baltimore District) has retained Earth Resources Technology, Inc. (ERT), under Contract No. W912QR-08-D-0012 to conduct a human health risk assessment (HHRA) for the Occidental Chemical Corporation (OCCP) of the former Lake Ontario Ordnance Works (LOOW), located in Niagara County, New York. ERT has subcontracted EA Engineering, Science, and Technology, Inc. (EA), to prepare this HHRA Work Plan Addendum and perform the HHRA. In support of the HHRA, a Work Plan is needed to identify the appropriate risk assessment guidance, methodology, toxicity values, and exposure parameters that will be used in the HHRA.

The HHRA will follow, with amendments as described in this Addendum, the procedures set forth in the June 2009 *Final Human Health Risk Assessment Work Plan for Phase IV Remedial Investigation/Feasibility Study at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, New York* (USACE 2009). Review of recent literature has identified various aspects of HHRAs which have been revised since completion of the 2009 HHRA Work Plan. This Work Plan Addendum was prepared to identify and present changes in the risk assessment approach, screening values, exposure values, or toxicity values from the 2009 HHRA Work Plan that will be incorporated into the HHRA for the OCCP. These changes are presented in italicized text. As a result, this Addendum, with the 2009 HHRA Work Plan, will serve as the Work Plan for the OCCP HHRA.



The HHRA general approach, presented in Section 1.2 of the 2009 HHRA Work Plan noted the following USACE and United States Environmental Protection Agency (USEPA) guidance that is used to formulate the HHRA:

- Risk Assessment Guidance for Superfund (RAGS), *Volume 1: Human Health Evaluation Manual (Part A) (Interim Final)*, EPA/540/1-89/002 (USEPA 1989).
- Risk Assessment Handbook, *Volume I: Human Health Evaluation, Engineer Manual*. EM 200-1-4 (USACE 1999). January 31.
- RAGS, *Volume 1: Human Health Evaluation Manual Supplemental Guidance – “Standard Default Exposure Factors” (Interim Final)*, Publication 9285.6-03 (USEPA 1991).
- *Guidelines for Data Useability in Risk Assessment (Part A)*. Office of Solid Waste and Emergency Response, Publication OSWER9285.7-09A (USEPA 1992).
- *Exposure Factors Handbook*, Volumes I, II, and III (USEPA 1997).
- RAGS, *Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments)*. Office of Emergency and Remedial Response (USEPA 2002).
- *Human Health Toxicity Values in Superfund Risk Assessments*. OSWER 9285.7-53. Office of Emergency and Remedial Response (USEPA 2003).
- RAGS, *Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment) Final*, EPA/540/R/99/005, OSWER 9285.7-02EP, Office of Superfund Remediation and Technology Innovation (USEPA 2004).

In addition to the guidance documents identified above, the following guidance documents have been set forth by the USEPA:

- *Guidelines for Carcinogen Risk Assessment*. Risk Assessment Forum. EPA/630/P-03/001F (USEPA 2005a).
- *Supplemental Guidance for Assessing Susceptibility From Early-Life Exposure to Carcinogens*. Risk Assessment Forum, EPA/630/R-03/003F (USEPA 2005b).
- *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part F: Supplemental Guidance for Inhalation Risk Assessment) Final*. Office of Superfund Remediation and Technology Innovation, EPA-540-R-070-002 (USEPA 2009).
- *Exposure Factors Handbook, 2011 Edition*. EPA/600/R-090/052F (USEPA 2011a).

In addition, the 2009 HHRA Work Plan identified the HHRA methodology, which involves a four-step process: data evaluation and hazard assessment, exposure assessment, toxicity assessment, and risk characterization. Each step was evaluated during preparation of this Addendum to determine changes in HHRA guidance and methodology. Specific sections of the 2009 HHRA Work Plan are referenced in the sections below to note changes or additions to guidance and methodology used in each step.

Data Evaluation and Hazard Assessment

In this step, site-specific monitoring data are evaluated, chemicals of potential (COPCs) are selected for inclusion throughout the remainder of the risk assessment, and the rationale for their selection is



documented. Section 2.0 of the 2009 HHRA Work Plan presents the data evaluation and hazard assessment approach. For the OCCP HHRA, data from the following reports and investigations will be used:

- Data collected from Exposure Unit (EU) 8 on OCCP in 2001 and described with sample identification prefix of C10-GS2 as presented in EA Engineering, Science, and Technology, Inc. 2002. *Final Report of Results for the Phase II Remedial Investigation at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, NY.* Prepared for the U.S. Army Corps of Engineers, Baltimore District. February.
- Data gathered during an August 2010 data gap investigation of EU 8 on OCCP.
- Data gathered during an October 2011 data gap investigation of the OCCP.

Media that will be evaluated in the OCCP HHRA include: surface soil (0 to 2 ft below ground surface [bgs]), total soil (0 to 25 ft bgs), surface water, and sediment. Soil samples were collected within EU 8, Presumed Storage Area/Ground Scar, and other areas identified as aerial anomalies. A surface water and sediment sample were collected from each of two ponds. One pond was sampled in and is located approximately 2,000 feet northeast of EU-8 and 1,800 feet due east of the north-south trending access road. A second pond, sampled in 2011, is located approximately 1,800 ft north-northeast of EU-8 and approximately 950 feet due east of the access road.

To determine COPCs, a risk-based screening of data from the above mentioned reports will be performed. The *USEPA Regional Screening Levels (RSLs) (USEPA 2011b)*, or the most current version at the time the HHRA is completed, will be used for risk-based screening purposes in the OCCP HHRA, in place of the RSLs identified in Section 2.3.1 of the 2009 HHRA Work Plan. The USEPA RSLs combine human health toxicity values with “standard” exposure scenarios for long-term/chronic exposures to estimate analyte concentrations in environmental media that are considered by the USEPA to be protective of human health (including sensitive populations), over a lifetime. The screening values are based on specific, conservative, fixed levels of risk. For carcinogens, this is 10^{-6} , which is the lower bound for potential acceptable carcinogenic risk as defined by the NCP (USEPA 1990). For non-carcinogens, the screening values are based on a hazard quotient of 1.0. To account for potential additivity or cumulative effects of multiple contaminants, one-tenth of the acceptable non-carcinogenic threshold is used for screening. The USEPA RSL table identifies some carcinogenic contaminants where the carcinogenic RSL is greater than $1/10^{\text{th}}$ the non-carcinogenic SL (identified in the USEPA RSL tables as “ca**”). In these instances, the more conservative $1/10^{\text{th}}$ the non-carcinogenic RSL will be used.

Risk-based screening concentrations used in the selection of COPCs are medium- and receptor-specific. For areas where a residential or trespasser scenario will be evaluated, soil concentrations will be compared to USEPA residential soil RSLs. For areas where an industrial scenario will be evaluated (e.g. commercial worker, construction worker, and operations/maintenance workers), soil concentrations will be compared to USEPA industrial soil RSLs. *For surface water and sediment, the USEPA tap water and residential soil RSLs will be used but will be modified by increasing by a factor of ten. The increase in the RSLs account for the reduced exposure expected for surface water and sediment contact in comparison to tap water and soil.*



Background comparison and other screening criteria, such as identified in Sections 2.3.2 and 2.3.3, will also occur as noted in the 2009 HHRA Work Plan.

Exposure Assessment

In the exposure assessment, the human population, or groups of individuals potentially exposed to site media (i.e., potential human receptors) are characterized. Pathways applicable to potential receptors at the site are identified from the many potential pathways of exposure. The COPCs in relevant media (e.g., soil) are converted into systemic doses, taking into account rates of contact (e.g., ingestion rates, inhalation rates) and absorption rates of different COPCs. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration).

The OCCP HHRA will assess two separate exposure areas within the Occidental Property. The first exposure area is identified as Exposure Unit (EU) 8. EU 8 was identified as a ground scar in a 1944 aerial photograph obtained from the National Archives. The area was presumed to be a former DOD storage area. Additional areas of concern have been identified within the Occidental Property that are not associated with EU 8. These areas will go through an initial screening, separate from EU 8. Based upon the COPCs identified, these areas may be evaluated separately as one group or combined with EU 8 per USACE concurrence.

For the OCCP HHRA, media of concern include soil (surface and subsurface), surface water, and sediment. Receptors of concern, identified in Section 3.1.2 of the 2009 HHRA Work Plan, include adult and adolescent trespasser, operations/maintenance worker, commercial worker, construction worker, and resident adult and child.

Section 3.1.3 of the 2009 HHRA Work Plan identifies the applicable exposure parameters for each receptor of concern. The USEPA recently updated recommendations for exposure parameters for some of the receptors of concern in the 2011 Exposure Factors Handbook (USEPA 2011a). Tables 1 through 8 present the revised exposure parameters for each receptor of concern. Specific exposure parameters are discussed below.

Soil Ingestion Rates

For the adult receptors (resident adult, adult trespasser, commercial worker), the soil ingestion rate has been reduced from 100 mg/day to 50 mg/day. The soil ingestion rate takes into account actual soil ingestion and dust ingestion. The 50 mg/day ingestion rate is consistent with revised USEPA guidance (USEPA 2011a). In addition, this ingestion rate is more consistent with the New York State Department of Environmental Conservation (NYSDEC) adult resident soil ingestion rate used in the calculation of the Soil Cleanup Objectives (SCOs). While the SCOs assume a soil ingestion rate of 100 mg/day, to be consistent with former USEPA guidance (USEPA 1991a,b). However, the NYSDEC takes into account that typical outdoor soil ingestion will only occur during a 31-week period (217 days) (NYSDEC 2006). NYSDEC further takes into account activity patterns for residents that limit the number of days on which soil ingestion occurs. For adults, it is assumed that they are not outdoors every day and soil ingestion occurs two days per week, through activities such as gardening and lawn care (NYSDEC 2006). Therefore, the NYSDEC time-weighted resident adult ingestion rate is 17 mg/day taking into account



activity patterns (NYSDEC 2006). For commercial workers, the NYSDEC assumes a soil ingestion rate of 50 mg/day (NYSDEC 2006). The use of 50 mg/day for adult soil ingestion rate is consistent with revised USEPA guidance (USEPA 2011a) and NYSDEC guidance (NYSDEC 2006).

For the trespassers, the soil ingestion rates for both the adult and adolescent have been revised to be consistent with USEPA guidance (USEPA 2011a). The adult trespasser soil ingestion rate (50 mg/day) has been set equal to that of the resident adult, consistent with the approach contained in the 2009 HHRA Work Plan. For the adolescent trespasser, the soil ingestion rate is equal to 100 mg/day as presented in Table 5-1 for the 6 to <21 years of age receptor in USEPA guidance (USEPA 2011a).

Dermal Contact Rates

For all receptors, dermal exposure parameters were updated to reflect USEPA guidance (USEPA 2004 and 2011a). The primary updates were to the skin surface area available for contact (SA) and the soil adherence factors (AF). For a majority of the receptors evaluated, the SA and AF are equal to the values set forth in Exhibit 3-5 of the USEPA RAGS Part E Dermal Guidance (USEPA 2004). Only those receptors not specifically identified in RAGS Part E are discussed further.

The adolescent trespasser or its age range (6 to 16 years) is not specifically identified in RAGS Part E. Therefore, a SA was determined for the adolescent trespasser. The SA for the adolescent trespasser assumes the exposed skin is limited to the head, hands, forearms, and lower legs. The mean SA for each body part was taken from Table 7-2 of USEPA 2011 EFH guidance (USEPA 2011a). The mean SA is consistent with USEPA RAGS E Dermal guidance which notes, "All SA estimates used 50th percentile values to correlate with average body weights used for all scenarios and pathways (USEPA 2004)." Table 7-2 presents two age ranges 6 to <11 years and 11 to <16 years. These two age ranges were averaged together to determine the SA (3,700 cm²) available for skin contact, as shown on Table 4.

For the operations/maintenance worker and commercial worker, the AFs shown in Tables 5 and 6 were based upon Exhibit 3-3 of USEPA RAGS E dermal guidance (USEPA 2004). Activities performed by the operations/maintenance worker are considered to be similar to the groundskeeper and possibly the staged activity: pipe layer (dry soil) as shown on Exhibit 3-3. AFs for the groundskeeper range from 0.02 mg/cm² (mean) to 0.1 mg/cm² (95th%), and AFs for the staged activity range from 0.07 mg/cm² (mean) to 0.2 mg/cm² (95th%). The selected AF of 0.07 mg/cm² represents a value within those shown for the groundskeeper and the staged activity but not an overly conservative value. For the commercial worker, any expected contact with soil is expected to be minimal and only happen during short time periods. Therefore, these activities are not represented under the commercial/industrial adults shown in Exhibit 3-3 of USEPA RAGS E dermal guidance (USEPA 2004). However, the body parts exposed for these activities were considered the same as the commercial worker (e.g., face, forearms, and hands). Therefore, a mean AF of 0.02 mg/cm² was selected to correspond to a low-end activity for a groundskeeper and is appropriate for the commercial worker (USEPA 2004).

Inhalation Exposures

For inhalation exposures, the USEPA has revised the procedures used to calculate risks (USEPA 2009). Inhalation risk calculations do not take into account a receptor's body weight or inhalation rate, which is



reflected in Tables 1 through 7. Changes to the inhalation risk calculations are discussed further under the Exposure Intakes.

Body Weights

The body weights for all receptors, except the adolescent trespasser, have not been changed from the 2009 HHRA Work Plan. It is noted that USEPA guidance does identify a higher body weight (80 kg) for an adult receptor (USEPA 2011a). However, the USEPA notes, “When using values other than 70 kg, however, the assessors should consider if the dose estimate will be used to estimate risk by combining it with a dose-response relationship that was derived assuming a body weight of 70 kg. If such an inconsistency exists, the assessor may need to adjust the dose-response relationship (page 8-1 of USEPA 2011a).” Therefore, the adult body weight will remain at 70 kg to be consistent with the dose relationships set forth for toxicity values used in the HHRA. For the adolescent trespasser, the body weight has been adjusted according to Table 8-1 of USEPA guidance (USEPA 2011a). The body weight of 45 kg is the average of two age ranges: 6 to <11 years and 11 to <16 years.

Food Ingestion Pathway

The ingestion rates for fruit and vegetable consumption (Table 8) are the same as those presented in the 2009 HHRA Work Plan. The USEPA has not set forth revised studies for their recommendations for fruit and vegetable consumption in the 2011 EFH (USEPA 2011a). The ingestion rate for game (deer) meat consumption (Table 8) have been increased to represent a cooked weight meal for an adult, adolescent, and child. The consumption rates translate to approximately 6 ounces for an adult and adolescent, and 2 ounces for a child.

For the food ingestion pathway, not all COPCs will be evaluated. Based upon a review of plant uptake studies, it is determined that plants do not readily uptake explosives. Most explosives detected on plant material were found within the root systems. The studies could not determine whether the explosives were taken up in the roots or attached to soil particles. *Therefore, the evaluation of explosives in the soil ingestion pathway will adequately account for any potential ingestion of explosives in soil.*

Exposure Point Concentrations

The calculation of exposure point concentrations (EPCs) is another aspect of the exposure assessment. Section 3.1.4 identified that the EPC will be calculated using ProUCL 4.0. The USEPA has updated the ProUCL program to 4.1 (USEPA 2011c). *ProUCL 4.1 (or the most current version at the time of the risk assessment) will be used to calculate EPCs for the OCC HHRA.*

Intake Equations

The final aspect of the exposure assessment is the listing of exposure intake equations. For exposure intakes, the receptor exposure parameters were combined with the EPC to determine a daily intake. Section 3.1.5 identified a generic equation for the calculation of intake. However, the following equations are set forth that take into account revised USEPA guidance. Tables 1 through 8 also present the appropriate exposure intake equations for each pathway (ingestion, dermal contact, and inhalation) evaluated.



The generic equation to calculate ingestion intake is given below:

$$(L)ADI = \frac{EPC \times CR \times EF \times ED}{BW \times AT} \times CF \quad (\text{Equation 1})$$

where:

- $(L)ADI$ = (Lifetime) Average daily intake (mg/kg-day)
- EPC = Concentration of a COPC in a specific medium (mg/kg L)
- CR = Ingestion Rate (mg/day)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time (days)
- CF = Conversion Factor (10^{-6} kg/mg, for soil only)

For chemicals that are considered mutagenic, the generic equation to calculate ingestion intake was modified as identified below:

$$(L)ADI = \frac{EPC \times IFSMadj \times EF}{AT} \times CF \quad (\text{Equation 2})$$

where:

- $(L)ADI$ = (Lifetime) Average daily intake (mg/kg-day)
- EPC = Concentration of a COPC in a specific medium (mg/kg or mg/L)
- $IFSMadj$ = Mutagenic Ingestion Rate ($CR \times ED \times$ Mutagenic adjustment factor/ BW), (mg-yr/kg-day)
- EF = Exposure frequency (days/year)
- AT = Averaging time (days)
- CF = Conversion Factor (10^{-6} kg/mg, for soil only)

The generic equation to calculate dermal intake is given below:

$$(L)ADI = \frac{EPC \times SA \times DA \times EF \times ED}{BW \times AT} \times CF \quad (\text{Equation 3})$$

where:

- $(L)ADI$ = (Lifetime) Average daily intake (mg/kg-day)
- EPC = Concentration of a COPC in a specific medium (mg/kg)
- SA = Surface Area for Contact (cm^2)
- DA = Absorbed Dose
For soil $DA =$ Absorption Factor (ABS) \times Adherence Factor (AF) (mg/cm^2)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)



- BW* = Body weight (kg)
- AT* = Averaging time (days)
- CF* = Conversion Factor (10⁻⁶ kg/mg, for soil only)

For chemicals that are considered mutagenic, the generic equation to calculate dermal intake was modified as identified below:

$$(L)ADI = \frac{EPC \times DF\text{SMadj} \times DA \times EF}{AT} \times CF \quad \text{(Equation 4)}$$

where:

- (L)ADI* = (Lifetime) Average daily intake (mg/kg-day)
- EPC* = Concentration of a COPC in a specific medium (mg/kg)
- DFSMadj* = Mutagenic Dermal Contact Factor
For soil and sludge (mg-yr/kg-day) = (SA x ED x AF x Mutagenic Adjustment Factor/BW)
- DA* = Absorbed Dose
For soil DA = Absorption Factor (ABS) (unitless)
- EF* = Exposure frequency (days/year)
- ED* = Exposure duration (years)
- AT* = Averaging time (days)
- CF* = Conversion Factor (10⁻⁶ kg/mg, for soil only)

For inhalation, exposure concentrations (ECs) are calculated. ECs are time weighted average concentrations from contaminant concentrations in air, adjusted based on the characteristics of the exposure scenario being evaluated. The generic equation to calculate inhalation exposure concentration is given below (USEPA, 2009a):

$$EC = \frac{EPC \times ET \times EF \times ED}{AT} \times CF \quad \text{(Equation 5)}$$

where:

- EC* = Exposure Concentration (ug/m³)
- EPC* = Concentration of a COPC in air (ug/m³)
- ET* = Exposure Time (hours/day)
- EF* = Exposure frequency (days/year)
- ED* = Exposure duration (years)
- AT* = Averaging time (lifetime in years x 365 days/year x 24 hours/day)
- CF* = Conversion Factor (10⁻³ mg/ug)

For chemicals that are considered mutagenic, the generic equation to calculate inhalation intake is modified as identified below:



$$EC = \frac{EPC \times ET \times EF \times INHMadj}{AT} \times CF \quad (\text{Equation 6})$$

where:

<i>EC</i>	=	Exposure Concentration (ug/m ³)
<i>EPC</i>	=	Concentration of a COPC in air (ug/m ³)
<i>ET</i>	=	Exposure Time (hours/day)
<i>EF</i>	=	Exposure frequency (days/year)
<i>INHMadj</i>	=	Mutagenic Inhalation Adjustment (ED x Mutagenic Adjustment Factor) (years)
<i>AT</i>	=	Averaging time (lifetime in years x 365 days/year x 24 hours/day)
<i>CF</i>	=	Conversion Factor (10 ⁻³ mg/ug)

Toxicity Assessment

Section 4.0 of the 2009 HHRA Work Plan identifies the toxicity assessment. The USEPA continually revises both carcinogenic and non-carcinogenic toxicity values for various chemicals. To account for the revisions, the OCCP HHRA will use the USEPA three-tiered hierarchy for toxicity values as identified in the 2009 HHRA Work Plan (USEPA 2003).

The USEPA has set forth a significant change in the determination of carcinogenic toxicity values for chemicals considered mutagenic to early-life exposures. The OCC HHRA will identify chemicals with a mutagenic mode of action. The USEPA recommends, for mutagenic chemicals, when no chemical-specific data exist, a default approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early-lifestage exposure (USEPA 2005a,b). A modification for early-lifestage exposure to mutagenic COPCs is required because available studies indicate higher cancer risks resulting from a given exposure occurring early in life when compared with the same amount of exposure during adulthood (USEPA 2005b). For this HHRA, the intakes for COPCs identified with a mutagenic mode of action were modified for the following (USEPA 2005b):

- *For exposures before 2 years of age (i.e., spanning a 2-year time interval from the first day of birth up until a child's second birthday), a 10-fold adjustment.*
- *For exposures between 2 and <16 years of age (i.e., spanning a 14-year time interval from a child's second birthday up until their sixteenth birthday), a 3-fold adjustment.*
- *For exposures after turning 16 years of age, no adjustment.*

Risk Characterization

The USEPA has not set forth any revised guidance for the risk characterization step. The OCCP HHRA will follow the risk characterization set forth in Section 5.0 of the 2009 HHRA Work Plan, except for the surface water and sediment exposure media.

For surface water and sediment, the OCCP HHRA will present a qualitative risk evaluation. Chemicals detected in surface water and sediment will be compared to the modified USEPA RSLs, as noted earlier.



COPCs that exceed the modified RSLs will be evaluated to determine if there is a concern for human contact with surface water and sediment.

References

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USEPA, 2011a. *Exposure Factors Handbook: 2011 Edition*. EPA/600/R-090/052F. September.

USEPA, 2011b. *Regional Screening Levels for Superfund*. November.

USEPA, 2011c *ProUCL Version 4.1.00*. Software developed by USEPA. Obtained on the Internet at <http://www.epa.gov/osp/hstl/tsc/software.htm>. Site Characterization and Monitoring Technical Support Center.

TABLE 1
VALUES USED FOR RESIDENT ADULT DAILY SOIL INTAKE EQUATIONS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW)

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Total Soil, Air
Exposure Point: OCCP Property
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	Chronic Daily Intake (CDI) (mg/kg/day) = $CS \times CR \times EF \times ED \times CF / (BW \times AT)$ Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) = $CS \times EF \times [(ED_{6-16} \times CR \times 3) + (ED_{16-30} \times CR \times 1)] / BW \times CF / (AT)$
	CR	Ingestion Rate	mg/day	50	U.S. EPA 2011a	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991	
	<i>IFSMadj</i>	<i>Mutagenic Ingestion Rate</i>	<i>(mg-yr)/(kg-day)</i>	31	<i>U.S. EPA 2011b</i>	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991	
	ED-C	Exposure Duration-Cancer	yr	24	U.S. EPA 1991	
	BW	Body Weight	kg	70	U.S. EPA 1991	
	AT-NC	Averaging Time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989		
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) = $CS \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT)$ Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) = $CS \times EF \times ABS \times [(ED_{6-16} \times SA \times AF \times 3) + (ED_{16-30} \times SA \times AF \times 1)] / BW \times CF / (AT)$
	SA	Surface Area for Contact	cm ² /event	5,700	U.S. EPA 2004	
	ABS	Dermal Absorption Fractions	unitless	Chemical-Specific	U.S. EPA 2004	
	AF	Adherence Factor	mg/cm ²	0.07	U.S. EPA 2004	
	EF	Exposure Frequency	event/yr	350	U.S. EPA 1991	
	<i>DFSMadj</i>	<i>Mutagenic Dermal Contact Factor</i>	<i>(mg-yr)/(kg-day)</i>	251	<i>U.S. EPA 2011b</i>	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	10,950	U.S. EPA 1989	
AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989		
Inhalation	CA	Chemical Concentration in Air	mg/m ³	Chemical-Specific	Chemical-Specific	Exposure Concentration (ug/m ³) = $CA \times CF_1 \times ET \times EF \times ED / AT \times CF_2$ Mutagenic Exposure Concentration (ug/m ³) = $CA \times ET \times EF \times CF_1 \times [(ED_{6-16} \times 3) + (ED_{16-30} \times 1)] / (AT \times CF_2)$
	ET	Exposure Time	hours/day	24	U.S. EPA 1991	
	CF ₁	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	CF ₂	Conversion Factor	hr/day	24	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991	
	<i>INHMadj</i>	<i>Mutagenic Inhalation Adjustment</i>	<i>yr</i>	44	<i>U.S. EPA 2011b</i>	
	ED-NC	Exposure Duration - Noncancer	yr	30	U.S. EPA 1991	
	ED-C	Exposure Duration - Cancer	yr	24	U.S. EPA 1991	
	AT-NC	Averaging Time - Noncancer	days	10,950	U.S. EPA 2009	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 2009	

Notes: The resident adult receptor takes into account age-adjusted factors to account for an exposure over a 30 year period. Therefore, the adult resident includes age range of 6 to 30 years of age to account for all exposures beyond the resident child. For the mutagenic Chronic Daily Intake (MCDI), the following adjustments are applied according to age range evaluated:

- 1) For exposures between 6 and <16 years of age, a 3-fold adjustment.
- 2) For exposures after 16 years of age, no adjustment.

Italicized text represents values that have changed from the 2009 Work Plan (USACE 2009).

TABLE 2
VALUES USED FOR RESIDENT CHILD DAILY SOIL INTAKE EQUATIONS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW)

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Total Soil, Air
Exposure Point: OCCP Property
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$\text{CDI (mg/kg/day)} = \text{CS} \times \text{CR} \times \text{EF} \times \text{ED} \times \text{CF} / (\text{BW} \times \text{AT})$ $\text{Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day)} = \text{CS} \times \text{EF} \times ((\text{ED}_{0-2} \times \text{CR} \times 10) + (\text{ED}_{2-6} \times \text{CR} \times 3)) / \text{BW} \times \text{CF} / (\text{AT})$
	CR	Ingestion Rate	mg/day	200	U.S. EPA 2011a	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991	
	<i>IFSMadj</i>	<i>Mutagenic Ingestion Rate</i>	<i>(mg-yr)/(kg-day)</i>	<i>427</i>	<i>U.S. EPA 2011b</i>	
	ED	Exposure Duration	yr	6	U.S. EPA 1991	
	BW	Body Weight	kg	15	U.S. EPA 1991	
	AT-NC	Averaging Time - Noncancer	days	2,190	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989		
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$\text{CDI (mg/kg/day)} = \text{CS} \times \text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED} \times \text{CF} / (\text{BW} \times \text{AT})$ $\text{Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day)} = \text{CS} \times \text{EF} \times \text{ABS} \times ((\text{ED}_{0-2} \times \text{SA} \times \text{AF} \times 10) + (\text{ED}_{2-6} \times \text{SA} \times \text{AF} \times 3)) / \text{BW} \times \text{CF} / (\text{AT})$
	SA	Surface Area for Contact	cm ² /event	2,800	U.S. EPA 2004	
	ABS	Dermal Absorption Fractions	unitless	Chemical-Specific	U.S. EPA 2004	
	AF	Adherence Factor	mg/cm ²	0.2	U.S. EPA 2004	
	EF	Exposure Frequency	event/yr	350	U.S. EPA 1991	
	<i>DFSMadj</i>	<i>Mutagenic Dermal Contact Factor</i>	<i>(mg-yr)/(kg-day)</i>	<i>1,195</i>	<i>U.S. EPA 2011b</i>	
	ED	Exposure Duration	yr	6	U.S. EPA 1991	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	BW	Body Weight	kg	15	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	2,190	U.S. EPA 1989	
AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989		
Inhalation	CA	Chemical Concentration in Air	mg/m ³	Chemical-Specific	Chemical-Specific	$\text{Exposure Concentration (ug/m}^3\text{)} = \text{CA} \times \text{CF}_1 \times \text{ET} \times \text{EF} \times \text{ED} / \text{AT} \times \text{CF}_2$ $\text{Mutagenic Exposure Concentration (ug/m}^3\text{)} = \text{CA} \times \text{ET} \times \text{CF}_1 \times \text{EF} \times [(\text{ED}_{0-2} \times 10) + (\text{ED}_{2-6} \times 3)] / (\text{AT} \times \text{CF}_2)$
	ET	Exposure Time	hours/day	24	U.S. EPA 1991	
	CF ₁	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	CF ₂	Conversion Factor	hr/day	24	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	350	U.S. EPA 1991	
	<i>INHMadj</i>	<i>Mutagenic Inhalation Adjustment</i>	<i>yr</i>	<i>32</i>	<i>U.S. EPA 2011b</i>	
	ED	Exposure Duration	yr	6	U.S. EPA 1991	
	AT-NC	Averaging Time - Noncancer	days	2,190	U.S. EPA 2009	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 2009	

Notes: For the mutagenic Chronic Daily Intake (MCDI), the following adjustments are applied according to age range evaluated:
1) For exposures before 2 years of age, a 10-fold adjustment.
2) For exposures between 2 and <6 years of age, a 3-fold adjustment.
Italicized text represents values that have changed from the 2009 Work Plan (USACE 2009).

TABLE 3
VALUES USED FOR ADULT TRESPASSER DAILY SURFACE SOIL INTAKE EQUATIONS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW)

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil, Air
Exposure Point: OCCP Property
Receptor Population: Trespasser
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI \text{ (mg/kg/day)} = CS \times CR \times EF \times ED \times CF / (BW \times AT)$
	CR	Ingestion Rate	mg/day	50	U.S. EPA 2011a (1)	
	EF	Exposure Frequency	day/yr	52	BPJ(2)	
	ED	Exposure Duration	yr	30	BPJ(1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	10,950	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI \text{ (mg/kg/day)} = CS \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT)$
	SA	Surface Area for Contact	cm ² /event	5,700	U.S. EPA 2004	
	ABS	Dermal Absorption Fractions	unitless	Chemical-Specific	U.S. EPA 2004	
	AF	Adherence Factor	mg/cm ²	0.07	U.S. EPA 2004	
	EF	Exposure Frequency	event/yr	52	BPJ(2)	
	ED	Exposure Duration	yr	30	BPJ(1)	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	10,950	U.S. EPA 1989	
AT-C	Averaging Time - Cancer	days	2.6E+04	U.S. EPA 1989		
Inhalation	CA	Chemical Concentration in Air	mg/m ³	Chemical-Specific	Chemical-Specific	$\text{Exposure Concentration (ug/m}^3\text{)} = CA \times CF_1 \times ET \times EF \times ED / AT \times CF_2$
	ET	Exposure Time	hours/day	2	BPJ	
	CF ₁	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	CF ₂	Conversion Factor	hr/day	24	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	52	BPJ(2)	
	ED	Exposure Duration	yr	30	BPJ(1)	
	AT-NC	Averaging Time - Noncancer	days	3,650	U.S. EPA 2009	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 2009	

Notes: Adult Trespasser is exposed to surface soil only.

BPJ = Best Professional Judgement

(1) The ingestion rate, exposure duration, skin surface area, and adherence factor for the adult trespasser was conservatively set at the same rate as an adult resident.

(2) Assumed exposure at 1 day/week.

(3) No mutagenic adjustment factors are applied to this receptor due to an age range of >16 years.

Italicized text represents values that have changed from the 2009 Work Plan (USACE 2009).

**TABLE 4
VALUES USED FOR ADOLESCENT TRESPASSER DAILY SURFACE SOIL INTAKE EQUATIONS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW)**

Scenario Timeframe: Current/Future Medium: Soil Exposure Medium: Surface Soil, Air Exposure Point: OCCP Property Receptor Population: Trespasser Receptor Age: Adolescent
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Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) = $CS \times CR \times EF \times ED \times CF / (BW \times AT)$
	CR	Ingestion Rate	mg/day	100	U.S. EPA 2011a (1)	
	EF	Exposure Frequency	day/yr	52	BPJ(2)	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) = $CS \times EF \times [(ED_{6-16} \times CR \times 3)/BW] \times CF / (AT)$
	<i>IFSMadj</i>	<i>Mutagenic Ingestion Rate</i>	<i>(mg-yr)/(kg-day)</i>	67	U.S. EPA 2011b	
	ED	Exposure Duration	yr	10	BPJ(3)	
	BW	Body Weight	kg	45	U.S. EPA 2011a (4)	
	AT-NC	Averaging Time - Noncancer	days	3,650	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989		
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) = $CS \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT)$
	SA	Surface Area for Contact	cm ² /event	3,700	U.S. EPA 2011a (5)	
	ABS	Dermal Absorption Fractions	unitless	Chemical-Specific	U.S. EPA 2004	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) = $CS \times EF \times ABS \times [(ED_{6-16} \times SA \times AF \times 3)/BW] \times CF / (AT)$
	AF	Adherence Factor	mg/cm ²	0.2	U.S. EPA 2004 (6)	
	EF	Exposure Frequency	event/yr	52	BPJ(2)	
	<i>DFSMadj</i>	<i>Mutagenic Dermal Contact Factor</i>	<i>(mg-yr)/(kg-day)</i>	493	U.S. EPA 2011b	
	ED	Exposure Duration	yr	10	BPJ(3)	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	BW	Body Weight	kg	45	U.S. EPA 2011a (4)	
	AT-NC	Averaging Time - Noncancer	days	3,650	U.S. EPA 1989	
AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989		
Inhalation	CA	Chemical Concentration in Air	mg/m ³	Chemical-Specific	Chemical-Specific	Exposure Concentration (ug/m ³) = $CA \times CF_1 \times ET \times EF \times ED / AT \times CF_2$
	ET	Exposure Time	hours/day	2	BPJ	
	CF ₁	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	Mutagenic Exposure Concentration (ug/m ³) = $CA \times ET \times CF \times EF \times [(ED_{6-16} \times 3)] / (AT \times CF_2)$
	CF ₂	Conversion Factor	hr/day	24	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	52	BPJ(2)	
	<i>INHMadj</i>	<i>Mutagenic Inhalation Adjustment</i>	<i>yr</i>	30	<i>U.S. EPA 2011b</i>	
	ED	Exposure Duration	yr	10	BPJ(3)	
	AT-NC	Averaging Time - Noncancer	days	3,650	U.S. EPA 2009	
AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 2009		

Notes:

Adolescent Trespasser is exposed to surface soil only.

BPJ = Best Professional Judgement

(1) The ingestion rate is taken from Table 5-1 of USEPA 2011a, for age range 6 to <21 years.

(2) Assumes 2 days/week during warm months (6 months).

(3) Assumed adolescent trespasser from ages 6 to 16.

(4) Taken from Table 8-1 of USEPA 2011a, equal to the average of two age ranges: 6 to <11 years and 11 to <16 years.

(5) Taken from Table 7-2 of USEPA 2011a, equal to the average of two age ranges: 6 to <11 years and 11 to <16 years. Assuming head, hands, forearms, and lower legs are exposed.

(6) The adherence factor is conservatively equal to that of a resident child.

Italicized text represents values that have changed from the 2009 Work Plan (USACE 2009).

For the mutagenic Chronic Daily Intake (MCDI), the following adjustments are applied according to age range evaluated:

1) For exposures between 7 and <16 years of age, a 3-fold adjustment.

TABLE 5
VALUES USED FOR OPERATIONS/MAINTENANCE WORKER DAILY SOIL INTAKE EQUATIONS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW)

Scenario Timeframe: Future
 Medium: Soil
 Exposure Medium: Surface Soil, Air
 Exposure Point: OCCP Property
 Receptor Population: Operations/Maintenance Worker
 Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI \text{ (mg/kg/day)} = CS \times CR \times EF \times ED \times CF / (BW \times AT)$
	CR	Ingestion Rate	mg/day	100	U.S. EPA 1991	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	25	U.S. EPA 1991	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	9,125	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI \text{ (mg/kg/day)} = CS \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT)$
	SA	Surface Area for Contact	cm ² /event	3,300	U.S. EPA 2004 (1)	
	ABS	Dermal Absorption Fractions	unitless	Chemical-Specific	U.S. EPA 2004	
	AF	Adherence Factor	mg/cm ²	0.07	U.S. EPA 2004	
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	25	U.S. EPA 1991	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	9,125	U.S. EPA 1989	
AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989		
Inhalation	CA	Chemical Concentration in Air	mg/m ³	Chemical-Specific	Chemical-Specific	$\text{Exposure Concentration (ug/m}^3\text{)} = CA \times CF_1 \times ET \times EF \times ED / AT \times CF_2$
	ET	Exposure Time	hours/day	8	U.S. EPA 1991	
	CF ₁	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	CF ₂	Conversion Factor	hr/day	24	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	25	U.S. EPA 1991	
	AT-NC	Averaging Time - Noncancer	days	9,125	U.S. EPA 2009	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 2009	

Notes: Operations/Maintenance Worker is exposed to surface soil only. No mutagenic adjustment factors are applied to this receptor due to an age range of >16 years.
 (1) Assumes only head, hands, and forearms are exposed
 Italicized text represents values that have changed from the 2009 Work Plan (USACE 2009).

TABLE 6
VALUES USED FOR COMMERCIAL WORKER DAILY SOIL INTAKE EQUATIONS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW)

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil, Air
Exposure Point: OCCP Property
Receptor Population: Commercial Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI \text{ (mg/kg/day)} = CS \times CR \times EF \times ED \times CF / (BW \times AT)$
	CR	Ingestion Rate	mg/day	50	U.S. EPA 2011a	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	25	U.S. EPA 1991	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	9,125	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI \text{ (mg/kg/day)} = CS \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT)$
	SA	Surface Area for Contact	cm ² /event	3,300	U.S. EPA 2004	
	ABS	Dermal Absorption Fractions	unitless	Chemical-Specific	U.S. EPA 2004	
	AF	Adherence Factor	mg/cm ²	0.02	U.S. EPA 2004	
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	25	U.S. EPA 1991	
	CF	Conversion Factor	kg/mg	1.E-06	U.S. EPA 1989	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	9,125	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m ³	Chemical-Specific	Chemical-Specific	$\text{Exposure Concentration (ug/m}^3\text{)} = CA \times CF_1 \times ET \times EF \times ED / AT \times CF_2$
	ET	Exposure Time	hours/day	1	BPJ	
	CF ₁	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	CF ₂	Conversion Factor	hr/day	24	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	25	U.S. EPA 1991	
	AT-NC	Averaging Time - Noncancer	days	9,125	U.S. EPA 2009	
AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 2009		

Notes:

Commercial Worker is exposed to surface soil only.

(1) No mutagenic adjustment factors are applied to this receptor due to an age range of >16 years.

Italicized text represents values that have changed from the 2009 Work Plan (USACE 2009).

TABLE 7
VALUES USED FOR CONSTRUCTION WORKER DAILY SOIL INTAKE EQUATIONS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW)

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Total Soil, Air
Exposure Point: OCCP Property
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI \text{ (mg/kg/day)} = \frac{CS \times CR \times EF \times ED \times CF}{(BW \times AT)}$
	CR	Ingestion Rate	mg/day	480	U.S. EPA 1991	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	1	BPJ (1)	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	365	U.S. EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	$CDI \text{ (mg/kg/day)} = \frac{CS \times SA \times AF \times ABS \times EF \times ED \times CF}{(BW \times AT)}$
	SA	Surface Area for Contact	cm ² /event	3,300	U.S. EPA 2004 (2)	
	ABS	Dermal Absorption Fractions	unitless	Chemical-Specific	U.S. EPA 2004	
	AF	Adherence Factor	mg/cm ²	0.2	U.S. EPA 2004	
	EF	Exposure Frequency	event/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	1	BPJ (1)	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA 1989	
	BW	Body Weight	kg	70	U.S. EPA 1989	
	AT-NC	Averaging Time - Noncancer	days	365	U.S. EPA 1989	
AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 1989		
Inhalation	CA	Chemical Concentration in Air	mg/m ³	Chemical-Specific	Chemical-Specific	$\text{Exposure Concentration (ug/m}^3\text{)} = \frac{CA \times CF_1 \times ET \times EF \times ED}{AT \times CF_2}$
	ET	Exposure Time	hours/day	8	BPJ	
	CF ₁	Conversion Factor	ug/mg	1,000	U.S. EPA 2009	
	CF ₂	Conversion Factor	hr/day	24	U.S. EPA 2009	
	EF	Exposure Frequency	day/yr	250	U.S. EPA 1991	
	ED	Exposure Duration	yr	1	BPJ (1)	
	AT-NC	Averaging Time - Noncancer	days	365	U.S. EPA 2009	
	AT-C	Averaging Time - Cancer	days	25,550	U.S. EPA 2009	

Notes: BPJ = Best Professional Judgement. No mutagenic adjustment factors are applied to this receptor due to an age range of >16 years.
(1) Construction events are assumed to extend for up to one year total in duration.
(2) Assumes only head, hands, and forearms are exposed
Italicized text represents values that have changed from the 2009 Work Plan (USACE 2009).

**TABLE 8
VALUES USED FOR DAILY FOOD EXPOSURE INTAKE EQUATIONS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW)**

Scenario Timeframe: Future
Medium: All
Exposure Medium: Game
Exposure Point: OCCP Property
Receptor Population: Resident, Trespasser
Receptor Age: Adult, Adolescent, Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value Resident Adult	RME Value Resident Child	RME Value Trespasser Adult	RME Value Trespasser Adolescent	RME Rationale/Reference	Equation / Model Name
Ingestion	CF	Contaminant Concentration in food	mg/kg	chemical-specific	chemical-specific	chemical-specific	chemical-specific		CDI for Home-grown produce (mg/kg/day) = CF x FVc x EFf x CFpf x ED / (BW x AT)
	EFg	Exposure Frequency for game meat	meals/yr	48	48	48	48	BPJ (1)	
	EFf	Exposure Frequency for food	meals/yr	1,050	1,050	NA	NA	BPJ (2)	
	FVc	Fruit and Veg consumption	kg/meal	0.5	0.1	NA	NA	U.S. EPA 1997 and 2011a (3)	CDI for Game Meat (mg/kg/day) = CF x Gc x CFm x EFg x ED / (BW x AT)
	Gc	Game (deer) consumption	kg/meal	<i>0.17</i>	<i>0.057</i>	<i>0.17</i>	<i>0.17</i>	BPJ (4)	
	CFpf	Contamination fraction of plant food	unitless	0.05	0.05	NA	NA	U.S. EPA 1997 (5)	
	CFm	Fraction of time spent at site	unitless	0.009	0.009	0.009	0.009	BPJ (6)	
	ED	Exposure Duration	years	30	6	30	10	U.S. EPA 1991	
	BW	Body Weight	kg	70	15	70	45	U.S. EPA 1991	
	AT-NC	Averaging Time - Non-carcinogen	days	10,950	2,190	10,950	3,650	U.S. EPA 1989	
AT-C	Averaging Time - Carcinogen	days	25,550	25,550	25,550	25,550	U.S. EPA 1989		

- Notes:**
- (1) Exposure frequency for game meat is assumed at 4 meals of game meat per month.
 - (2) Assumes 3 meals per day at 350 days/year.
 - (3) RME rate of 22.4 g/kg-day (12.4 for fruit and 10 for vegetables) for total intake of fruit and vegetables converted for 70 kg adult and 15 kg child (U.S. EPA 1997, Table 1-2).
 - (4) Ingestion of deer meat is assumed at a rate of 6 ounces/meal for an adult and an adolescent and 2 ounces/meal for the child based on a dry weight (cooked) basis.
 - (5) Suburban rate for fruit and vegetables, Table 13-71 of USEPA 1997, approximately 5%.
 - (6) The home range for a white-tailed deer in northern New York State is approximately 233 hectares to 135 hectares, depending upon the season and sex of the deer. The size of areas of concern in the Occidental Property are approximately 3 acres. Based upon the home range of the deer and the area of the site, the expected time spent at the site is approximately 0.5% to 1%. Italicized text represents values that have changed from the 2009 Work Plan (USACE 2009).