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BASELINE HUMAN HEALTH RISK ASSESSMENT
ST LOUIS ARMY AMMUNITION PLANT
ST LOUIS, MISSOURI
CONTRACT NO DACW41-96-D-8014
TASK ORDER 0019

Prepared for
Department of the Army
U S Army Engineer District
Kansas City District
Corps of Engineers
Kansas City Missouri

And
Department of the Army
Base Realignment and Closure
Atlanta Field Office
Ft McPherson Georgia

March 2004

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for the St Louis Army Ammunition Plant St Louis MO
Contract No DACW41 96 D 8014 Task Order No 0019

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Very truly yours

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bgs	below ground surface
BRAC	Base Realignment and Closure
CALM	Cleanup Levels for Missouri
CENWK	Kansas City District USACE
COPCs	Chemicals of Potential Concern
CTE	Central Tendency Exposure
EBS	Environmental Baseline Survey
FOST	Finding of Suitability to Transfer
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
IEUBK	Integrated Exposure Uptake Biokinetic (model)
IRIS	Integrated Risk Information System
J&E	Johnson and Ettinger Vapor Intrusion Model
LOAEL	Lowest Observed Adverse Effect Level
MDNR	Missouri Department of Natural Resources
MDHSS	Missouri Department of Health and Senior Services
msl	mean sea level
NCEA	National Center for Environmental Assessment
NOAEL	No Observed Adverse Effect Level
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbon
PbB	Blood lead concentration (ug/dL)
PbB_t	Target Blood Lead Level of Concern (10 ug/dL)
PCB	Polychlorinated Biphenyl
PRGs	Preliminary Remediation Goals
RAGS	Risk Assessment Guidance for Superfund
RfD	Reference Dose
RME	Reasonable Maximum Exposure
SAP	Sampling and Analysis Plan
SCEM	Site Conceptual Exposure Model
SF	Slope Factor
SLAAP	St Louis Army Ammunition Plant

List of Abbreviations, Acronyms, and Terms

SLOP	St Louis Ordnance Plant
SSEBS	Site Specific Environmental Baseline Survey
SVOCs	Semi volatile Organic Compounds
UCL	Upper Confidence Limit
URS	URS Group Inc
USACE	U S Army Corps of Engineers
USEPA	U S Environmental Protection Agency
VOC	Volatile Organic Compounds

This document provides a Baseline Human Health Risk Assessment (HHRA) for site related chemicals identified in various environmental media at the St Louis Army Ammunition Plant (SLAAP) located in St Louis Missouri The methodologies used in performing this risk assessment are consistent with guidelines established by the U S Environmental Protection Agency (USEPA) in Risk Assessment Guidance for Superfund (RAGS) (USEPA 1989a) and the Missouri Department of Natural Resources (MDNR) in Cleanup Levels for Missouri (CALM) (MDNR 2001) This HHRA was prepared on behalf of the U S Army Corps of Engineers (USACE) Kansas City District (CENWK) and Base Realignment and Closure (BRAC) Headquarters under URS Group Inc (URS) Contract number DACW41 96 D 8014 Task Order 0019

The St Louis Ordnance Plant (SLOP) was constructed in 1941 as a 276 acre small arms ordnance plant that produced 30 and 50 caliber munitions In 1944 21 05 acres in the northeast portion of SLOP were converted from small arms munitions production to 105 mm Howitzer shell production and this portion was designated as SLAAP Additional land was acquired on the north side of SLOP Currently the SLAAP property contains seven unoccupied buildings that were used to house SLAAP s main operating processes

Previous investigations demonstrated the presence of a number of chemicals in soil and groundwater at the Site This HHRA evaluated potential risks and hazards for soils and groundwater in support of the Finding of Suitability to Transfer (FOST) process Contaminants in shallow soils (0 0 5 feet bgs) combined surface and subsurface soils (0 10 feet bgs) and groundwater were characterized as part of the Site Specific Environmental Baseline Survey (SSEBS) These data were screened against risk based screening values including both the Preliminary Remediation Goals (PRGs USEPA 2002a) and CALM screening values (MDNR 2001) to identify the Chemicals of Potential Concern (COPCs) for quantitative evaluation in the HHRA

At the present time a number of buildings are present at SLAAP and one building that was present at the beginning of this investigation (Building 3) has since been removed The fate of the remaining buildings is currently unknown To address the uncertainty of which buildings may or may not remain onsite the HHRA evaluated soils under each building railroad roadway and the Northeast parking area as separate exposure areas In the event that any existing Site features were demolished, this provides the information necessary to address the risks associated with newly exposed soils This approach also addresses the fact that different industrial activities occurred in different buildings former buildings or other Site areas and that different chemicals and chemical concentrations are found in each of these In addition risks and hazard indices were calculated for numerous hotspots across the Site as well as on a Site wide basis

Several different land use scenarios were evaluated in the HHRA in order to allow Site decision makers to make informed decisions about future uses of the property Alternative scenarios evaluated included trespassers commercial/industrial workers and hypothetical future residents potentially exposed to surface soils (0 0 5 feet bgs) and excavation/construction workers exposed to deeper soils (0 10 feet bgs) Cancer risks and hazard indices were calculated for each of these scenarios under both Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) conditions

For soils at most areas of the Site and for Site wide groundwater the RME cancer risks were within or below the target risk range of 10^{-4} to 10^{-6} identified in the National Oil and Hazardous Substances Pollution Contingency Plan (USEPA 1990) most hazard indices were below the threshold of 1 and most blood lead levels were below 10 micrograms/deciliter The CTE cancer risks hazard indices and blood lead levels were even lower

Areas found to exceed a cancer risk of 10^{-4} or hazard index of 1 are listed below

- Building 2 An RME hazard index of 3 was calculated for a hypothetical future resident Aroclor 1248[1] was the primary contributor to this elevated hazard index The CTE hazard index for this receptor was 0 4
- Building 5 An RME hazard index of 6 and a cancer risk of 2×10^{-4} was calculated for a hypothetical future resident The CTE hazard index was 1 and the CTE cancer risk was 2×10^{-5} The pesticide DDT was the primary contributor to the hazard index DDT and benzo(a)pyrene were the primary contributors to the cancer risks
- Hotspot 2 This Hotspot covers the majority of the Building 2 footprint An RME hazard index of 2 was calculated for a residential scenario The CTE hazard index was 0 4 Aroclor 1248 was the primary contributor to this hazard index
- Hotspot 5A This Hotspot covers a small portion of the Building 5 footprint RME cancer risks were 1×10^{-3} for residents and 3×10^{-4} for industrial/commercial workers CTE cancer risks were 4×10^{-4} for residents and 2×10^{-5} for industrial/commercial workers RME Hazard indices were 33 for residents and 3 for industrial/commercial workers CTE Hazard indices were 15 for residents and 1 for industrial/commercial workers DDT was the primary contributor to the hazard index DDT and benzo(a)pyrene were the primary contributors to the cancer risks
- Site wide soils Site wide risks and hazards were calculated by combining soil samples from across the entire Site The RME hazard index was 6 for the residential scenario and the CTE hazard index was 1 The primary contributors to the elevated hazard index were Aroclor 1248 Aroclor 1254 and DDT It is important to note that while these hazards are defined as Site wide the distribution of these chemicals is relatively limited to a few portions of the Site
- Areas found to exceed recommended thresholds for PbB levels are listed below
- Hotspot 5A This Hotspot covers a small portion of the Building 5 footprint For non residential scenarios the probabilities that fetal PbB would exceed the PbB_t (i e 10 ug/dL) range from 0 6 to 30 2% exceeding the 5% threshold recommended by USEPA For the residential scenario modeled PbB levels ranged from 10 4 to 17 4 ug/dL exceeding the threshold of 10 ug/dL recommended by USEPA

[1] The term PCB 1248 and Aroclor 1248 are synonymous terms as are PCB 1254 and Aroclor 1254

- Hotspot 7C This Hotspot covers a small portion of the Building 7 footprint For non residential scenarios the probabilities that fetal PbB would exceed the PbB_t (i e 10 ug/dL) range from 0 6 to 12 2% exceeding the 5% threshold recommended by USEPA For the residential scenario modeled PbB levels ranged from 6 3 to 11 0 ug/dL exceeding the threshold of 10 ug/dL recommended by USEPA

This document provides a Human Health Risk Assessment (HHRA) for site related chemicals identified in various media at the St Louis Army Ammunition Plant (SLAAP) located in St Louis Missouri Previous investigations have indicated the presence of a number of chemicals in soil and groundwater at the Site The primary goal of this HHRA is to address whether these chemicals pose a potential health threat to current and reasonably anticipated future receptor populations

This document was prepared on behalf of the U S Army Corps of Engineers (USACE) Kansas City District (CENWK) and Base Realignment and Closure (BRAC) Headquarters under URS Group Inc (URS) Contract number DACW41 96 D 8014 Task Order 0019

The U S Army has designated the SLAAP property for transfer The results of this risk assessment will be used to support the property transfer consistent with the Finding of Suitability to Transfer (FOST) process in accordance with American Society for Testing and Materials (ASTM) Method D 6008 96 Standard of Practice for Environmental Baseline Surveys and ASTM Method E 1527 97 Standard Practice for Environmental Site Assessments Phase I Environmental Site Assessment Process (ASTM 1996) The FOST process determines that a real property is environmentally suitable for transfer because

- The property has never been contaminated (i e no release or disposal of hazardous substances or petroleum products has occurred) or
- The property has been contaminated but is still suitable for transfer because

  environmental remedial actions have been taken to protect human health and the environment consistent with the property s intended use or

  the contamination is present at levels that do not represent a threat to human health and the environment consistent with the intended use

The technical approaches and assumptions used in this risk assessment are based on information presented in the Site Specific Environmental Baseline Survey (SSEBS) Sampling and Analysis Plan (URS 2002) and technical scoping discussions among the Missouri Department of Health and Senior Services (MDHSS) Missouri Department of Natural Resources (MDNR) USACE and URS The methodologies used in performing this risk assessment are consistent with guidelines established by the U S Environmental Protection Agency (USEPA) in Risk Assessment Guidance for Superfund (RAGS) (USEPA 1989a) and the MDNR in Cleanup Levels for Missouri (CALM) (MDNR 2001) The risk assessment was conducted using the steps listed below and detailed in following sections

- Site Description/Background Information
- Identification of Chemicals of Potential Concern
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis

In addition risk calculation spreadsheets are presented in **Attachment A** and detailed evaluation of data is presented in **Attachment B**

1 1 SITE DESCRIPTION

The SLAAP property (Site) is an approximately 21 acre site that is located in an urban mixed use (commercial industrial and residential) neighborhood adjacent to Interstate 70 in St Louis Missouri The Site is bounded on the north by Interstate 70 (I 70) on the west by Goodfellow Boulevard on the south by PURO Chemical Division (PURO) and the east by Riverview Boulevard Commercial and industrial properties directly border the Site The nearest residential neighborhoods are located behind commercial properties on the west side of Goodfellow Boulevard and across I 70 to the north

The Site has been vacant since 1998 The SLAAP property contains seven unoccupied buildings Except for small grassy areas buildings and asphalt cover the SLAAP property A railroad spur that once served the former Building 202 ABC (renumbered as Building 3) remains near the middle of the property Building 3 was recently demolished as part of a polychlorinated biphenyl (PCB) remediation effort (Arrowhead Contracting 2003) A security fence encompasses the Site The general layout of the Site is shown in **Figure 1-1**

1 2 SITE HISTORY

The St Louis Ordnance Plant (SLOP) was constructed in 1941 as a 276 acre small arms ordnance plant that produced 30 and 50 caliber munitions In 1944 21 05 acres in the northeast portion of SLOP were converted from small arms munitions production to 105 mm Howitzer shell production and this portion was designated as SLAAP Additional land was acquired on the north side of SLOP Currently the SLAAP property contains seven unoccupied buildings that were used to house SLAAP s main operating processes

After World War II SLAAP was placed on standby status It was reactivated from November 1951 to December 1954 and again from November 1966 to December 1969 to support 105 mm Howitzer shell production The plant was maintained and operated by the Chevrolet Shell Division of General Motors from 1951 until 1958 by the U S Defense Corporation from 1958 to 1966 and by the Chevrolet Motor Division of General Motors from 1966 until 1972 when Donovan Construction Company was awarded the maintenance and surveillance contract

In 1984 buildings at SLAAP were renovated to house filing and administrative operations by more than 500 personnel from the U S Army Aviation Systems Command From 1986 to 1990, SLAAP was under the command of the U S Army Armament Munitions and Chemical Command In 1989 the Department of the Army determined that SLAAP was no longer required to support its munitions mission and most industrial equipment was removed from the plant In 1990 plant ownership and control were placed under the U S Army Aviation and Troop Command As of 1993 SLAAP maintenance and surveillance activities were being subcontracted by Donovan Construction Company to Plant Facilities and Engineering Inc From 1998 to the spring of 2003 SLAAP was vacant and under the control of U S Army Aviation and Missile Command The Army BRAC program assumed responsibility for the Site in the spring of 2003

1 3 SITE GEOLOGY

The geology of the SLAAP property based on the Comprehensive EBS Report (TTEMI 2000) and initial and Contingency Sampling Program field investigations for the SSEBS generally consists of fill materials lean clay (silty clay) fat clay and cherty gravel overlying Pennsylvanian age shale Underlying the shale is the Mississippian age St Genevieve limestone

Fill material consisting of a thin layer of gravel (typically one foot thick) is usually present underneath asphalt and concrete In addition fill material consisting of lean clay is encountered throughout the Site generally ranging in thickness from 1 to 8 feet However since the fill material was likely cut from adjacent lean clay portions of the Site the interface is not clear and the true depth of the fill may be significantly deeper in some portions of the Site than described on the boring logs Underlying the fill material is lean clay and in most of the borings fat clay is underlying the lean clay The thickness of the fill/lean clay/fat clay overburden materials overlying the shale range from approximately 14 to 26 feet

Shale was encountered in ten of the thirteen monitoring well borings and twelve soil borings completed during the Comprehensive EBS and SSEBS investigations at depths ranging from 12 to 31 9 feet bgs The maximum thickness of shale encountered was 15 feet however all of these borings were terminated prior to reaching the bottom of the shale unit According to the Comprehensive EBS a soil boring drilled in 1971 at SLAAP encountered a medium hard medium to fine grained limestone (St Genevieve limestone) at 65 feet and the bedrock units beneath the Site were reported as flat lying (TTEMI 2000)

1 4 SITE HYDROGEOLOGY

Bedrock units in and around St Louis are capable of yielding varying amounts of groundwater Well yield depends on site specific geologic and well characteristics Most wells in the St Louis area yield a maximum of 50 gallons per minute from depths down to 800 feet bgs (USATHMA 1979) These wells are screened in limestones and sandstones ranging in age from Mississippian to Ordovician Water yields of up to 1 955 gallons per minute (gpm) can be expected from wells drilled in thick alluvial deposits that contain little silt or clay like material However no potable water wells are reported to exist within 3 miles down gradient of SLAAP (USAEHA 1993)

No surface water is present on the SLAAP property The closest body of water the Mississippi River is located about 3 miles from the property Stormwater on the property is collected by catch basins that discharge to the Metropolitan St Louis Sewer District combined sewer system

Regional groundwater flow in the SLAAP area is north northeast toward the Mississippi River The stormwater runoff in St Louis County discharges to the Missouri River to the north the Mississippi River to the east and the Meramec River to the south

1 5 EXPOSURE AREAS EVALUATED IN THE HHRA

At the present time a number of buildings are present at SLAAP Building 3 has been recently demolished and the contaminated soils have been removed (Arrowhead Contracting 2003) The fate of the remaining buildings is unknown To address this uncertainty the risk assessment has evaluated soils under buildings (and former buildings) separately as individual exposure areas Specifically this approach

- Provides an evaluation of potential risks should one or more buildings be removed and
- Addresses the fact that different industrial activities occurred in different buildings and that each building contains specific chemicals and chemical concentrations related to those past activities

In addition to calculating risks for the individual building exposure areas the risk assessment also evaluated potential risks based on

- Site wide soil data
- Hotspot soil data and
- Site wide groundwater data

A detailed discussion of the individual exposure areas evaluated in the HHRA is presented in **Section 3 3**

The first step in the risk assessment process is the identification of the Chemicals of Potential Concern (COPCs) to be considered for the estimation of potential risks The COPCs are a subset of all of the chemicals detected at the Site representing those chemicals that have the greatest potential to pose risks for the Site By careful screening of Site data the risk assessment can limit the chemicals undergoing a full evaluation without underestimating overall Site risks

Site related risks were determined for individual exposure areas for soils i e on an area by area basis and on a site wide basis for groundwater Because of this COPCs differed from one area to another and between different media

2 1 IDENTIFICATION OF SOIL COPCs

Previous soil sampling indicated the presence of a limited number of chemicals at the Site Soil COPCs were developed independently for each exposure area Soil analytical results from each exposure area were compared with risk based screening criteria specifically USEPA Region IX Preliminary Remediation Goals (PRGs) for Residential Soil (USEPA 2002a) and MDNR Cleanup Levels for Missouri (CALM) residential soil (Scenario A) values (MDNR 2001) The risk based screening levels used for each target analyte in soil are presented in **Table 4 2** of the SSEBS (URS 2004) Any chemical with a detected concentration exceeding either screening value was retained as a COPC for soil in that exposure area Chemicals with no detected concentrations in an exposure area were not considered COPCs

For purposes of evaluating potential exposure to surface and subsurface soils by different receptor populations soil COPCs were separated into two groups Potential exposures to surface soils were based on soil analytical data collected from 0 to 6 inches bgs Because the deepest trench that a future excavation worker is reasonably expected to dig is about 10 feet bgs exposures to subsurface soils were based on soil analytical data collected from 0 to 10 feet bgs

Summaries of analytical data for soil sampling results in each exposure area with comparison to screening criteria and selection of COPCs are presented in **Attachment B**

2 2 IDENTIFICATION OF GROUNDWATER COPCs

As noted previously groundwater in the vicinity of the Site is not used as a drinking water source The only potential direct exposure to groundwater is if a Future Excavation Worker were to trench into areas containing shallow groundwater (i e 0 to 10 ft bgs) Groundwater analytical results were compared with PRGs for Tap Water (USEPA 2002a) and CALM groundwater target concentrations (MDNR 2001) The risk based screening levels used for each target analyte in groundwater are presented in **Table 4-3** of the SSEBS (URS 2004) Any chemicals found in shallow groundwater above the groundwater screening values were retained as COPCs for the purpose of evaluating direct exposure

In addition to direct contact there is the potential for inhalation of volatile contaminants i e volatile organic compounds (VOCs) released from groundwater This could include areas where the depth to groundwater is greater than the depth of excavation (i e >10 feet bgs) VOCs found to be present in the uppermost groundwater unit at concentrations exceeding their respective screening concentrations were retained as COPCs even when groundwater is located greater than 10 ft bgs For this risk assessment a volatile contaminant was defined as a contaminant

having both a molecular weight less than 200 and a Henry s Law Constant greater than 10^{5} atm m^3/mole (USEPA 1991a)

2 3 TREATMENT OF CHEMICALS DETECTED IN BACKGROUND SAMPLES

Some compounds were present at the Site in exceedance of the screening criteria due to naturally occurring background conditions or non site related anthropogenic activities These include metals and essential nutrients present in soil throughout the entire geological area surrounding the Site Additionally along the railroad these included the same metals and essential nutrients along with semi volatile organic compounds (SVOCs) typically associated with normal railroad operations (i e railroad tie preservatives and releases from diesel engines) that may be unrelated to Site impacts USEPA has recently developed guidance for addressing risks associated with background chemicals (USEPA 2002b) Consistent with this guidance the risk assessment evaluated background as follows

- For inorganic chemicals such as arsenic Site levels were compared to both risk based screening levels and local background

  If the concentrations were within the local background range and below the risk based screening levels they were excluded from further evaluation in the risk assessment

  If the concentrations were within the local background range but exceeded the risk based screening levels they were identified as COPCs COPCs in this category were not evaluated quantitatively in the risk assessment but were discussed in the uncertainty analysis

  If the concentrations exceeded the local background range but were below the risk based screening levels they were excluded from further evaluation in the risk assessment

  If the concentrations exceeded the local background range and the risk based screening levels they were retained as COPCs for quantitative evaluation in the risk assessment

- All organic chemicals are assumed to be of anthropogenic origin (i e not naturally occurring)

  If the maximum concentrations were below the risk based screening levels they were excluded from further evaluation in the risk assessment

  If the concentrations were above the risk based screening levels they were retained as COPCs for quantitative evaluation in the risk assessment

  Several background locations were selected along the railroad in order to differentiate those chemicals that were related to normal railroad operations from those that were related to industrial activities at SLAAP This sampling focused on a subgroup of SVOCs the polynuclear aromatic hydrocarbons (PAHs) typically associated with railroads Risks associated with these background chemicals were evaluated quantitatively in the risk assessment The risk assessment discusses the overall risks associated with railroad areas on the SLAAP property as well as the relative contribution from non site specific and site specific sources

The purpose of the exposure assessment is to estimate the magnitude of potential chemical exposure among various receptor populations The steps required to perform an exposure assessment include the following

- Identification of potential receptor populations
- Evaluation of potential exposure pathways for completeness
- Evaluation of exposure parameters
- Estimation of exposure point concentrations

The approach used in this HHRA was to incorporate conservative exposure assumptions when estimating the magnitude of potential exposures so that potential risks posed by the Site were not underestimated At the same time exposure scenarios that were considered unlikely were excluded since they do not reflect realistic exposure conditions Scenarios and exposure assumptions used in this HHRA were previously submitted and approved in the SSEBS Sampling and Analysis Plan (SAP) (URS 2002)

In this risk assessment exposure is defined for both central tendency exposure (CTE) and reasonable maximum exposure (RME) conditions The RME is meant to represent the maximum exposure for an individual in a population that could reasonably be encountered The CTE represents the exposure for an individual under average conditions

3 1 IDENTIFICATION OF POTENTIAL RECEPTOR POPULATIONS

A receptor population is identified as an individual or group of individuals that may potentially be exposed to Site related chemicals The potential receptor populations may include both present and hypothetical future populations Because land use conditions vary by exposure area potential receptor populations may vary by area Potential receptor populations for the SLAAP property and their definitions are summarized below

- **Current Trespasser/Site Visitor** Current trespassers or sporadic visitors to the Site property
- **Future Industrial/Commercial Worker** Hypothetical future employees of potential industrial or commercial properties on the Site The Future Industrial/Commercial Worker is assumed to work outside performing non intrusive duties (i e not involved in soil excavation)
- **Future Excavation/Construction Worker** Hypothetical future employees or contractors who perform soil excavation duties (e g utility installation/repair foundation construction) in which they are potentially exposed to contamination in subsurface soil and shallow groundwater
- **Future Resident** Hypothetical future residents who may live on the Site in the unlikely event that it is converted to a residential property

While these four exposure scenarios do not represent every potential receptor population that could conceivably exist at SLAAP they are considered the most conservative (i e high end exposure) populations that are likely to be encountered at the Site Although other receptor

populations may potentially be present at the Site exposure to Site related contaminants by these populations is likely to be more sporadic and involve less intensive contact

3 2 EVALUATION OF POTENTIAL EXPOSURE PATHWAYS

An exposure pathway is a mechanism by which a receptor may come into contact with a chemical Once exposure occurs the potential exists for the chemical to pose a health risk to the receptor An exposure pathway consists of the following four necessary elements as defined in RAGS (USEPA 1989a)

- a chemical source and a mechanism of chemical release
- a medium of transport for the chemical
- an exposure point at which the receptor may make contact with the chemical
- an exposure route through which chemical uptake by the receptor may occur

The evaluation of potential exposure pathways for completeness of the four elements is critical Each of these four elements must be present for an exposure pathway to be complete The absence of any one of these elements results in an incomplete exposure pathway Health risks do not exist in an incomplete exposure pathway Only potentially complete pathways are addressed in the risk assessment

Figure 3 1 presents a site conceptual exposure model (SCEM) for the SLAAP facility This figure is a visual depiction of potential exposure pathways and the sources and mechanisms by which each receptor population might be exposed Potentially complete and significant exposure pathways are indicated with solid lines

Exposure scenarios are developed based on current uses of the Site as well as potential future uses Given that the Site is not an active facility at this time and that access is controlled by security fencing current exposure is likely to be restricted to occasional Site visitors and trespassers The most likely future property use at SLAAP is assumed to be industrial or commercial Excavation work associated with future building construction utility installation and maintenance etc is likely Residential development is considered to be unlikely for all portions of the Site for the foreseeable future However because many of the properties surrounding the Site are residential and in order to be able to evaluate whether the property can be transferred without restriction this hypothetical future land use was evaluated in the HHRA

Groundwater is not used at the Site for either drinking water or industrial purposes Groundwater is not used as a drinking water source in the City of St Louis Additionally the City of St Louis has established Ordinance 13 272 (City of St Louis 1885) that prohibits the installation of drinking water wells within the city limits indicating that Site groundwater will not be used as a source of drinking water Thus groundwater was not evaluated as a drinking water source for current or future receptors in the HHRA Incidental exposure to shallow groundwater could occur via excavation activities and releases of VOCs from groundwater could result in exposure to individuals in excavation trenches or inside buildings These pathways are evaluated in the HHRA

Given the current conditions and anticipated future use of the facility the following receptor populations were evaluated in the HHRA

- **Current Trespasser/Site Visitor** Currently most areas of the Site are covered by buildings or paved Trespassers or visitors could contact contaminated soils around the periphery of the property in areas of exposed surface soil Exposure could occur via direct dermal contact or incidental ingestion of soil or inhalation of dust The inhalation exposure route is considered insignificant relative to the other two routes since exposed soils are vegetated and thus unlikely to generate substantial amounts of dust The HHRA quantitatively evaluated direct dermal contact and incidental ingestion of exposed surface soils by current trespassers/visitors A future trespasser/visitor scenario was not quantitatively evaluated in the HHRA since more conservative (e g health protective) future use scenarios were evaluated

  In addition to soil exposure current trespassers could also be exposed to contaminants in buildings at SLAAP As described below building exposures cannot be adequately addressed using USEPA s risk assessment process as described in RAGS (USEPA 1989a)

- **Future Industrial/Commercial Worker** Given that the most likely future use of the Site is as a commercial/industrial facility the future worker scenario is considered the most realistic future scenario for the facility In contrast to the trespasser exposure by workers could occur anywhere on Site including areas that are currently paved or covered with buildings since it is likely that some or all of the buildings currently on site will be removed in the future For purposes of the HHRA workers could be considered anybody who works at the Site on a daily basis for an extended period of time (years) Industrial/commercial workers could be exposed to surface soils via direct dermal contact incidental ingestion and inhalation As was true for the trespasser inhalation of dust was considered minor/insignificant and was not evaluated quantitatively

- **Future Excavation/Construction Worker** Construction workers utility workers and other excavation workers could be exposed to both surface and subsurface contamination during any type of excavation work For industrial/commercial workers exposure could occur from direct dermal contact and incidental ingestion of surface soils and inhalation of VOCs released from the underlying groundwater For purposes of the HHRA excavation work was evaluated for soils ranging from 0 10 ft bgs consistent with the deepest routine depth anticipated for utility lines

- **Hypothetical Future Resident** Although residential use of the property is unlikely a hypothetical resident (combined adult/child scenario) was evaluated for potential exposure to surface soil and VOCs This scenario uses the same exposure routes used for the industrial/commercial worker (direct dermal contact incidental ingestion and inhalation of VOCs released from the underlying groundwater) Residential scenarios are generally considered the most conservative scenarios evaluated in a HHRA thus the inclusion of this scenario in the HHRA should provide a conservative (health protective) estimate of potential risks for other populations that may be present on site but that were not evaluated quantitatively

  Residential exposure to groundwater via ingestion is not currently considered likely since it is illegal to construct a domestic supply well within the city of St Louis Additionally groundwater contamination was fully characterized as part of the SSEBS (URS 2004) Limited perched and turbid groundwater was found on site In addition monitoring wells had yields that were very poor It is unlikely that on site groundwater would be usable as a

domestic water supply Based on this the HHRA did not quantitatively evaluate groundwater as a potential drinking water source

It should be noted that this risk assessment does not provide a quantitative evaluation for ecological risks associated with the Site The limited area of the Site not covered by buildings or pavement offers minimal habitat of poor quality (i e mowed lot) and there are no surface water bodies present at the Site As identified by MDNR (1993) there are no endangered species in the vicinity of the Site Ecological risks associated with the Site are assumed to be negligible

Several buildings currently on site are likely to contain some level of contamination Current risk assessment protocols cannot accurately estimate risks associated with chemicals on the walls and floors of buildings The potential acceptability of contamination in the building related materials are evaluated based on comparisons to standards for lead asbestos and PCBs A discussion of potential human exposure to contaminated building material as described above is included in this HHRA **(Section 5 2 14)** From a risk perspective it should be noted that the buildings are not occupied at this time nor are they likely to be occupied in the future without requiring substantial renovation first Such renovation (e g cleaning painting wall partitions new flooring active ventilation system etc) would undoubtedly reduce or eliminate potential exposure to any residuals on the building materials

3 3 EXPOSURE AREAS

At the present time a number of buildings are present at SLAAP and one building that was present at the beginning of this investigation (Building 3) has been removed The fate of the remaining buildings is currently unknown To address the uncertainty of which buildings may or may not remain the risk assessment evaluated the footprints under each building railroad roadway and the Northeast parking area as separate exposure areas In the event that any existing Site features were demolished this provides the information necessary to address the risks associated with newly exposed soils This approach also addresses the fact that different industrial activities occurred in different buildings former buildings or other Site areas and that different chemicals and chemical concentrations are found in each of these In addition to calculating risks for the individual exposure areas the risk assessment also calculated risks as follows

- Site wide data Risk calculations were performed for all soils treating them as a single exposure unit This provides risk information in the event that all current structures (i e buildings parking lots roadways railroads etc) are removed
- Hotspot data A number of potential hotspots were evaluated as part of the SSEBS (URS 2004) Potential hotspots are relatively small areas where known or suspected releases may have occurred Examples include stained soils under machinery locations where the Comprehensive EBS (TTEMI 2000) found chemicals present above screening levels or areas where chemicals were known to have been handled but where no data existed These hotspot areas typically cover a small fraction of the area covered by the building with which they are associated For purposes of the risk assessment all soil data collected from the 0 10 foot bgs interval during the SSEBS including those designated as risk assessment samples in the SAP (URS 2002) were included in the hotspot evaluation Hotspots were defined as discrete areas of contamination where one or more chemicals were present above screening levels (e g exceedances) A hotspot could consist of one or more samples In

the event that adjacent samples showed exceedances they were pooled as a single hotspot Samples with no exceedances were used to identify the boundaries of the hotspots and were not included in the hotspot dataset when calculating risks

- Although groundwater in the vicinity of the Site is not used as a drinking water source exposure is possible if shallow groundwater is contacted by excavation workers or if VOCs are released from groundwater into overlying buildings Potential exposure to groundwater at the Site is evaluated in this HHRA on a Site wide basis

A summary of the individual exposure areas and hotspots evaluated in the HHRA is presented in **Table 3 1** and shown on **Figures 3-2** and **3-3**

3 4 EVALUATION OF EXPOSURE ASSUMPTIONS

In order to calculate the chronic daily intake of Site contaminants and to estimate the associated potential health risks a number of exposure parameters must first be defined and quantified The exposure parameter values used in this risk assessment have been selected from the Exposure Factors Handbook (USEPA 1997a 1989b) Office of Solid Waste and Emergency Response (OSWER) Directive 9285 6 03 (Standard Default Exposure Factors USEPA 1991b) RAGS (USEPA 1989a) Peer Review Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2001a) and through the use of professional judgement

Exposure was evaluated for both RME and CTE exposure The RME is an estimate of the maximum exposure that can reasonably be expected to occur The CTE represents a more typical exposure for the average individual As stipulated in **Section 4** of the approved SAP (URS 2002) the exposure parameters used in the risk calculations are listed in **Table 3-2** and described in the following paragraphs

3 4 1 Averaging Time

The assumed lifespan used as the averaging time for evaluating carcinogens as given in the OSWER Directive 9285 6 03 (USEPA 1991b) is 70 years (25 550 days) for all receptors

The averaging time used for evaluating non carcinogens is based on the duration and frequency of exposure For exposure pathways with exposure durations of more than one year the averaging time for non carcinogens is calculated by multiplying the exposure duration times 365 days/year For the Future Excavation/Construction Worker pathway which has an exposure duration of less than one year the averaging time for non carcinogens is an estimate of the total number of days that the construction activity would take to complete (including weekends and holidays) An estimate of 42 days was used for CTE and 84 days for RME

3 4 2 Exposure Duration

Exposure duration refers to the number of years in which exposure occurs On site workers were assumed to have an RME duration of 25 years as given in OSWER Directive 9285 6 03 (USEPA 1991b) A CTE exposure duration of 5 years was assumed based on information supplied by the Bureau of Labor Statistics (U S Department of Labor 1992) showing 5 years to be the average time an individual spends at one job

For the Hypothetical Future Resident the RME exposure duration was assumed to be 30 years (24 years as an adult and 6 years as a small child) which is the 90th percentile for an individual living in a single residence (USEPA 1989b) Nine years (3 years as an adult 6 years as a small child) which is the 50th percentile for an individual living at a single residence was used to evaluate the CTE scenario These same exposure durations were used to evaluate the trespasser scenario based on the assumption that a trespasser could be a local resident however it was assumed that trespassers were either older children (greater than 6 years old) or adults

Utility installation or building construction is considered the most likely future Site specific excavation activity This type of activity generally occurs over a relatively short duration Based on professional judgment this activity was estimated to be completed within one year for both the RME and the CTE scenarios

3 4 3 Exposure Frequency

Exposure frequency refers to the total number of days per year spent at the Site

On site workers were assumed to spend 250 days per year on site for both RME and CTE exposure based on a 5 day working week for 50 weeks per year (OSWER Directive 9285 6 03 USEPA 1991b)

Excavation/construction workers were assumed to have an exposure frequency of 60 days (12 workweeks) and 30 days (6 workweeks) for RME and CTE exposure respectively This was based on professional judgement regarding the number of workdays subsurface construction would take to complete as discussed in the SAP (URS 2002)

Because of the location of the Site and the limited size of the evaluated exposure areas trespassers were assumed to visit the Site on an infrequent basis It was assumed that the trespasser will visit the area 12 days per year for RME and 6 days per year for CTE exposure as discussed in the SAP (URS 2002)

Residents were evaluated using the standard default assumption of 350 days per year for both the CTE and RME scenario (USEPA 1991b)

3 4 4 Incidental Soil Ingestion Rate

The incidental soil ingestion rate refers to the amount of soil that is ingested daily via incidental contact (e g hand to mouth contact) Missouri Industrial CALM values assume a soil ingestion rate of 100 mg/day This value was applied to the assessment of an on site worker for the RME exposure scenario For calculations of CTE exposure a value of 50 mg/day was used based on recommendations by USEPA (1997a) for worker populations and the Standard Default Exposure Factors (USEPA 1991b) These exposure estimations were also applied to the Site trespasser scenario

Soil excavation activity may involve increased exposure to soil A soil ingestion rate of 330 mg/day as recommended by USEPA (USEPA 2001a) was used to evaluate the RME exposure scenario for the construction worker For calculations of construction worker central tendency exposure a value of 100 mg/day was used This is the CTE ingestion rate for construction work recommended by USEPA s Technical Review Workgroup for lead

For RME residential exposure scenarios USEPA recommends the use of soil ingestion rates of 100 mg/day for individuals over the age of 6 years and 200 mg/day for 0 to 6 year old children (USEPA 1991b) CTE soil ingestion rates were assumed to be one half the RME rate (i e 50 mg/day for individuals over the age of 6 years and 100 mg/day for 0 to 6 year old children)

3 4 5 Incidental Groundwater Ingestion Rate

The incidental groundwater ingestion rate refers to the amount of groundwater that is ingested daily via incidental contact (e g hand to mouth contact) Based on professional judgement a RME value of 2 ml/day was used as the incidental groundwater ingestion rate for excavation activity A value of one half of the RME rate 1 ml/day was used for CTE exposure

3 4 6 Body Weight

The body weight for adults and children were obtained from OSWER Directive 9285 6 03 (USEPA 1991b) The assumed body weight for adults is 70 kg This value was used for on site workers excavation/construction workers adult residents and trespassers For 0 6 year old child residents a time weighted average body weight of 15 kg was used

3 4 7 Surface Area of Exposed Skin

Exposed skin surface area is important when evaluating uptake of chemicals that are absorbed dermally For dermal exposure to soil an RME surface area of 3 300 cm^2 was used to evaluate potential adult receptor scenarios (hypothetical on site workers, excavation/construction workers trespassers and adult residents) and 1913 cm^2 for the child resident based on the surface areas of face forearms and hands (USEPA 1997a) For central tendency exposure the total exposed surface area assumed to be limited to the head and hands is 2 000 cm^2 for adults and 1440 cm^2 for children (USEPA 1997a) The same adult skin surface areas were used for evaluating potential exposure of excavation/construction workers to shallow groundwater

3 4 8 Dermal Soil Adherence Factor

Dermal soil adherence is used in conjunction with exposed skin surface area to define the total amount of soil adhering to exposed skin surfaces An RME soil adherence rate of 0 9 mg/cm^2 based on the 95th percentile reported in RAGS Part E (USEPA 2001b) was used to evaluate the RME scenario for the excavation/construction worker scenario For the excavation/construction worker scenario an adherence rate of 0 2 mg/cm^2 was used to evaluate CTE exposure

For Site workers an RME adherence rate of 0 2 mg/cm^2 was based on the value recommended for commercial/industrial workers in the USEPA soil screening guidance (USEPA 2001a) The CTE adherence rate of 0 03 mg/cm^2 was based on the reported mean soil adherence of soil to hands head and arms for groundskeepers (USEPA 1997a)

For trespassers and residents RME and CTE adherence rates were taken from RAGS, Part E (USEPA 2001b) An adherence rate of 0 3 mg/cm^2 was used for RME and 0 04 mg/cm^2 was used for CTE based on the reported 95th percentile and mean soil adherence of soil to hands head and arms for a soccer players (USEPA 1997a) (Note Soil adherence rates for

residents/trespassers per se are not presented in RAGS Soccer players were chosen as a surrogate for trespassers and residents because they represent an outdoor activity with relatively high soil contact by youths)

3 4 9 Dermal Soil Absorption Factor

Dermal soil absorption factors used to estimate chemical absorption through the skin are chemical class specific values Dermal soil absorption values identified in RAGS Part E (USEPA 2001b) were used in the risk assessment This guidance indicates a dermal soil absorption fraction of 10% for most semi volatile compounds and chemical specific values for several others (including most of the SVOCs found at SLAAP) Unless otherwise specified metals and volatile compounds were not evaluated for dermal exposure as indicated in the guidance (USEPA 2001b)

3 4 10 Permeability Constant

The permeability constant is used when evaluating uptake of chemicals that are absorbed dermally from aqueous media Chemical specific permeability constants as reported in RAGS Part E (USEPA 2001b) were used to estimate dermal absorption of chemicals from water For inorganic chemicals without chemical specific values the generic permeability constant for water (0 001 cm/hour) was used

3 4 11 Exposure Time

Exposure time used to evaluate inhalation by an excavation/construction worker refers to the number of hours per day in which the exposure occurs A standard workday is eight hours long The RME exposure time for the future excavation/construction worker of 4 hours per day assumes that half of that time is spent actually working in the trench A CTE exposure duration of 2 hours per day was assumed based on professional judgement

3 4 12 Inhalation Rate

The inhalation rate is used to estimate the volume of trench air that an excavation/construction worker might breath while working in a trench Inhalation rates were taken from the Exposure Factors Handbook (USEPA 1997a) An inhalation rate of 2 05 m^3/hour based on the assumption that half of the time spent working in a trench would involve moderate activity levels and half heavy activity levels was used to evaluate the RME scenario For the CTE scenario a rate of 1 3 m^3/hour was used based on the assumption that half of the time spent working in a trench would involve light activity levels and half would involve moderate activity levels

3 5 EXPOSURE POINT CONCENTRATIONS

Exposure Point Concentrations are the chemical concentrations to which a receptor is exposed when contact is made with a specific environmental medium Site data for each exposure area were collected using two different approaches For evaluating representative risks for each exposure area risks were calculated using sample data collected using a systematic sampling grid In addition separate hotspot risk evaluations were performed for any hotspots identified

in each exposure area as described in **Section 3 3** The purpose of this two tiered evaluation was to provide Site risk managers with sufficient risk information to support hotspot removal if warranted without providing a biased overview of overall risks for each exposure area

In general the 95% upper confidence limit of the mean (95% UCL) was used to estimate the RME and the average concentration was used to estimate the CTE exposure point concentration for chemicals The 95% UCL was calculated by various methods based on guidance from USEPA as described in later sections The arithmetic mean was used to estimate exposure to lead in accordance with USEPA guidance (USEPA 2002e 2003c)

If a sample was non detect a surrogate concentration of ½ of the detection limit was used for calculation of the exposure point concentration

Since all data were reviewed by a chemist with a portion undergoing full validation and determined to be of acceptable quality for use in a risk assessment data qualified as J or UJ were included in all exposure point concentration calculations For J qualified detections the estimated result was used while UJ qualifed non detects used a surrogate concentration of ½ of the estimated detection limit

The 95% UCL was not calculated for data sets with only one detected concentration For these chemicals the maximum detected concentration was used as the RME exposure point concentration In addition the maximum detected concentration was used as the RME exposure point concentration in cases where the 95% UCL exceeded the maximum detected concentration **Attachment C** presents a flow diagram outlining the rationale used in the calculation of the 95% UCL for both the Parametric and Nonparametric methods including supporting text These methods were verified by the California Department of Toxic Substances Control and have been accepted by the EPA Region V and the Illinois Environmental Protection Agency in submitted/accepted risk assessments The following sections briefly describe the various statistical methods used to calculate the 95% UCL

3 5 1 Calculation of the 95% UCL for lognormally distributed datasets

For chemicals displaying a lognormal distribution pattern the 95% UCL was calculated using the equation shown below

$$UCL = e^{(x+0\ 5S^2+sH/\sqrt{n-1})}$$

Where

UCL = upper confidence limit

e = base of the natural log (2 718)

x = mean of the log transformed data

s = standard deviation of the log transformed data

H = H statistic

n = number of samples

3 5 2 Calculation of the 95% UCL for normally distributed datasets

For chemicals displaying a normal distribution pattern based on USEPA guidance (USEPA 1992) the 95% UCL was calculated using the equation shown below

$$UCL = x + t(s / \sqrt{n})$$

Where

UCL = upper confidence limit

x = mean of the untransformed data

s = standard deviation of the untransformed data

t = Student t statistic

n = number of samples

3 5 3 Calculation of the 95% UCL based on Non parametric Methods

The accuracy of the above statistical methods relies on the assumption that the data set being analyzed is distributed normally or lognormally For sample data with other distributions the use of the H or t statistic to estimate the 95% UCL can result in a 95% UCL value that is unrealistically large Based on USEPA guidance a non parametric statistical method for calculating the 95% UCL may be more appropriate for chemicals displaying a non lognormal distribution (USEPA 1997b 2002c) Although a technical discussion of the available non parametric methods is beyond the scope of this document these include several bootstrap and jackknife methods Depending on the nature/statistical distribution of the data collected at the Site if the H or t statistic approaches were deemed to be inappropriate a non parametric method was used to calculate exposure point concentrations

The toxicity assessment provides a summary of the toxicity values that are used to evaluate potential adverse health effects associated with chemical exposure The following sections provide an overview of the development and use of these toxicity values in this risk assessment

4 1 TOXICITY ASSESSMENT OF NON CARCINOGENIC EFFECTS

To estimate the potential non carcinogenic hazards posed by the COPCs at the Site a hazard index (HI) approach was used The concept of the hazard index is based on the assumption that non carcinogenic toxicological effects of chemicals occur only after a threshold dose is achieved The reference dose (RfD) for a compound is an estimate of the threshold dose at which the most sensitive human population will experience an observed adverse effect for that compound The hazard index is the ratio of the chronic daily intake of a chemical to its specific reference dose As long as the chronic daily intake of a chemical is less than the reference dose the exposure is unlikely to result in any adverse non carcinogenic health effect A hazard index in excess of one indicates that the chronic daily intake has exceeded the reference dose and a potential health hazard may exist A hazard index of less than one indicates that adverse health effects are unlikely to occur

The first step in developing an RfD is to identify a threshold dose or no observed adverse effect level (NOAEL) A NOAEL is the highest level of a chemical (determined in epidemiological studies or animal studies) at which there is no statistically or biologically significant effect of concern often called the critical toxic effect For certain substances only a LOAEL or lowest observed adverse effect level has been determined This is the lowest dose of a substance that produces either a statistically or biologically significant indication of an adverse toxic effect The NOAEL or the LOAEL may be used to calculate the RfD of a particular chemical

RfDs are calculated by dividing the NOAEL (or LOAEL) by a combined uncertainty factor which generally ranges from 10 to 10 000 Individual uncertainties include variations in the sensitivity of individuals within a population the extrapolation of data from experimental animals to humans an incomplete database less than lifetime to lifetime extrapolation and LOAEL to NOAEL extrapolation The RfD is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg/day)

The USEPA defines a chronic RfD as an estimate of a daily exposure level for the human population that is unlikely to result in deleterious effects during a lifetime (i e 70 years) A chronic RfD is used to evaluate the potential non carcinogenic hazards associated with long term chemical exposures

Subchronic RfDs have been developed for a few chemicals to characterize potential non carcinogenic hazards associated with short term chemical exposures The USEPA defines subchronic exposure as periods ranging from 2 weeks to 7 years (USEPA 1989a) In this risk assessment subchronic RfDs were used to evaluate the future construction/utility worker scenarios when available Chronic RfDs were used for this scenario if there were no subchronic values

4 2 TOXICITY ASSESSMENT OF CARCINOGENIC EFFECTS

To estimate the potential risk from exposure to carcinogenic chemicals of potential concern at the Site incremental carcinogenic risks (i e cancer risks attributable to site contaminants) were calculated The incremental cancer risk for a chemical is the product of the chronic daily intake of the chemical multiplied by a cancer slope factor (SF) for that chemical The incremental carcinogenic risk provides an estimate of the potential increase in cancer incidence for a receptor population An incremental cancer risk of 1×10^{6} corresponds to 1 chance in one million that an individual will acquire cancer due to exposure to Site chemical A risk range of 10^{-4} to 10^{6} represents USEPA s opinion on what are generally acceptable levels for a site (National Oil and Hazardous Substances Pollution Contingency Plan March 1990 40 CFR 300)

Slope factors are used to evaluate potential carcinogenic effects and are developed based on a dose response curve for carcinogenicity of the specific chemical Given the large degree of uncertainty that exists in predicting actual cancer risks the USEPA takes a precautionary conservative approach when developing SFs to insure that risks from carcinogenic chemicals are not underestimated The SF is used to estimate an upper bound probability of an individual developing cancer as a result of exposure to a potential carcinogen

In estimating risks posed by potential carcinogens USEPA generally assumes that any exposure level is associated with a finite probability however minute of producing a carcinogenic response USEPA assumes that a small number of molecular events can evoke changes in a single cell that can lead to uncontrolled cellular proliferation This mechanism for carcinogenicity is referred to as non threshold since there is theoretically no level of exposure for such a substance that does not pose a small though finite probability of producing a carcinogenic response

It is generally assumed by USEPA in developing SFs that the risk of cancer is linearly related to dose A linearized multistage model is one of the most commonly used models by USEPA for low dose extrapolation of experimentally derived data to the low dose range This mathematical model is based on the multi stage theory of carcinogenesis wherein the response is assumed to be linear at low doses From the slope of the extrapolation curve estimated by the model USEPA calculates the upper 95th percent confidence limit of the slope The SF expressed in units of $(mg/kg/day)^{-1}$ is used to convert the chronic daily intake of a chemical, normalized over a lifetime directly to a cancer risk This represents an estimation of an upper bound incremental lifetime probability that an individual will develop cancer as a result of exposure to a potential carcinogen This model provides an estimate of cancer risk at low doses and is likely to overestimate the actual cancer risk which may be as low as zero

4 3 SOURCES OF THE TOXICITY VALUES

The hierarchy of sources of toxicity values used in this risk assessment are listed below

- USEPA Integrated Risk Information System Database (IRIS) (USEPA 2003a)
- Health Effects Assessment Summary Table (HEAST) (USEPA 1997c)
- USEPA s National Center for Environmental Assessment (NCEA) Provisional Values (as presented in USEPA 2002a)

Summaries of the Toxicity Values used in this Risk Assessment are presented in **Table 4-1** The carcinogenic slope factors used for polychlorinated biphenyls in the calculations vary by exposure pathway and scenario as specified in the IRIS database (USEPA 2003a) For dermal contact with and incidental ingestion of soil scenarios slope factors of 1 0 (mg/kg day) ^{1} (CTE) and 2 0 (mg/kg day) ^{1} (RME) were used respectively For scenarios involving incidental ingestion of groundwater slope factors of 0 3 (mg/kg-day) ^{1} (CTE) and 0 4 (mg/kg-day) ^{1} (RME) were used

4 4 TOXICITY ASSESSMENT OF LEAD

Lead is not evaluated in a risk evaluation using the same methods applied to other chemicals While it has both carcinogenic and non carcinogenic properties USEPA does not furnish either slope factors (SFs) or reference doses (RfDs) for lead Lead is a neurodevelopmental toxicant and its toxic properties are related to an individuals age Young children are especially sensitive to lead Relatively low levels of lead exposure can cause adverse effects in children This is because 1) Children have a higher rate of lead absorption through the gastrointestinal tract than adults and 2) because young children s nervous systems are still developing Adult nervous systems being relatively static organs with little potential for growth or regeneration are relatively resistant to lead toxicity

The USEPA has developed two computer models to estimate lead uptake from various environmental media Since children have been identified as the most sensitive population to toxic effects of lead both models address childhood exposure either directly or indirectly (e g fetal exposure) One model termed the Integrated Exposure Uptake Biokinetic (IEUBK) Model predicts the amount of lead that will be found in the bloodstream of a directly exposed child (USEPA 1994) The other model referred to as the Adult Lead Model (USEPA 1996) is designed to address adult exposure in an industrial setting The receptor of concern in the adult lead model is an unborn fetus in a pregnant worker The IEUBK model is considered applicable for hypothetical future residents and the adult lead model for the other scenarios evaluated at SLAAP

The IEUBK model as applied by MDNR identifies an allowable surface soil lead level of 260 mg/kg for residential soils a level thought to be protective of children Although no workforce is currently present at the Site use of default worker assumptions in the Adult Lead Model results in an allowable surface soil lead concentration for uncontrolled exposures in the range of 750 1 750 mg/kg depending on the demographic makeup of the workforce This range is considered protective of a developing fetus in a pregnant site worker For this risk assessment lead concentrations in soil were compared to both 260 mg/kg and 750 mg/kg Three samples exceeded 260 mg/kg for lead as follows

- Sample RA 02SB 01 (0 0 5 bgs) at 721 mg/kg in Building 2 Area and Hotspot 2
- Sample RA 05SB 05 (0 0 5 bgs) at 1 790 mg/kg in Building 5 Area and Hotspot 5A
- Sample RA 07SB 15 (0 0 5 bgs) at 900 mg/kg in Building 7 Area and Hotspot 7C

Therefore both the Adult Lead Model and IEUBK model were used to predict blood lead levels for the receptors outlined in Section 3 2 of this report (i e current trespasser/site visitor future industrial/commercial worker future excavation/construction worker and future resident) for the areas listed above The models were also used to predict blood lead levels for the same receptors to site wide soils

The purpose of risk characterization is to quantify and describe the potential health risks associated with Site specific impacts

In this portion of the Risk Assessment potential health risks are estimated for each COPC and exposure pathway These risk estimates are calculated using the exposure parameters developed in **Section 3** and the toxicity values reported in **Section 4**

5 1 EQUATIONS AND MODELS USED TO CALCULATE RISKS AND HAZARDS

5 1 1 General Risk Equations

Potential cancer risks and non cancer hazard quotients have been calculated using the general equations that follow Because residences often include children exposure terms for children are included in the applicable cancer equations for the Hypothetical Future Resident scenario (i e dermal contact and incidental ingestion of soil) For adult only scenarios (industrial/commercial worker excavation/construction worker trespasser/site visitor) the child exposure terms are eliminated from the equations

Equation 1 (soil ingestion – cancer)

Resident Child and adult combined

$$CR = (CS^* CF_1^*EF^*SF_{oral}^*((IR_{child}^*ED_{ch\ ld}/BW_{h\ ld}) + (IR_{d\ lt}^*ED_{d\ lt}/BW_{ad\ lt})))/(AT_c)$$

Industrial/Commercial Excavation/Construction Trespasser/Site visitor

$$CR = (CS^* CF_1^*IR_{ad\ lt}^*EF^*ED_{ad\ lt}^*SF_{oral})/(BW_{d\ lt}^*AT)$$

Equation 2 (soil ingestion – non cancer)

Resident Child only

$$HI = (CS^* CF_1^*IR_{ch\ ld}^*EF^*ED_{ch\ ld})/(BW_{h\ ld}^*AT^*RfD_{oral})$$

Industrial/Commercial Excavation/Construction Trespasser/Site visitor

$$HI = (CS^* CF_1^*IR_{d\ lt}^*EF^*ED_{ad\ lt})/(BW_{dult}^*AT_c^*RfD_{oral})$$

Equation 3 (dermal contact with soil cancer)

Resident Child and adult combined

$$CR = (CS^* CF_1^*AD^*AB^*EF^*SF_{oral}^*((SA_{ch\ ld}^*ED_{child}/BW_{ch\ ld}) + (SA_{d\ lt}^*ED_{d\ lt}/BW_{d\ lt})))/(AT_c)$$

Industrial/Commercial Excavation/Construction Trespasser/Site visitor

$CR = (CS^* CF_1^*AD^*AB^* SA_{d\ lt}^*EF^*ED_{d\ lt}^*SF_{oral})/(BW_{d\ lt}^*AT)$

Equation 4 (dermal contact with soil non cancer)

Resident Child only

$HI = (CS^*CF_1^*AD^*AB^*SA_{ch\ ld}^*EF^*ED_{h\ ld})/(BW_{h\ ld}^*AT^* RfD_{ral})$

Industrial/Commercial Excavation/Construction Trespasser/Site visitor

$HI = (CS^* CF_1^*AD^*AB^*SA_{d\ lt}^*EF^*ED_{ad\ lt})/(BW_{d\ lt}^*AT_{nc}^* RfD_{o\ l})$

Equation 5 (inhalation of volatilized soil contaminants – cancer)

Excavation/Construction

$CR = (C^*IH_{d\ lt}^*ET^*EF^*ED_{d\ lt}^*SF_{hal})/(AT^*BW_{d\ lt})$

Equation 6 (inhalation of volatilized soil contaminants – non cancer)

Excavation/Construction

$HI = (C^*IH_{d\ lt}^*ET^*EF^*ED_{d\ lt})/(AT_{nc}^*BW_{d\ lt}^*RfD_{nhal})$

Equation 7 (groundwater ingestion cancer)

Excavation/Construction

$CR = (CW^*IR_{d\ lt}^*EF^*ED_{d\ lt}^*SF_{ral})/(BW_{ad\ lt}^*AT)$

Equation 8 (groundwater ingestion – non cancer)

Excavation/Construction

$HI = (CW^*IR_{d\ lt}^*EF^*ED_{d\ lt})/(BW_{d\ lt}^*AT_{nc}^*RfD_{oral})$

Equation 9 (direct dermal contact with groundwater cancer)

Excavation/Construction

$CR = (CW*CF_2*SA_{d\ lt}*PC*ET*EF*ED_{d\ lt}*SF_{ral})/(BW_{d\ lt}*AT\ )$

Equation 10 (direct dermal contact with groundwater non cancer)

Excavation/Construction

$HI = (CW*CF_2*SA_{d\ lt}*PC*ET*EF*ED_{d\ lt})/(BW_{d\ lt}*AT_{nc}*RfD\ _{l})$

Where

CR = Cancer risk (unitless)

CS = Contaminant concentration in soil (mg/kg)

CW = Contaminant concentration in water (mg/L)

C_{air} = Contaminant concentration in air (mg/m^3)

IR_{adult} = Adult ingestion rate (soil mg/day groundwater L/day)

IH_{adult} = Adult inhalation rate (m^3/hr)

IR_{child} = Child ingestion rate (soil mg/day)

EF = Exposure frequency (days/year)

ED_{child} = Child exposure duration (years)

ED_{adult} = Adult exposure duration (years)

BW_{child} = Child body weight (kg)

BW_{adult} = Adult body weight (kg)

CF_1 = Conversion factor (kg/mg)

CF_2 = Conversion factor (L/cm^3)

AT_c = Averaging time for carcinogenic effects (days)

AT_{nc} = Averaging time for non carcinogenic effects (days)

SA_{child} = Child exposed dermal surface area (cm^2/day)

SA_{adult} = Adult exposed dermal surface area (cm^2/day)

AB = Absorbed fraction (unitless)

AD = Adherence factor for soil (mg/cm^2)

PC = Permeability constant (cm/hr)

ET = Exposure Time (hours/day)

SF_{oral} = Oral cancer slope factor (mg/kg day) [1]

RfD_{oral} = Oral reference dose (mg/kg day)

SF_{inhal} = Inhalation cancer slope factor (mg/kg day) [1]

RfD_{inhal} = Inhalation reference dose (mg/kg day)

5 1 2 Contaminant Volatilization into a Building

The hazard/risks associated with volatilization into a building were estimated using the Johnson and Ettinger (J&E) advanced soil and groundwater models for chemical volatilization (i e vapor intrustion) into a building (USEPA 2003b) This is a spreadsheet application obtained from the USEPA that is used to evaluate potential emissions of VOCs from subsurface soil and groundwater into an overlying building Calculations were performed only for volatile COPCs Per USEPA guidance (USEPA 1991a) volatile chemicals are defined as chemicals with a molecular weight of less than 200 daltons and a Henry s Law constant of 1 x 10^{5} atm m^3/mole or greater Four VOCs (1 1 dichloroethylene 1 2 dichloroethane carbon tetrachloride and chloroform) were detected in groundwater at concentrations exceeding screening criteria in one well (02MW 01) No VOCs were detected in subsurface soil at concentrations exceeding screening criteria anywhere on site However to be conservative and regardless of whether the screening criteria were exceeded or not any soil VOC detections corresponding to groundwater VOC detections at 02MW 01 were targeted for evaluation for potential indoor air exposure to humans Based on this conservative approach it was determined that since 1 1 1 trichloroethane was detected in both soil and groundwater at 02MW 01 it would be evaluated using the advanced J&E soil model even though it was below screening criteria for both media

Since the buildings currently on the Site are likely to be replaced prior to reoccupation of the Site conservative default values (USEPA 2003b) were used in all J&E calculations for the following exposure parameters

- Average soil temperature (13 89 degrees C)
- Depth below grade to bottom of enclosed space (both 15 cm and 200 cm since both *slab on grade* and *basement* foundation scenarios were evaluated)
- Soil properties for silty clay
  - dry bulk density (1 38 g/cm^3)
  - total porosity (0 481 unitless)
  - water filled porosity (0 216 cm^3/cm^3)
  - organic carbon fraction (0 002 unitless)
- Enclosed space floor thickness (10 cm)
- Soil building pressure differential (40 g/cm s^2)
- Enclosed floor space length and width (1000 cm)
- Enclosed space height (366 cm)
- Floor wall crack width (0 1 cm)
- Indoor air exchange rate (0 25 unitless)
- Average vapor flow rate into building (5 L/min)

These default parameters are designed to be protective of residential properties (homes) and are considered protective for other building uses such as commercial/industrial buildings

Site specific parameters used in the J&E models were as follows

- Depth below grade to top of soil contamination (both 15 cm and 200 cm since both *slab on grade* and *basement* foundation scenarios were evaluated and it was assumed that contamination was uniform throughout the soil column between the building foundation and water table a conservative assumption)
- Depth below grade to bottom of soil contamination (272 5 cm = depth below grade to water level in monitoring well 02MW 01)
- Soil stratum (silty clay was identified as the dominant soil type throughout SLAAP including the 02MW 01 soil and groundwater sample location)

Exposure point concentrations were based on the maximum detected VOC concentrations in groundwater and soil thereby making a conservative assumption that the highest VOC concentrations found on the Site are present throughout the Site

5 1 3 Groundwater Chemical Volatilization into a Trench

The hazard/risks associated with inhalation of groundwater chemicals volatilized into a trench were estimated on a Site wide basis using a model outlined in a USEPA memo Derivation of a Volatilization Factor to Estimate Upper Bound Exposure Point Concentration for Workers in Trenches Flooded with Groundwater off gassing Volatile Organic Chemicals (USEPA 1999) Exposure point concentrations were based on the maximum detected chemical concentrations in groundwater The model estimates the concentration of a groundwater chemical in the trench air based on the multiplication of the chemical concentration in the groundwater by a volatilization factor for the chemical The volatilization factor is based on the rate of mass transfer of the chemical from the groundwater to the air and the rate of air exchange between the trench and surrounding air Standard risk equations are then applied to calculate the risk/hazard associated with inhalation of the estimated trench air concentrations

Conservative default values (USEPA 1999) for the mass transfer of volatile organic compounds were used The model was based on a trench 30 meters long and 3 meters high The trench width is not used in this model An air exchange rate of 0 15 exchanges per second (based on a 10 mile per hour wind speed) was used to account for air replenishment in the trench A mixing factor of 0 5 was incorporated to account for incomplete mixing of air in the trench

5 1 4 Exposure to Lead in Soils

For all exposure scenarios lead levels were compared to the MDNR CALM value of 260 mg/kg which in turn is based on the IEUBK lead model for children (USEPA 1994) For adult worker scenarios soil concentrations of less than 750 1 750 mg/kg are considered protective to a developing fetus in a pregnant site worker (the most sensitive endpoint of concern) however all exposure scenarios were evaluated for any area with at least one lead concentration in soil exceeding 260 mg/kg

5 2 RESULTS

Non carcinogenic hazard indices and carcinogenic risks for Site soils for each receptor population are presented on an area by area basis as summarized in the sections below **Tables 5-1** through **5-4** summarize the risks and hazards associated with Site soils Risks associated with groundwater are evaluated on a Site wide basis and are summarized in **Tables 5-5** and **5-6** Supporting risk calculations/spreadsheets are presented in **Attachment A**

5 2 1 Building 1

COPCs were identified in both surface soil and subsurface soil at Building 1

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 2 X 10^{7} (trespassers/site visitors) to 1 X 10^{5} (hypothetical future residents) and RME hazard indices ranged from 0 0009 (trespassers/site visitors) to 0 2 (hypothetical future residents) The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 3 X 10^{6} and the RME hazard index was 0 02

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 5 X 10^{8} and the RME hazard index was 0 01

5 2 2 Building 2

COPCs were identified in both surface soil and subsurface soil at Building 2

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 6 X 10^{7} (trespassers/site visitors) to 4 X 10^{5} (hypothetical future residents) and RME hazard indices ranged from 0 02 (trespassers/site visitors) to 3 (hypothetical future residents) Aroclor 1248 was the primary contributor to the elevated hazard index for the hypothetical future resident scenario The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 9 X 10^{6} and the RME hazard index was 0 3

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 2 X 10^{7} and the RME hazard index was 0 2

Lead was also identified as a COPC for Building 2 at a maximum detected concentration of 721 mg/kg (surface soil) The exposure point concentration for surface soil was 73 9 mg/kg which is below the level of concern of 260 mg/kg for child populations The exposure point concentration for combined subsurface and surface soil was 35 mg/kg which is below the target range of 750 1 750 mg/kg for adult populations For non residential scenarios the probability that fetal PbB would exceed the PbB_t (i e 10 ug/dL) ranged from 0 6 to 0 9% below the 5% threshold recommended by USEPA (USEPA 2003c) For the residential scenario modeled PbB levels ranged from 1 8 to 2 7 ug/dL below the threshold of 10 ug/dL recommended by USEPA (USEPA 2002e)

5 2 3 Building 4

COPCs were identified in both surface soil and subsurface soil at Building 4

None of the surface soil COPCs are potential carcinogens RME hazard indices ranged from 0 0004 (trespassers/site visitors) to 0 1 (hypothetical future residents) The RME hazard index for industrial/commercial workers which is considered the most likely future use of the Site was 0 009

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0-10 feet bgs) was estimated at 3×10^{-8} and the RME hazard index was 0 005

5 2 4 Building 5

COPCs were identified in both surface soil and subsurface soil at Building 5

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 4×10^{6} (trespassers/site visitors) to 2×10^{-4} (hypothetical future residents) and RME hazard indices ranged from 0 03 (trespassers/site visitors) to 6 (hypothetical future residents) The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 5×10^{5} and the RME hazard index was 0 5 DDT was the primary contributor to the elevated hazard index DDT and benzo(a)pyrene were the primary contributors to the elevated cancer risks

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 1×10^{6} and the RME hazard index was 0 9

Lead was also identified as a COPC for Building 5 at a maximum detected concentration of 1790 mg/kg (surface soil) The exposure point concentration for surface soil was 140 1 mg/kg which is below the level of concern of 260 mg/kg for child populations The exposure point concentration for combined subsurface and surface soil was 79 4 mg/kg which is below the target range for adult populations For non residential scenarios the probability that fetal PbB would exceed the PbB_t (i e , 10 ug/dL) ranged from 0 6 to 0 9%, below the 5% threshold recommended by USEPA (USEPA 2003c) For the residential scenario modeled PbB levels ranged from 2 2 to 3 5 ug/dL below the threshold of 10 ug/dL recommended by USEPA (USEPA 2002e)

5 2 5 Building 6

COPCs were identified in both surface soil and subsurface soil at Building 6

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 3×10^{9} (trespassers/site visitors) to 2×10^{7} (hypothetical future residents) and RME hazard indices ranged from 0 0001 (trespassers/site visitors) to 0 04 (hypothetical future residents) The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 5×10^{8} and the RME hazard index was 0 003

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 1×10^{8} and the RME hazard index was 0 02

5 2 6 Building 7

COPCs were identified in both surface soil and subsurface soil at Building 7

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 6 X 10^{7} (trespassers/site visitors) to 3 X 10^{5} (hypothetical future residents) and RME hazard indices ranged from 0 09 (trespassers/site visitors) to 0 2 (hypothetical future residents) The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 8 X 10^{6} and the RME hazard index was 0 02

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 1 X 10^{7} and the RME hazard index was 0 02

Lead was also identified as a COPC for Building 7 at a maximum detected concentration of 900 mg/kg (surface soil) The exposure point concentration for surface soil was 82 mg/kg which is below the level of concern of 260 mg/kg for child populations The exposure point concentration for combined subsurface and surface soil was 46 5 mg/kg which is below the target range of 750 1 750 mg/kg for adult populations For non residential scenarios the probability that fetal PbB would exceed the PbB_t (i e 10 ug/dL) ranged from 0 6 to 1 0% below the 5% threshold recommended by USEPA (USEPA 2003c) For the residential scenario modeled PbB levels ranged from 1 8 to 2 8 ug/dL below the threshold of 10 ug/dL recommended by USEPA (USEPA 2002e)

5 2 7 Building 8

COPCs were identified in both surface soil and subsurface soil at Building 8 None of the COPCs identified in surface soil in this area have RfDs therefore no hazard indices were calculated for surface soil in this area

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 3 X 10^{8} (trespassers/site visitors) to 1 X 10^{6} (hypothetical future residents) The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 4 X 10^{7}

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 3 X 10^{8} and the RME hazard index was 0 003

5 2 8 Northeast Parking Area

COPCs were identified in both surface soil and subsurface soil at the Northeast Parking Area None of the COPCs identified in soil in this area have RfDs therefore no hazard indices were calculated for surface soil in this area

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 2 X 10^{7} (trespassers/site visitors) to 1 X 10^{5} (hypothetical future residents) The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 3 X 10^{6}

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 7 X 10^{8}

5 2 9 Railroads

COPCs were identified in both surface soil and subsurface soil at the Railroads None of the COPCs identified in surface soil in this area have RfDs therefore no hazard indices were calculated for surface soil in this area

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 2 X 10^{8} (trespassers/site visitors) to 1 X 10^{6} (hypothetical future residents) The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 3 X 10^{7}

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 8 X 10^{9} and the RME hazard index was 0 005

5 2 10 Roadways

COPCs were identified in both surface soil and subsurface soil at the Roadways

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 6 X 10^{8} (trespassers/site visitors) to 3 X 10^{6} (hypothetical future residents) and RME hazard indices ranged from 0 002 (trespassers/site visitors) to 0 5 (hypothetical future residents) The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 8 X 10^{7} and the RME hazard index was 0 04

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 3 X 10^{8} and the RME hazard index was 0 09

5 2 11 Hotspot Areas

Hotspot areas identified from the sampling results cover relatively small areas of the Site, and as such are likely to overestimate risks to individuals who will work or reside in larger areas The exception is Hotspot 2 which essentially covers the entire footprint of Building 2[2] Cancer risks and hazard indices for each of the individual Hotspot areas are summarized in **Tables 5-1** through **5-4**, and are not repeated verbatim here Hotspots that exceeded either a cancer risk of 1 X 10^{-4} or a hazard index of 1 are briefly discussed below

For surface soils Hotspot 5A was the only Hotspot that exceeded a cancer risk of 1 X 10^{-4} (residents 1 X 10^{3} industrial/commercial workers 3 X 10^{-4}) DDT and benzo(a)pyrene were

[2] Hotspot 2 is considered somewhat of an anomaly relative to the other hotspots Because this hotspot covers such a large area it contains a large number (19) of samples including most of the systematic (gridded) samples collected for the risk assessment as well as characterization samples collected throughout the building for the SSEBS As a result the calculated hotspot RME exposure point concentration for PCB of 2 4 mg/kg is slightly less than that calculated for the Building 2 risk samples (3 3 mg/kg) and the resultant hazard index calculations are also slightly lower for the hotspot

the primary contributors to risk at Hotspot 5A Hotspots 2 (resident HI of 2) and 5A (resident HI of 33 and industrial/commercial worker HI of 3) were the only Hotspots that exceeded a hazard index of 1 For Hotspot 2 Aroclor 1248 was the primary contributor to the elevated hazard index for Hotspot 5A DDT was the primary contributor

For combined subsurface and surface soils no Hotspots exceeded a cancer risk of 1 X 10^{-4} Hotspot 5A was the only Hotspot that exceeded a hazard index of 1 (excavation/construction worker HI of 8) DDT was the primary contributor to the elevated hazard index

Lead was also identified as a COPC for Hotspots 2 5A and 7C at maximum detected concentrations of 721 mg/kg (Hotspot 2) 1 790 (Hotspot 5A) and 900 mg/kg (Hotspot 7C) The exposure point concentrations for surface soil were as follows

- 80 mg/kg (Hotspot 2)
- 1 790mg/kg (Hotspot 5A)
- 900 mg/kg (Hotspot 7C)

The exposure point concentration for combined subsurface and surface soil were as follows

- 40 mg/kg (Hotspot 2)
- 905 mg/kg (Hotspot 5A)
- 306 7 mg/kg (Hotspot 7C)

For non residential scenarios the probability that fetal PbB would exceed the PbB_t (i e 10 ug/dL) are as follows

- 0 6 to 1 0% (Hotspot 2)
- 0 6 to 30 2% (Hotspot 5A)
- 0 6 to 12 2% (Hotspot 7C)

For the residential scenario modeled PbB levels are as follows

- 1 8 to 2 7 ug/dL (Hotspot 2)
- 10 4 to 17 4 ug/dL (Hotspot 5A)
- 6 3 to 11 0 ug/dL (Hotspot 7C)

5 2 12 Site Wide Soils

Site wide risks were estimated by combining soil samples from across the entire Site Just as the use of Hotspot data can potentially overestimate risk the combining of data from across the entire Site can potentially underestimate risks to individuals who may only be exposed to only a portion of the Site

For the Site wide evaluation COPCs were identified in both surface soil and subsurface soil

RME cancer risks associated with surface soil (0 0 5 feet bgs) ranged from 2 X 10^{6} (trespassers/site visitors) to 1 X 10^{-4} (hypothetical future residents) and RME hazard indices ranged from 0 03 (trespassers/site visitors) to 6 (hypothetical future residents) The primary contributors to the elevated hazard index were Aroclor 1248 Aroclor 1254 and DDT The

RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 3 X 10^{5} and the RME hazard index was 0 6

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0 10 feet bgs) was estimated at 5 X 10^{7} and the RME hazard index was 0 7

Lead was also identified as a COPC on a Site wide basis with a maximum detected concentration of 1 790 mg/kg (surface soil) The exposure point concentration for surface soil was 48 1 mg/kg which is below the level of concern of 260 mg/kg for child populations The exposure point concentration for combined subsurface and surface soil was 24 6 mg/kg which is below the target range of 750 1 750 mg/kg for adult populations For non residential scenarios the probability that fetal PbB would exceed the PbB_t (i e 10 ug/dL) ranged from 0 6 to 0 8% below the 5% threshold recommended by USEPA (USEPA 2003c) For the residential scenario modeled PbB levels ranged from 1 6 to 2 3 ug/dL below the threshold of 10 ug/dL recommended by USEPA (USEPA 2002e)

5 2 13 Site Wide Groundwater

Groundwater and subsurface soil were evaluated on a Site wide basis for potential vapor intrusion into buildings and construction trenches and for direct contact (dermal and incidental ingestion) pathways in a trench

As seen in **Table 5-5** risks and hazards associated with vapor intrusion into a building are low The total cancer risks are 1 X 10^{7} and 3 x 10^{7} for slab on grade and basement structures respectively The hazard indices are 0 0009 and 0 001 for slab on grade and basement structures respectively It is important to note that the maximum detected concentrations of all volatile COPCs were found at the same location (02MW 01) Although groundwater and subsurface soil were evaluated on a Site wide basis the results from the J&E modeling are most representative for the area immediately adjacent to well 02MW 01 risks and hazards for other areas of the Site are likely to be lower

Similar to vapor intrusion into a building risks associated with direct exposure to groundwater in a trench and inhalation of VOCs released from groundwater into the trench are also low (**Table 5-6**) The RME hazard index is estimated to be 0 03 and the RME cancer risk is 7 X 10^{7}

5 2 14 Building Related Materials

As discussed in **Section 3 2** buildings on site may contain contaminants such as lead PCBs or asbestos Risks associated with such materials cannot be readily quantified using standard risk assessment protocols however as discussed below they have been evaluated to some extent as part of the SSEBS

PCBs asbestos and lead based paint are all believed to be present at concentrations exceeding regulatory action levels on multiple building surfaces across the Site PCBs have been detected in excess of action levels in wipe samples from buildings 1 4 and 5 and above the CALM (MDNR 2001) in concrete samples from Building 2 Asbestos has been found in buildings throughout the Site in materials such as thermal systems insulation transite siding wall coverings and floor tiles No comprehensive lead based paint survey of the facility has been

conducted but lead based paint was found in the former Building 3 and is assumed to be present in all buildings at the Site

The exceedance of regulatory standards indicates the potential for unacceptable exposure to workers in one or more buildings as they currently exist Any building on Site that is to be occupied should be thoroughly surveyed to identify materials containing contamination that could affect the proposed use of that building

The USEPA guidance for risk assessments provides a systematic means for organizing analyzing and presenting information on the nature and magnitude of potential risks to human health posed by exposure to chemicals based on current and hypothetical future exposure pathways Despite the advanced state of the current methodology uncertainties and limitations are inherent in the risk assessment process The uncertainty can lead to an over or under estimation of potential risks Available data quality incomplete information about existing conditions and future circumstances as well as other factors discussed below contribute to these uncertainties and limitations

This section identifies some of the uncertainties associated with this risk assessment in order to help site decision makers (USEPA MDNR USACE Department of the Army [BRAC] etc) make informed decisions about future site use Uncertainties are discussed as they relate to each of the following portions of the risk assessment

- Data collection
- Data evaluation
- Exposure point concentrations
- Exposure assessment
- Toxicity assessment
- Risk characterization

6 1 DATA COLLECTION

There are several sources of uncertainty associated with data collection These may include both sampling and analysis

6 1 1 Sampling Uncertainties

In the risk assessment it was assumed that samples collected were representative of the area to which various populations may be exposed However the collected samples may not be completely representative due to random variability of samples Chemicals in Site soils may not be homogeneously distributed in the environment Variability in the selection of sampling locations may result in either an over or under estimation of actual chemical concentrations and thus an over or under estimation of Site risks

Another sampling uncertainty involves the suite of analytes that were analyzed In particular dioxin analysis was not conducted over most of the Site In the area where dioxin analysis was conducted (Building 2) the dioxins contributed 2×10^{5} risk to the residential scenario Samples collected around the outside of Building 2 contained lower dioxin levels Given the incineration activities that occurred at Building 2 in conjunction with the presence of PCBs it is not surprising that dioxins were present While it is likely that dioxin levels are lower on other portions of the Site, and that some dioxins are likely to be present as anthropogenic background the lack of dioxin data may result in an underestimation of risk for the remainder of the Site

6 1 2 Sampling Analysis

Samples were analyzed using USEPA approved procedures and were subject to data validation procedures to assure that data were suitable for use in decision making However sample analysis is subject to uncertainties with precision and accuracy Uncertainties associated with precision and accuracy of analytical methods are generally random While these sources of error are typically of low magnitude compared to other sources of uncertainty they may contribute to an over or under estimation of risks Given the extensive data validation efforts that were performed on the Site data it is reasonable to conclude that the data used in the HHRA were of acceptable quality

6 2 DATA EVALUATION

In evaluating data it was assumed that a chemical not detected in a given sample was actually present at one half of its sample quantitation limit These concentrations are used in the calculation of the arithmetic mean and 95% UCL of a chemical concentration This is a conservative approach that may lead to an over estimation of risks when sample quantitation limits are high or measured chemical concentrations are very low

Of the qualified data presented in **Attachment B** the vast majority were either U qualified indicating non detect or UJ qualified indicating the data were non detected and the Practical Quantitation Limit (PQL often referred to as the reporting limit or detection limit) was estimated In addition a number of SVOC results were qualified with J (estimated concentration) as well as many samples for a few metals (thallium mercury) A review of the data indicates that most of the J qualified data were estimated at concentrations below the PQL While there is some uncertainty as to whether these low values under or over estimate actual concentrations it is unlikely that any of these reported values exceed their respective PQLs Since all data were reviewed by a chemist with a portion undergoing full data validation and found to be of acceptable quality for use in the risk assessment both J and UJ qualified data were used

6 3 EXPOSURE POINT CONCENTRATIONS

The 95% UCL of a chemical concentration was used to estimate the RME exposure point concentration for that chemical in some instances This is a conservative estimation of the chemical concentration and likely results in an over estimation of potential risk For this reason CTE values were also calculated to characterize the average risks

In the case of groundwater which was evaluated on a Site wide basis the highest measured concentrations were used as the exposure point concentrations This is a worst case scenario that could lead to an over estimation of Site related risks for some portions of the Site

Vapor intrusion into buildings was estimated using by using both soil and groundwater data in the Johnson & Ettinger model EPA's Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (USEPA, 2002d) recommends that soil gas data be used for estimating vapor intrusion but since this guidance document was released after the completion of the initial field work no soil gas data were available While the lack of soil gas data represents a potential under estimation of risk it is believed that this under estimation is

minor compared to the likely overestimation of risk given the conservative nature of the Johnson & Ettinger model In addition a worst case scenario monitoring well that was assumed to be representative of groundwater site wide A potential uncertainty in estimating vapor intrusion exists due to the lack of groundwater data from directly beneath the existing buildings Given the likelihood of future site owners demolishing the existing structures and the distribution of monitoring wells across the site it is impossible to say whether the lack of data beneath the existing structures represents an over estimation or under estimation of risks to a future occupant

It was conservatively assumed that chemical concentrations would remain unchanged with time The potential reduction in concentration by migration degradation and natural attenuation was not considered In reality these processes will likely reduce the chemical concentrations for future exposure scenarios The use of existing chemical concentrations for future use scenarios likely results in an over estimation of potential Site related risks

In some cases models (EMSOFT Johnson & Ettinger etc) were used to characterize the transport of a chemical from the source media to an exposure point These models are generalizations of the many interacting transport mechanisms that may be present for a chemical at a Site The ability of these models to accurately predict chemical transport may vary depending on the environmental conditions present at the Site The models are generally conservative containing assumptions and estimations of chemical properties that likely over estimate the amount of chemical that is available for exposure In addition they do not account for all modes of transport and degradation some of which may attenuate the movement of the chemical from the source area to the exposure point In contrast the use of Site specific assumptions such as mean wind speed could lead to an underestimation of exposure point concentrations during days when there is little wind Given that the HHRA is intended to evaluate risks and hazards over an extended time (i e at least one month) the use of such Site specific values will probably not result in any underestimation of risks and hazards Given the other conservative elements inherent in these models the use of such models is likely to result in an overestimation of risks and hazards rather than an underestimation

Several of the models (EMSOFT groundwater to trench volatilization model etc) used in the estimation of exposure point concentrations are not sophisticated numeric models that entail model validation and reiterative processing of data to drive the modeled results As such the ability of these models to accurately predict chemical transport under the Site conditions may not be well understood Given the uncertainty inherent in these models they are usually designed with conservative assumptions and are likely to over predict exposure to Site related chemicals

6 4 EXPOSURE ASSESSMENT

The exposure assessment relied on a number of assumptions for potential human exposure Assumptions used were based upon the following

- Site specific information
- USEPA risk assessment guidances
- Professional judgement

The CTE scenarios represent assumptions which are considered central values or realistically conservative estimates for the exposed population However even the CTE scenarios assume individuals are exposed on a relatively continuous basis over a long period of time which likely over estimates actual exposures

The RME scenarios are developed to provide an upper bound risk estimate These scenarios are based on a combination of maximum exposure assumptions for exposure variables and are thus highly likely to over estimate potential risks

Both CTE and RME exposure scenarios provide useful information when characterizing site risks and when making site management decisions

6 5 TOXICITY ASSESSMENT

In general the available scientific information is insufficient to provide a thorough understanding of all the potential toxic properties of chemicals to which humans may be exposed Consequently varying degrees of uncertainty surround the assessment of adverse health effects in the exposed populations Sources of uncertainty related directly to toxicity data include

- Use of dose response data from experiments on homogeneous sensitive animal populations to predict effects in heterogeneous human populations with a wide range of sensitivities
- Extrapolation of data from 1) high dose animal studies to low dose human exposures 2) acute or subchronic toxicity studies to chronic exposure scenarios and 3) one exposure route to another (e g from ingestion to dermal absorption)
- Use of single chemical test data that do not account for multiple exposures or synergistic and antagonistic responses
- Toxicity values (RfDs or SFs) are predicted values and have incorporated factors to provide a margin of safety for even the most sensitive subpopulations and likely over estimate potential risks for all receptors evaluated in this risk assessment

Based on the above a high degree of uncertainty may be associated with the toxicity values used in this risk assessment In an attempt to minimize the consequences of uncertainty USEPA typically relies on a conservative approach in determining toxicity values The current USEPA toxicity values used in this risk assessment are likely to over estimate the potential risk and hazard

6 6 RISK CHARACTERIZATION

Several background chemicals were found at the Site at levels exceeding their respective health based screening levels These included inorganic compounds which are often present as naturally occurring compounds and organic compounds (PAHs) which are present in many urban areas as anthropogenic (man made) background As discussed in USEPA s guidance on evaluation of background chemicals (USEPA 2002b) these chemicals were retained in the risk assessment as COPCs whenever the screening values were exceeded In the case of inorganic compounds quantitative risk values were not calculated if the COPCs exceeded screening levels but were present at background levels However risks were calculated for inorganic COPCs if

both screening levels and background levels were exceeded In the case of organic COPCs risks were calculated whenever screening concentrations were exceeded regardless of whether the chemicals were present at background levels Inclusion of background chemicals in the risk calculations will tend to overestimate Site related risks and hazards since the incremental risks associated with the background level has been included in the overall calculation Exclusion of inorganic chemicals present at background levels will result in an underestimation of total risks but will not affect the Site related risk estimates since these chemicals are not Site related

It should be noted that in general the risks associated with background chemicals are relatively low usually in the 10^{6} to 10^{5} range Arsenic is an exception The Site specific background concentration for arsenic is 13 22 mg/kg At this concentration the estimated cancer risk to a residential receptor is 4×10^{5} and the hazard index is 0 6

Because there are uncertainties in each step of the risk assessment process these uncertainties are often magnified in the final risk characterization The final quantitative estimates of risk may be one or several orders of magnitude different from the actual potential risk associated with a given exposure Because of the conservative approaches used in each step the overall results of this risk assessment are most likely to over estimate the potential Site risks

The HHRA for SLAAP evaluated potential risks and hazards for soils and groundwater for several alternative land use scenarios in support of the FOST process Alternative scenarios evaluated included trespassers commercial/industrial workers excavation workers and hypothetical future residents Cancer risks and hazard indices were calculated for numerous exposure areas and hotspots across the Site as well as on a Site wide basis for both RME (high end) and CTE (mid range) conditions

For soils at most areas of the Site and for Site wide groundwater the RME cancer risks were within or below the target risk range of 10^{-4} to 10^{-6} identified in the National Oil and Hazardous Substances Pollution Contingency Plan (USEPA 1990) most hazard indices were below the threshold of 1 and most PbB levels were below acceptable thresholds The CTE cancer risks hazard indices and PbB levels were even lower The 10^{-4} risk criterion is utilized within the HHRA for comparison purposes since risks that exceed this level are above both EPA and MDNR benchmark levels and represent a level of concern The acceptable risk level for the Site has not been established and will ultimately be determined as part of a risk management decision that is beyond the scope of the HHRA

Areas found to exceed a cancer risk of 10^{-4} or hazard index of 1 are listed below

- Building 2 An RME hazard index of 3 was calculated for a hypothetical future resident Aroclor 1248[3] was the primary contributor to this elevated hazard index The CTE hazard index for this receptor was 0 4
- Building 5 An RME hazard index of 6 and a cancer risk of 2×10^{-4} was calculated for a hypothetical future resident The CTE hazard index was 1 and the CTE cancer risk was 2×10^{-5} The pesticide DDT was the primary contributor to the hazard index DDT and benzo(a)pyrene were the primary contributors to the cancer risks
- Hotspot 2 This Hotspot covers the majority of the Building 2 footprint An RME hazard index of 2 was calculated for a residential scenario The CTE hazard index was 0 4 Aroclor 1248 was the primary contributor to this hazard index
- Hotspot 5A This Hotspot covers a small portion of the Building 5 footprint RME cancer risks were 1×10^{-3} for residents and 3×10^{-4} for industrial/commercial workers CTE cancer risks were 4×10^{-4} for residents and 2×10^{-5} for industrial/commercial workers RME Hazard indices were 33 for residents and 3 for industrial/commercial workers CTE Hazard indices were 15 for residents and 1 for industrial/commercial workers DDT was the primary contributor to the hazard index DDT and Aroclor 1248 were the primary contributors to the cancer risks
- Site wide soils Site wide risks and hazards were calculated by combining soil samples from across the entire Site The RME hazard index was 6 for the residential scenario and the CTE hazard index was 1 The primary contributors to the elevated hazard index were Aroclor 1248 Aroclor 1254 and DDT It is important to note that while these risks are defined as Site wide the distribution of these chemicals is relatively limited to a few portions of the Site

[3] The term PCB 1248 and Aroclor 1248 are synonymous terms as are PCB 1254 and Aroclor 1254

Areas found to exceed recommended thresholds for PbB levels are listed below

- Hotspot 5A This Hotspot covers a small portion of the Building 5 footprint For non residential scenarios the probabilities that fetal PbB would exceed the PbB_t (i e 10 ug/dL) range from 0 6 to 30 2% exceeding the 5% threshold recommended by USEPA (USEPA 2003c) For the residential scenario modeled PbB levels ranged from 10 4 to 17 4 ug/dL exceeding the threshold of 10 ug/dL recommended by USEPA (USEPA 2002e)
- Hotspot 7C This Hotspot covers a small portion of the Building 7 footprint For non residential scenarios the probabilities that fetal PbB would exceed the PbB_t (i e 10 ug/dL) range from 0 6 to 12 2% exceeding the 5% threshold recommended by USEPA (USEPA 2003c) For the residential scenario modeled PbB levels ranged from 6 3 to 11 0 ug/dL exceeding the threshold of 10 ug/dL recommended by USEPA (USEPA 2002e)

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U S Environmental Protection Agency (USEPA) 2002b Role of Background in the CERCLA Cleanup Program OSWER 9285 6 07P April

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Table 3 1
Exposure Areas Evaluated in the HHRA
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

EXPOSURE AREA	
Focused Hotspot Areas	Systematic Risk Assessment Areas
Building 1 hotspot A (1A)	Building 1
Building 1 hotspot B (1B)	Building 2
Building 1 hotspot C (1C)	Building 4
Building 2 hotspot (2)	Building 5
Building 4 hotspot A (4A)	Building 6
Building 4 hotspot B (4B)	Building 7
Building 4 hotspot C (4C)	Building 8
Building 4 hotspot D (4D)	Northeast Parking Area
Building 5 hotspot A (5A)	Railroads
Building 5 hotspot B (5B)	Roadways
Building 6 hotspot (6)	
Building 7 hotspot A (7A)	Combined Data points
Building 7 hotspot B (7B)	Site Wide
Building 7 hotspot C (7C)	
Building 8 hotspot A (8A)	
Building 8 hotspot B (8B)	
Northeast Parking Area hotspot (NE)	
Roadways hotspot A (RDA)	
Roadways hotspot B (RDB)	
Roadways hotspot C (RDC)	
Railroad hotspot (RR)	
Sewer Line hotspot A (SEA)	
Sewer Line hotspot B (SEB)	

TABLE 3 2
Exposure Parameters
Human Health Risk Asessment
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Future Excavation/ Construction Worker		Future Worker		Current Trespasser		Hypothetical Future Resident	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Exposure Frequency (days/year)	30	60	250	250	6	12	350	350
Exposure Duration (years)	1	1	5	25	9	30	6/3[a]	6/24[a]
Incidental Soil Ingestion Rate (mg/day)	100	330	50	100	50	100	100/50	200/100
Incidental Groundwater Ingestion Rate (ml/day)	1	2						
Body Weight (kg)	70	70	70	70	70	70	15/70[a]	15/70[a]
Averaging Time for Non Carcinogens (days)	42	84	1 825	9 125	3 285	10 950	2 190	2 190
Averaging Time for Carcinogens (days)	25 550	25 550	25 550	25 550	25 550	25 550	25 550	25 550
Area of Exposed Skin (cm^2)	2 000	3 300	2 000	3 300	2 000	3 300	1440/2000[a]	1913/3300[a]
Exposure Time (hours/day)	2	4						
Inhalation Rate (m^3/hour)	1 3	2 05						
Permeability Constant (cm/hr)	chemical specific							
Dermal Soil Adherence Factor (mg/cm^2)	0 2	0 9	0 03	0 2	0 04	0 3	0 04	0 3
Dermal Absorption Factor (unitless)	chemical specific							

[a] Residential exposure is evaluated using a combined child/adult scenario for cancer effects child only for non cancer effects

Table 4 1
Toxicity Values for Chemicals of Potential Concern
Human Health Risk Assessment
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Chemical	Permeability Constant (cm/hr)	Dermal Absorption (unitless)	Slope Factor				Chronic Reference Dose				Subchronic Reference Dose			
			Oral (mg/kg day)		Inhalation (mg/kg-day)		Oral (mg/kg day)		Inhalation (mg/kg-day)		Oral (mg/kg-day)		Inhalation (mg/kg-day)	
Aroclor 1248	NA	1 4E 1	2/1	IRIS	NA		NTV		NA		NTV		NA	
Aroclor 1254	NA	1 4E 1	2/1[6]	IRIS	NA		2 0E 5	IRIS	NA		5 0E 5	HEAST	NA	
Benzo(a)anthracene	4 7E 1	1 3E 1	7 3E 1	NCEA	NA		NTV		NA		NTV		NA	
Benzo(a)pyrene	7 0E 1	1 3E 1	7 3E+0	IRIS	NA		NTV		NA		NTV		NA	
Benzo(b)fluoranthene	7 0E 1	1 3E 1	7 3E 1	NCEA	NA		NTV		NA		NTV		NA	
Benzo(k)fluoranthene	7 0E 1	1 3E 1	7 3E 2	NCEA	NA		NTV		NA		NTV		NA	
Carbon Tetrachloride	1 6E 2	NA	1 3E 1	IRIS	5 3E 2	IRIS	7 0E-4	IRIS	7 0E-4	R2R	7 0E-4	IRIS	7 0E 4	R2R
Chloroform	6 8E 3	0	NTV		NTV		1 0E 2	IRIS	8 6E 4	NCEA	1 0E 2	HEAST	8 6E 4	NCEA
Chrysene	4 7E 1	NA	7 3E 3	IRIS	NA		NTV		NA		NTV		NA	
DDE	NA	3 0E 2	3 4E 1	IRIS	NA		5 0E-4	DDT	NA		5 0E-4	DDT	NA	
DDT	NA	3 0E 2	3 4E 1	IRIS	NA		5 0E-4	IRIS	NA		5 0E-4	IRIS	NA	
1 1 Dichloroethene	1 2E 2	0	NTV		NTV		5 0E 2	IRIS	5 7E 2	IRIS	5 0E 2		5 7E 2	HEAST
Dibenzo(a h)anthracene	1 5E+0	1 3E 1	7 3E+0	NCEA	NA		NTV		NA		NTV		NA	
1 2 Dichloroethane	4 2E 3	0	9 1E 2	IRIS	9 1E 2	IRIS	3 0E 2	NCEA	1 4E 3	NCEA	3 0E 2	NCEA	1 4E 3	NCEA
1 2 Diphenylhydrazine	1 3E 2	NA	8 0E 1	IRIS	NA		NTV		NA		NTV		NA	
Indeno(1 2 3 cd)pyrene	1 0E+0	1 3E 1	7 3E 1	NCEA	NA		NTV		NA		NTV		NA	
Polychlorinated biphenyls	NA	1 4E 1	2/1[6]	IRIS	NA		NTV		NA		NTV		NA	
TCDD	NA	3 0E 2	1 5E+5	HEAST	NA		NTV		NTV		NTV		NA	
Total Aroclors	NA	1 4E 1	2/1	IRIS	NA		NTV		NA		NTV		NA	
Antimony[1]	NA	0	NTV		NA		4 0E-4	IRIS	NA		4 0E-4	HEAST	NA	
Arsenic[2]	1 0E 3	3 0E 2	1 5E+0	IRIS	NA		3 0E-4	IRIS	NA		3 0E-4	HEAST	NA	
Barium	NA	0	NTV		NA		7 0E 2	IRIS	NA		7 0E 2	HEAST	NA	
Beryllium	NA	0	NTV		NA		2 0E 3	IRIS	NA		5 0E 3	HEAST	NA	
Cadmium	NA	1 0E 3	NTV		NA		5 0E-4	IRIS	NA		NTV		NA	
Chromium[3]	NA	0	NTV		NA		3 0E 3	IRIS	NA		2 0E 2	HEAST	NA	
Copper	NA	0	NTV		NA		4 0E 2	HEAST	NA		4 0E 2	HEAST	NA	
Lead[5]	NA	0	NTV		NA		NTV		NA		NTV		NA	
Mercury[7]	NA	0	NTV		NA		3 0E 4	IRIS	NA		3 0E 3	HEAST	NA	

NTV indicates that no toxicity value was found for that chemical of concern
NA indicates that the exposure pathway is not applicable to this risk evaluation
Oral reference dose is for metallic antimony
[2]Oral reference dose is for inorganic arsenic
[3]Oral reference dose is for chromium VI salt
Route tp-route extrapolation from oral value
[5]EPA does not supply toxicity values for lead Lead is evaluated using the IEUBK model for children or the adult lead model for adults
Slope Factor for polychlorinated biphenyls is dependent on exposure pathway For relevant pathways at SLAAP RME SF is 2 0 CTE SF is 1 0
[7]Oral reference dose is for mercuric chloride

Table 5 1
Potential Risks and Hazards for Excavation/Construction Workers
Surface and Subsurface Soils
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Exposure Area	Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Systematic Risk Assessment Areas				
Building 1	0 0023	3 1E 9	0 014	4 8E 8
Building 2	0 015	1 0E 8	0 17	1 8E 7
Building 4	0 0014	1 8E 9	0 0054	2 7E 8
Building 5	0 085	4 4E 8	0 85	9 5E 7
Building 6	0 0036	5 9E 10	0 024	1 1E 8
Building 7	0 0047	6 6E 9	0 023	1 0E 7
Building 8	0 0010	2 2E 9	0 0034	2 8E 8
Northeast Parking Area	0	3 9E 9	0	6 8E 8
Railroads	0 0014	6 9E 10	0 0050	8 1E 9
Roadways	0 024	2 1E 9	0 085	2 5E 8
Combined Data points				
Site Wide	0 10	3 8E 8	0 68	5 0E 7
Focused Hotspot Areas				
Building 1 hotspot A (1A)	0 0032	2 7E 10	0 031	1 0E 8
Building 1 hotspot B (1B)	0 0069	9 5E 9	0 060	2 1E 7
Building 1 hotspot C (1C)	0 035	2 6E 8	0 20	3 0E 7
Building 2 hotspot (2)	0 018	1 8E 8	0 17	2 4E 7
Building 4 hotspot A (4A)	0 0015	8 5E 9	0 006	1 9E 7
Building 4 hotspot B (4B)	0 0014	3 2E 8	0 0054	9 4E 7
Building 4 hotspot C (4C)	0	7 7E 9	0	1 4E 7
Building 4 hotspot D (4D)	0 0019	0 0E+0	0 0076	0 0E+0
Building 5 hotspot A (5A)	1 3	6 7E 7	8 0	9 9E 6
Building 5 hotspot B (5B)	0	1 5E 8	0	3 3E 7
Building 6 hotspot (6)	0 0033	4 8E 10	0 021	8 6E 9
Building 7 hotspot A (7A)	0 0046	1 4E 8	0 025	2 8E 7
Building 7 hotspot B (7B)	0 00015	8 4E 10	0 00088	1 3E 8
Building 7 hotspot C (7C)	0 0019	2 4E 9	0 0071	6 0E 8
Building 8 hotspot A (8A)	0	7 0E 9	0	1 5E 7
Building 8 hotspot B (8B)	0	3 4E 9	0	5 8E 8
Northeast Parking Area hotspot (NE)	0	1 7E 8	0	4 5E 7
Roadways hotspot A (RDA)	0	1 1E 8	0	2 7E 7
Roadways hotspot B (RDB)	0 036	1 7E 9	0 29	3 9E 8
Roadways hotspot C (RDC)	0 0020	0 0E+0	0 0081	0 0E+0
Railroad hotspot (RR)	0 0019	0	0 0090	0
Sewer Line hotspot A (SEA)	0	3 0E 8	0	5 5E 7
Sewer Line hotspot B (SEB)	0	3 4E 9	0	3 2E 8

Table 5 2
Potential Risks and Hazards for Industrial/Commercial Workers
Surface Soils
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Exposure Area	Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Systematic Risk Assessment Areas				
Building 1	0 0051	8 3E 8	0 018	2 9E 6
Building 2	0 034	2 8E 7	0 31	9 0E 6
Building 4	0 0036	0 0E+0	0 0092	0 0E+0
Building 5	0 079	1 5E 6	0 48	5 4E 5
Building 6	0 0010	2 2E 9	0 0034	5 1E 8
Building 7	0 0072	2 8E 7	0 022	8 1E 6
Building 8	0	1 4E 8	0	3 6E 7
Northeast Parking Area	0	8 8E 8	0	3 0E 6
Railroads	0	1 1E 8	0	3 1E 7
Roadways	0 016	3 6E 8	0 036	8 4E 7
Combined Data points				
Site Wide	0 11	1 1E 6	0 56	2 6E 5
Focused Hotspot Areas				
Building 1 hotspot A (1A)	0 010	1 4E 8	0 033	4 7E 7
Building 1 hotspot B (1B)	0 013	4 0E 7	0 046	9 0E 6
Building 1 hotspot C (1C)	0 018	5 8E 7	0 055	8 8E 6
Building 2 hotspot (2)	0 034	3 7E 7	0 23	8 9E 6
Building 4 hotspot A (4A)	0	3 2E 7	0	5 1E 6
Building 4 hotspot B (4B)	0 0051	9 9E 7	0 010	2 6E 5
Building 4 hotspot C (4C)				
Building 4 hotspot D (4D)	0 0048	0 0E+0	0 011	0 0E+0
Building 5 hotspot A (5A)	1 2	2 4E 5	2 8	3 2E 4
Building 5 hotspot B (5B)	0	8 8E 8	0	1 4E 6
Building 6 hotspot (6)	0 0015	4 7E 9	0 0058	1 3E 7
Building 7 hotspot A (7A)	0 0075	4 7E 7	0 026	1 5E 5
Building 7 hotspot B (7B)	0	2 1E 8	0	3 4E 7
Building 7 hotspot C (7C)	0 0051	1 0E 7	0 010	1 6E 6
Building 8 hotspot A (8A)	0	3 2E 8	0	1 0E 6
Building 8 hotspot B (8B)	0	5 3E 8	0	8 5E 7
Northeast Parking Area hotspot (NE)	0	7 6E 7	0	1 2E 5
Roadways hotspot A (RDA)				
Roadways hotspot B (RDB)	0 042	6 5E 8	0 083	1 0E 6
Roadways hotspot C (RDC)	0 0065	0 0E+0	0 015	0 0E+0
Railroad hotspot (RR)				
Sewer Line hotspot A (SEA)				
Sewer Line hotspot B (SEB)				

No COPCs were identified in surface soils in these areas

Table 5 3
Potential Risks and Hazards for Trespassers/Site Visitors
Surface Soils
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Exposure Area	Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Systematic Risk Assessment Areas				
Building 1	0 00012	3 8E 9	0 00085	2 0E 7
Building 2	0 00086	1 2E 8	0 018	6 0E 7
Building 4	0 000086	0 0E+0	0 00044	0 0E+0
Building 5	0 0019	6 6E 8	0 025	3 6E 6
Building 6	0 000025	9 7E 11	0 00016	3 2E 9
Building 7	0 00018	1 3E 8	0 0012	5 8E 7
Building 8	0	6 5E 10	0	2 5E 8
Northeast Parking Area	0	4 0E 9	0	2 1E 7
Railroads	0	4 9E 10	0	2 2E 8
Roadways	0 00038	1 6E 9	0 0017	5 9E 8
Combined Data points				
Site Wide	0 0025	4 6E 8	0 031	1 7E 6
Focused Hotspot Areas				
Building 1 hotspot A (1A)	0 00025	6 5E 10	0 0020	3 4E 8
Building 1 hotspot B (1B)	0 00032	1 8E 8	0 0022	6 4E 7
Building 1 hotspot C (1C)	0 00044	2 6E 8	0 0028	5 5E 7
Building 2 hotspot (2)	0 00086	1 6E 8	0 013	5 8E 7
Building 4 hotspot A (4A)	0	1 4E 8	0	3 6E 7
Building 4 hotspot B (4B)	0 00012	4 5E 8	0 00049	1 8E 6
Building 4 hotspot C (4C)				
Building 4 hotspot D (4D)	0 00012	0 0E+0	0 00052	0 0E+0
Building 5 hotspot A (5A)	0 029	1 0E 6	0 14	2 1E 5
Building 5 hotspot B (5B)	0	4 0E 9	0	1 0E 7
Building 6 hotspot (6)	0 000035	2 0E 10	0 00029	8 1E 9
Building 7 hotspot A (7A)	0 00018	2 1E 8	0 0014	1 1E 6
Building 7 hotspot B (7B)	0	9 6E 10	0	2 4E 8
Building 7 hotspot C (7C)	0 00012	4 5E 9	0 00049	1 1E 7
Building 8 hotspot A (8A)	0	1 5E 9	0	7 1E 8
Building 8 hotspot B (8B)	0	2 4E 9	0	6 0E 8
Northeast Parking Area hotspot (NE)	0	3 4E 8	0	8 6E 7
Roadways hotspot A (RDA)				
Roadways hotspot B (RDB)	0 0010	2 9E 9	0 0040	7 4E 8
Roadways hotspot C (RDC)	0 00015	0 0E+0	0 00074	0 0E+0
Railroad hotspot (RR)				
Sewer Line hotspot A (SEA)				
Sewer Line hotspot B (SEB)				

No COPCs were identified in surface soils in these areas

Table 5 4
Potential Risks and Hazards for Hypothetical Future Residents
Surface Soils
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Exposure Area	Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Systematic Risk Assessment Areas				
Building 1	0 066	1 3E 6	0 23	1 1E 5
Building 2	0 41	4 5E 6	3 0	3 7E 5
Building 4	0 047	0 0E+0	0 12	0 0E+0
Building 5	1 0	2 4E 5	5 8	2 2E 4
Building 6	0 013	3 6E 8	0 043	2 2E 7
Building 7	0 092	4 4E 6	0 24	3 2E 5
Building 8	0	2 2E 7	0	1 4E 6
Northeast Parking Area	0	1 4E 6	0	1 2E 5
Railroads	0	1 7E 7	0	1 2E 6
Roadways	0 21	5 5E 7	0 46	3 3E 6
Combined Data points				
Site Wide	1 2	1 7E 5	5 9	1 1E 4
Focused Hotspot Areas				
Building 1 hotspot A (1A)	0 12	2 2E 7	0 31	1 9E 6
Building 1 hotspot B (1B)	0 17	6 1E 6	0 60	3 6E 5
Building 1 hotspot C (1C)	0 23	9 5E 6	0 65	3 8E 5
Building 2 hotspot (2)	0 41	6 0E 6	2 2	3 7E 5
Building 4 hotspot A (4A)	0	4 9E 6	0	2 0E 5
Building 4 hotspot B (4B)	0 066	1 5E 5	0 13	1 0E 4
Building 4 hotspot C (4C)				
Building 4 hotspot D (4D)	0 063	0 0E+0	0 14	0 0E+0
Building 5 hotspot A (5A)	15	3 8E 4	33	1 3E 3
Building 5 hotspot B (5B)	0	1 4E 6	0	5 6E 6
Building 6 hotspot (6)	0 019	7 6E 8	0 073	5 6E 7
Building 7 hotspot A (7A)	0 10	7 2E 6	0 29	6 1E 5
Building 7 hotspot B (7B)	0	3 3E 7	0	1 4E 6
Building 7 hotspot C (7C)	0 066	1 5E 6	0 13	6 4E 6
Building 8 hotspot A (8A)	0	5 0E 7	0	4 0E 6
Building 8 hotspot B (8B)	0	8 2E 7	0	3 4E 6
Northeast Parking Area hotspot (NE)	0	1 2E 5	0	4 8E 5
Roadways hotspot A (RDA)				
Roadways hotspot B (RDB)	0 54	1 0E 6	1 1	4 1E 6
Roadways hotspot C (RDC)	0 084	0 0E+0	0 20	0 0E+0
Railroad hotspot (RR)				
Sewer Line hotspot A (SEA)				
Sewer Line hotspot B (SEB)				

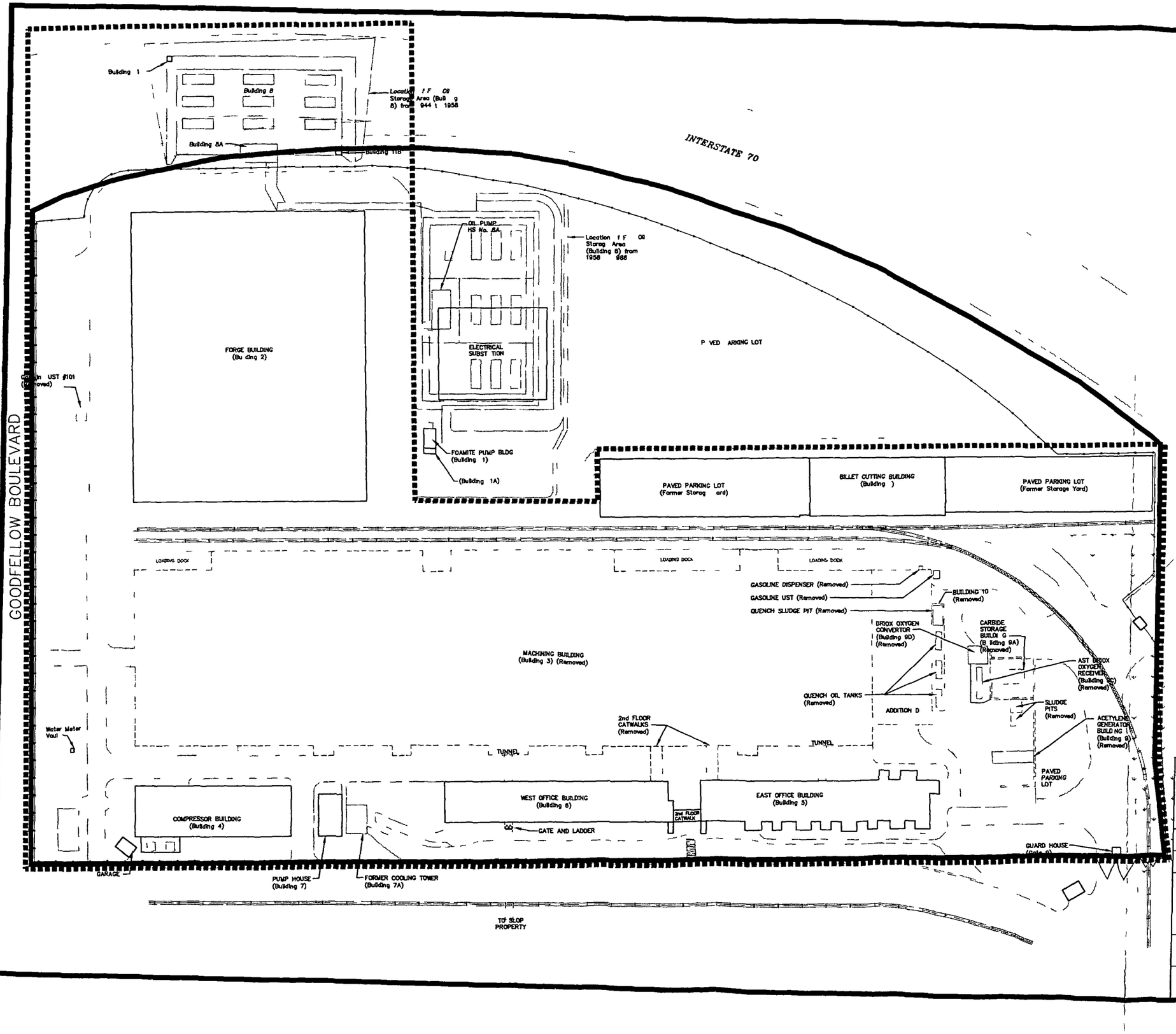
No COPCs were identified in surface soils in these areas

Table 5-5
Summary of Cancer Risks and Non-Cancer Hazard Indices
Indoor Air
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index	Cancer Risk
Hypothetical Future Resident		
(Houses with Basements)		
Soil		
1 1 1 Trichloroethane	0 000036	NA
Groundwater		
1 1 Dichloroethylene	0 0014	NA
1 2 Dichloroethane	NA	5 10E 09
Carbon Tetrachloride	NA	4 80E-08
Chloroform	NA	2 00E 07
Total	**0 00144**	**2 53E-07**
Hypothetical Future Resident		
(Houses with Slab on Grade Foundations)		
Soil	0 00008	NA
1 1 1 Trichloroethane		
Groundwater		
1 1 Dichloroethylene	0 00082	NA
1 2 Dichloroethane	NA	2 90E-09
Carbon Tetrachloride	NA	2 80E-08
Chloroform	NA	1 10E 07
Total	**0 0009**	**1 41E-07**

Table 5 6
Potential Risks and Hazards for Excavation/Construction Workers
Site Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
0 0078	1 0E 7	0 025	6 6E 7



LEGEND

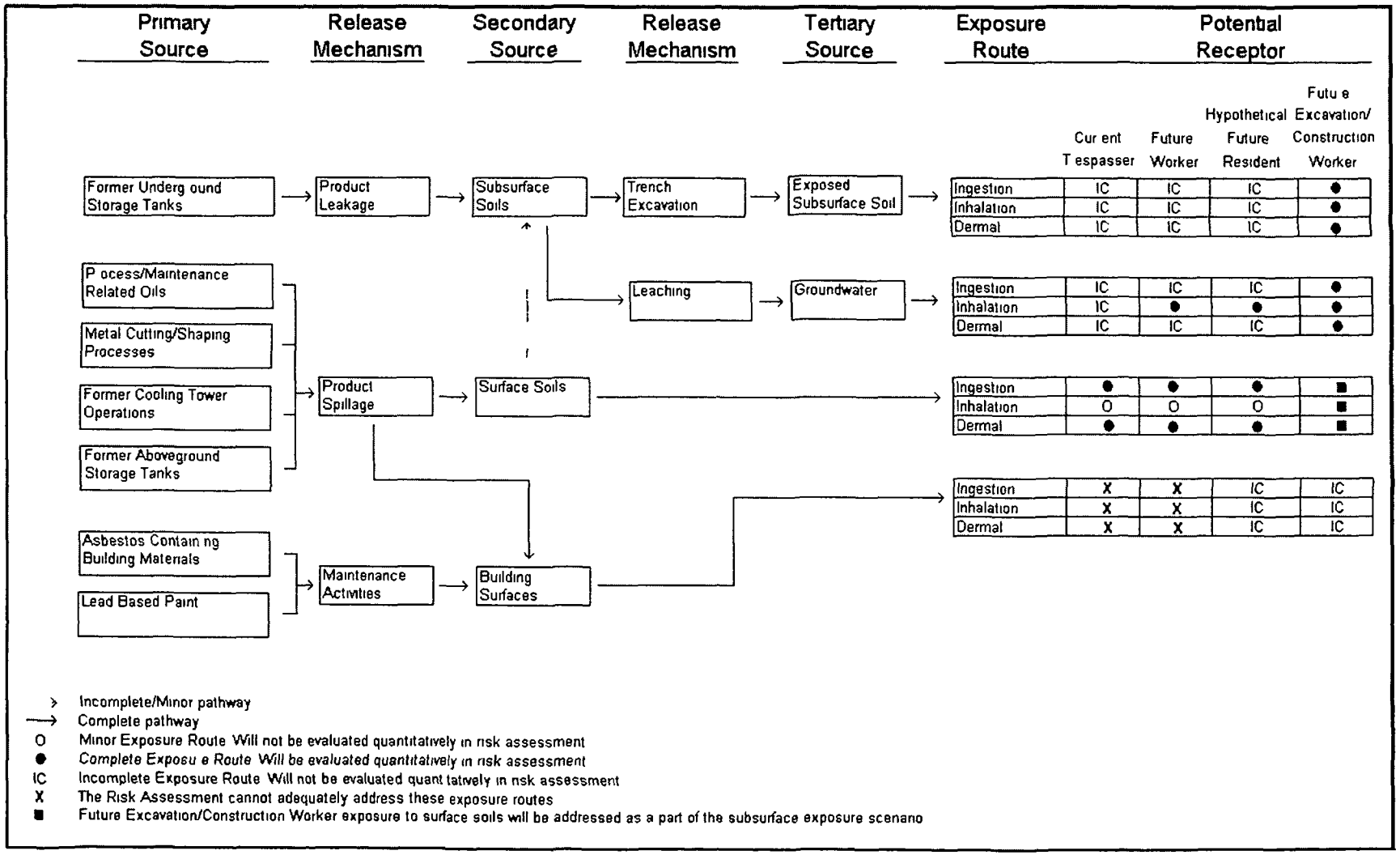
- ORIGINAL SLAAP PROPERTY BOUNDARY (1944 to 1958)
- PRESENT SLAAP PROPERTY BOUNDARY (1958 TO PRESENT)

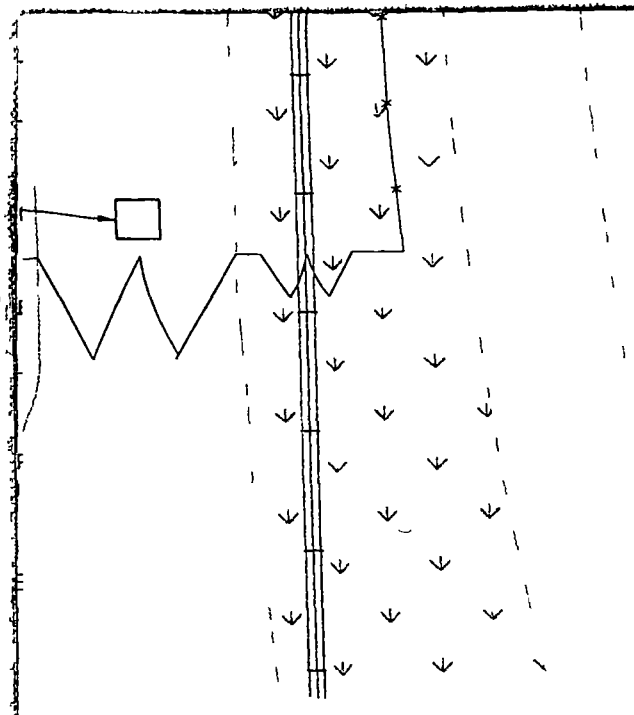
URS 10975 El Monte Suite 100 Overland Park Kansas 66211

SITE	ST LOUIS ARMY AMMUNITION PLANT
LOCATION	ST LOUIS MISSOURI
TITLE	HUMAN HEALTH RISK ASSESSMENT INSTALLATION LAYOUT

DRAWN BY	CHK'D BY	APPROVED BY
R A D	M G M	J C G
JOB NO	DATE	FIG NO
16529173	3/19/04	1-1

Figure 3 1
Site Conceptual Exposure Model
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri





40 0 40 80

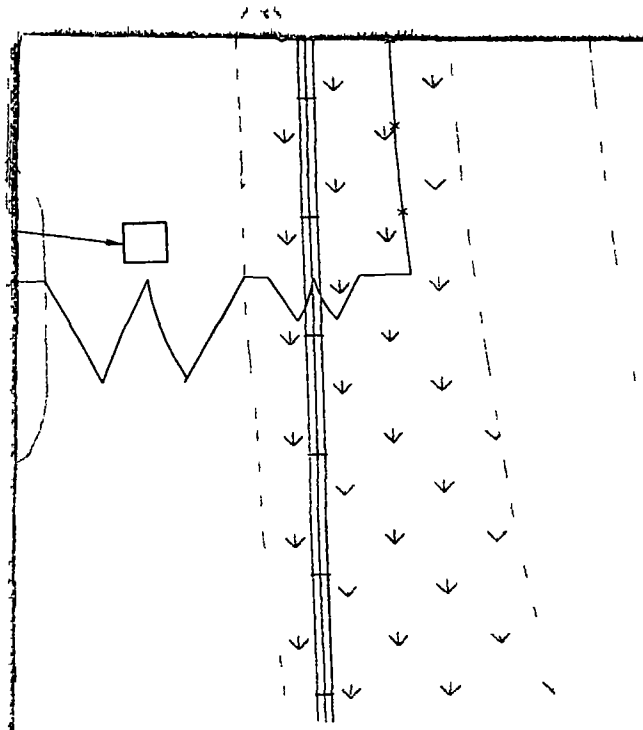
SCALE FEET

URS

10975 El Monte Suite 100
Overland Park Kansas 66211

SITE	ST LOUIS ARMY AMMUNITION PLANT
LOCATION	ST LOUIS MISSOURI
TITLE	HUMAN HEALTH RISK ASSESSMENT LOCATION OF SYSTEMATIC RISK ASSESSMENT SAMPLES

DRAWN BY	CHK D BY	APPROVED BY
R A D	M G M	J C G
JOB NO	DATE	DWG NO
16529173	3/19/04	3-2



URS

10975 El Monte Suite 100
Overland Park Kansas 66211

SITE	ST LOUIS ARMY AMMUNITION PLANT
LOCATION	ST LOUIS MISSOURI
TITLE	HUMAN HEALTH RISK ASSESSMENT SITE-WIDE HOTSPOT LOCATIONS

DRAWN BY	CHK D BY	APPROVED BY
T M S	M G M	J C G
JOB NO	DATE	DWG NO
16529173	3/19/04	3-3

Attachment A 1 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 1 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	1 5	8 7	10/10	6 2	4 5	0 03	NE	NE	13 22
Beryllium	mg/kg	0 12	0 63	10/10	0 61	0 49	0	NE	NE	1 01
Chromium	mg/kg	5	46	10/10	26 9	20 7	0	3 0E-03	NTV	25 46
Copper	mg/kg	1 6	1260	10/10	368	140	0	4 0E 02	NTV	59 1
Benzo(a)anthracene	mg/kg	0 003	1 7	7/10	0 74	0 33	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 004	1 2	7/10	0 31	0 14	0 13	NTV	7 3	0 74
Benzo(b)fluoranthene	mg/kg	0 005	1 7	7/10	0 66	0 31	0 13	NTV	0 73	0 63
Dibenz(a h)anthracene	mg/kg	0 003	0 29	4/10	0 107	0 057	0 13	NTV	7 3	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 002	0 7	7/10	0 45	0 21	0 13	NTV	0 73	0 41

Building 1 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	1 5	8 7	30/30	5 4	4 8	0 03	NE	NE	13 22
Beryllium	mg/kg	0 087	0 69	30/30	0 55	0 5	0	NE	NE	1 01
Chromium	mg/kg	5	46	30/30	21 6	18 7	0	2 0E-02	NTV	25 46
Copper	mg/kg	1 6	1260	30/30	125	54	0	4 0E-02	NTV	59 1
Benzo(a)anthracene	mg/kg	0 002	1 7	20/30	0 28	0 17	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 003	1 2	16/30	0 15	0 085	0 13	NTV	7 3	0 74
Benzo(b)fluoranthene	mg/kg	0 001	1 7	18/30	0 26	0 16	0 13	NTV	0 73	0 63
Dibenz(a h)anthracene	mg/kg	0 003	0 29	5/30	0 053	0 038	0 13	NTV	7 3	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 001	0 7	17/30	0 18	0 11	0 13	NTV	0 73	0 41

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A 1-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{oral}	SF	Hazard Index	Cancer Risk
Chromium	21 6	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Copper	125	1E 6	0 9	0	3 300	60	1	70	84	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 28	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 6E 9
Benzo(a)pyrene	0 15	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 4E 8
Benzo(b)fluoranthene	0 26	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 5E 9
Dibenz(a h)anthracene	0 053	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	5 0E 9
Indeno(1 2 3 cd)pyrene	0 18	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 7E 9
												Total	0 0E+0	2 6E 8

Attachment A-1-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $_c$ RfD $_{ral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT $_c$ = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED $SF_{o\ al}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD $_i$	SF $_{ral}$	Hazard Index	Cancer Risk
Chromium	21 6	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	3 6E 3	NA
Copper	125	1E 6	330	60	1	70	84	25 550	4 0E 02	NTV	1 1E 2	NA
Benzo(a)anthracene	0 28	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 3E 9
Benzo(a)pyrene	0 15	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 2E 8
Benzo(b)fluoranthene	0 26	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 1E 9
Dibenz(a h)anthracene	0 053	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	4 3E 9
Indeno(1 2 3 cd)pyrene	0 18	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 9
										Total	1 4E 2	2 2E 8

Attachment A-1 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD $_{ral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
RfD $_{ral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
Chromium	18 7	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Copper	54	1E 6	0 2	0	2 000	30	1	70	42	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 17	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 1E 10
Benzo(a)pyrene	0 085	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	5 4E 10
Benzo(b)fluoranthene	0 16	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 0E 10
Dibenz(a h)anthracene	0 038	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 4E 10
Indeno(1 2 3 cd)pyrene	0 11	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	7 0E 11
												Total	0 0E+0	1 1E 9

Attachment A-1-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	18 7	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	9 5E 4	NA
Copper	54	1E 6	100	30	1	70	42	25 550	4 0E 02	NTV	1 4E 3	NA
Benzo(a)anthracene	0 17	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 1E 10
Benzo(a)pyrene	0 085	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 0E 9
Benzo(b)fluoranthene	0 16	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 0E 10
Dibenz(a h)anthracene	0 038	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	4 7E 10
Indeno(1 2 3 cd)pyrene	0 11	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 3E 10
										Total	2 3E 3	2 0E 9

Attachment A 1 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT $RfD_{o\ al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF_{or}	Hazard Index	Cancer Risk
Chromium	26 9	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	368	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 74	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 6E 7
Benzo(a)pyrene	0 31	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	6 8E 7
Benzo(b)fluoranthene	0 66	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 4E 7
Dibenz(a h)anthracene	0 107	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 3E 7
Indeno(1 2 3 cd)pyrene	0 45	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	9 8E 8
												Total	0 0E+0	1 3E 6

Attachment A-1-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $_c$ $RfD_{o\ l}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED $SF_{o\ al}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT_c	$RfD_{o\ al}$	$SF_{o\ al}$	Hazard Index	Cancer Risk
Chromium	26 9	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	8 8E 3	NA
Copper	368	1E 6	100	250	25	70	9 125	25 550	4 0E 02	NTV	9 0E 3	NA
Benzo(a)anthracene	0 74	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 9E 7
Benzo(a)pyrene	0 31	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	7 9E 7
Benzo(b)fluoranthene	0 66	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 7E 7
Dibenz(a h)anthracene	0 107	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 7E 7
Indeno(1 2 3 cd)pyrene	0 45	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 1E 7
										Total	1 8E 2	1 5E 6

Attachment A 1-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF_o	Hazard Index	Cancer Risk
Chromium	20 7	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	140	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 33	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 3E 9
Benzo(a)pyrene	0 14	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	5 6E 9
Benzo(b)fluoranthene	0 31	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 2E 9
Dibenz(a h)anthracene	0 057	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 3E 9
Indeno(1 2 3 cd)pyrene	0 21	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	8 4E 10
												Total	0 0E+0	1 1E 8

Attachment A-1-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{o\ al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Chromium	20 7	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	3 4E 3	NA
Copper	140	1E 6	50	250	5	70	1 825	25 550	4 0E 02	NTV	1 7E 3	NA
Benzo(a)anthracene	0 33	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	8 4E 9
Benzo(a)pyrene	0 14	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 6E 8
Benzo(b)fluoranthene	0 31	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	7 9E 9
Dibenz(a h)anthracene	0 057	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 5E 8
Indeno(1 2 3 cd)pyrene	0 21	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	5 4E 9
										Total	5 1E 3	7 2E 8

Attachment A-1 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT	RfD	SF_o	Hazard Index	Cancer Risk
Chromium	26 9	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	368	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 74	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 4E 8
Benzo(a)pyrene	0 31	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	5 9E 8
Benzo(b)fluoranthene	0 66	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 2E 8
Dibenz(a h)anthracene	0 107	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 0E 8
Indeno(1 2 3 cd)pyrene	0 45	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	8 5E 9
												Total	0 0E+0	1 1E 7

Attachment A-1-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	26 9	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4 2E 4	NA
Copper	368	1E 6	100	12	30	70	10 950	25 550	4 0E 02	NTV	4 3E 4	NA
Benzo(a)anthracene	0 74	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 1E 8
Benzo(a)pyrene	0 31	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 6E 8
Benzo(b)fluoranthene	0 66	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	9 7E 9
Dibenz(a h)anthracene	0 107	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 6E 8
Indeno(1 2 3 cd)pyrene	0 45	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	6 6E 9
										Total	8 5E 4	8 8E 8

Attachment A 1 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Chromium	20 7	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	140	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 33	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	7 6E 11
Benzo(a)pyrene	0 14	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	3 2E 10
Benzo(b)fluoranthene	0 31	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	7 1E 11
Dibenz(a h)anthracene	0 057	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 3E 10
Indeno(1 2 3 cd)pyrene	0 21	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	4 8E 11
												Total	0 0E+0	6 5E 10

Attachment A-1-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	20 7	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	8 1E 5	NA
Copper	140	1E 6	50	6	9	70	3 285	25 550	4 0E 02	NTV	4 1E 5	NA
Benzo(a)anthracene	0 33	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 6E 10
Benzo(a)pyrene	0 14	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 5E 9
Benzo(b)fluoranthene	0 31	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 4E 10
Dibenz(a h)anthracene	0 057	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	6 3E 10
Indeno(1 2 3 cd)pyrene	0 21	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 3E 10
										Total	1 2E 4	3 1E 9

Attachment A 1 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{ch\ d}\ EF\ ED_{hild})/(BW_{\ ild}\ AT_{nc}\ RfD\ )$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ l}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ l}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
BW_{d} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
$R_fD_{\ l}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{child}\ ED_{hild}/BW_{hild})+(SA_{ad\ l}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ra} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	$RfD_{\ l}$	SF	Hazard Index	Cancer Risk
Chromium	26 9	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E-03	NTV	0	NA
Copper	368	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4 0E-02	NTV	0	NA
Benzo(a)anthracene	0 74	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	5 5E 7
Benzo(a)pyrene	0 31	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 3E 6
Benzo(b)fluoranthene	0 66	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	4 9E 7
Dibenz(a h)anthracene	0 107	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	7 9E 7
Indeno(1 2 3-cd)pyrene	0 45	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 3E 7
															Total	0 0E+0	4 5E 6

Attachment A 1 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{or\ l})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{dult} = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{dult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{ral}\ ((IR_{child}\ ED_{hild}/BW_{hild})+(IR_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	$IR_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ l}$	AT_{nc}	AT	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
Chromium	26 9	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 1E 1	NA
Copper	368	1E 6	200	100	350	6	24	15	70	2 190	25 550	4 0E 02	NTV	1 2E 1	NA
Benzo(a)anthracene	0 74	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	8 5E 7
Benzo(a)pyrene	0 31	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 5E 6
Benzo(b)fluoranthene	0 66	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	7 5E 7
Dibenz(a h)anthracene	0 107	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 2E 6
Indeno(1 2 3-cd)pyrene	0 45	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	5 1E 7
													Total	2 3E 1	6 9E 6

Attachment A 1 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm /day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ l}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ l}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
$R_fD_{\ l}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{\ l}\ ((SA_{child}\ ED_{hild}/BW_{hild})+(SA_{d\ l}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ l}$	AT_{nc}	AT	$RfD_{\ l}$	SF_{ral}	Hazard Index	Cancer Risk
Chromium	20 7	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	140	1E-6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 33	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 8
Benzo(a)pyrene	0 14	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	4 8E 8
Benzo(b)fluoranthene	0 31	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 8
Dibenz(a h)anthracene	0 057	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 0E 8
Indeno(1 2 3-cd)pyrene	0 21	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	7 2E 9
															Total	0 0E+0	9 7E 8

Attachment A 1 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{hild}\ EF\ ED_{h\ ld})/(BW_{hild}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
BW_{dult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
$IR_{ch\ ld}$ = Soil Ingestion Rate for a Child (mg/day)
IR_{dult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{hild}/BW_{hild})+(IR_{dult}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
$SF_{or\ l}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	$IR_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
Chromium	20 7	1E-6	100	50	350	6	3	15	70	2 190	25 550	3 0E-03	NTV	4 4E 2	NA
Copper	140	1E-6	100	50	350	6	3	15	70	2 190	25 550	4 0E 02	NTV	2 2E 2	NA
Benzo(a)anthracene	0 33	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	1 4E 7
Benzo(a)pyrene	0 14	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	5 9E 7
Benzo(b)fluoranthene	0 31	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 3E 7
Dibenz(a h)anthracene	0 057	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 4E 7
Indeno(1 2 3 cd)pyrene	0 21	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 9E 8
													Total	6 6E 2	1 2E-6

Attachment A-1-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	1 1E 9	2 6E 8
	Ingestion	0 0023	0 014	2 0E 9	2 2E 8
	Total	0 0023	0 014	3 1E 9	4 8E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	1 1E 8	1 3E 6
	Ingestion	0 0051	0 018	7 2E 8	1 5E 6
	Total	0 0051	0 018	8 3E 8	2 9E 6
Current Trespasser/Site Visitor					
	Dermal	0	0	6 5E 10	1 1E 7
	Ingestion	0 00012	0 00085	3 1E 9	8 8E 8
	Total	0 00012	0 00085	3 8E 9	2 0E 7
Hypothetical Future Resident					
	Dermal	0	0	9 7E 8	4 5E 6
	Ingestion	0 066	0 23	1 2E 6	6 9E 6
	Total	0 066	0 23	1 3E 6	1 1E 5

Attachment A 2 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Building 2 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day) [1]	Background
Dioxin TEQ	mg/kg	1 79E-06	1 13E-04	7/7	7 25E-05	4 24E-05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0081	14	6/12	3 3	1 2	0 14	2 0E-05	2/1	
Arsenic*	mg/kg	4 2	18 7	12/12	6 8	6 2	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 44	0 77	12/12	0 64	0 59	0	NE	NE	1 01
Lead	mg/kg	10	721	12/12	180	73 9	0	NE	NE	363

Building 2 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
Dioxin TEQ	mg/kg	1 58E 06	1 13E 04	15/15	5 52E-05	3 07E 05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0074	14	14/36	1 11	0 46	0 14	5 0E-05	2/1	
Arsenic*	mg/kg	1 8	8 9	36/36	6 4	6	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 44	0 97	36/36	0 68	0 64	0	NE	NE	1 01
Lead	mg/kg	7 7	721	36/36	68	35	0	NE	NE	363
Benzo(a)pyrene	mg/kg	0 003	0 17	12/36	0 044	0 029	0 13	NTV	7 3E+00	0 74

* Present at background level.

Lead has no RfD or SF and is evaluated separately

The RfD for PCB 1254 is used to evaluate hazard for PCB 1248

IRIS recommends using a slope factor of 2 0 for RME and 1 0 for CTE

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-2-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	5 52E 05	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	NTV	1 5E+05	NA	2 5E 8
PCB 1248	1 11	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	9 4E 2	3 1E 8
Benzo(a)pyrene	0 044	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	4 2E 9
												Total	9 4E 2	6 0E 8

Attachment A-2-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	5 52E 05	1E 6	330	60	1	70	84	25 550	NTV	1 5E+05	NA	9 2E 8
PCB 1248	1 11	1E 6	330	60	1	70	84	25 550	5 0E 05	2 0E+00	7 5E 2	2 5E 8
Benzo(a)pyrene	0 044	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	3 6E 9
										Total	7 5E 2	1 2E 7

Attachment A-2-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	3 07E 05	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	NTV	1 5E+05	NA	9 3E 10
PCB 1248	0 46	1E 6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E 05	1 0E+00	5 3E 3	4 3E 10
Benzo(a)pyrene	0 029	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 8E 10
												Total	5 3E 3	1 5E 9

Attachment A-2-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	3 07E 05	1E 6	100	30	1	70	42	25 550	NTV	1 5E+05	NA	7 7E 9
PCB 1248	0 46	1E 6	100	30	1	70	42	25 550	5 0E 05	1 0E+00	9 4E 3	7 7E 10
Benzo(a)pyrene	0 029	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 6E 10
										Total	9 4E 3	8 9E 9

Attachment A-2-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	7 25E 05	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	NTV	1 5E+05	NA	7 5E 7
PCB 1248	3 3	1E 6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 5E 1	2 1E 6
												Total	1 5E 1	2 9E 6

Attachment A-2-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	7 25E 05	1E 6	100	250	25	70	9 125	25 550	NTV	1 5E+05	NA	3 8E 6
PCB 1248	3 3	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 6E 1	2 3E 6
										Total	1 6E 1	6 1E 6

Attachment A-2-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	4 24E 05	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	NTV	1 5E+05	NA	8 0E 9
PCB 1248	1 2	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E 05	1 0E+00	4 9E 3	7 0E 9
												Total	4 9E 3	1 5E 8

Attachment A-2-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	4 24E 05	1E 6	50	250	5	70	1 825	25 550	NTV	1 5E+05	NA	2 2E 7
PCB 1248	1 2	1E 6	50	250	5	70	1 825	25 550	2 0E 05	1 0E+00	2 9E 2	4 2E 8
										Total	2 9E 2	2 6E 7

Attachment A-2-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	7 25E 05	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	NTV	1 5E+05	NA	6 5E 8
PCB 1248	3 3	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2 0E+00	1 1E 2	1 8E 7
												Total	1 1E 2	2 5E 7

Attachment A-2-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	7 25E 05	1E 6	100	12	30	70	10 950	25 550	NTV	1 5E+05	NA	2 2E 7
PCB 1248	3 3	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2 0E+00	7 7E 3	1 3E 7
										Total	7 7E 3	3 5E 7

Attachment A-2-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	4 24E 05	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	NTV	1 5E+05	NA	4 6E 10
PCB 1248	1 2	1E 6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1 6E 4	4 1E 10
												Total	1 6E 4	8 7E 10

Attachment A-2-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	4 24E 05	1E 6	50	6	9	70	3 285	25 550	NTV	1 5E+05	NA	9 6E 9
PCB 1248	1 2	1E 6	50	6	9	70	3 285	25 550	2 0E 05	1 0E+00	7 0E 4	1 8E 9
										Total	7 0E 4	1 1E 8

Attachment A 2 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{c} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{ch\ ld}\ ED_{child}/BW_{child})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ l}$	SF_{ral}	Hazard Index	Cancer Risk
Dioxin TEQ	7 25E 05	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	1 5E+05	NA	2 5E 6
PCB 1248	3 3	1E 6	0 3	0 14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	8 5E 1	7 2E 6
															Total	8 5E 1	9 7E 6

Attachment A-2 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{c}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	7 25E 05	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	1 5E+05	NA	1 7E 5
PCB 1248	3 3	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	2 1E+0	1 0E 5
													Total	2 1E+0	2 7E 5

Attachment A-2-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
$SA_{ch\ ld}$ = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{o\ al}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{ad\ lt}\ ED_{ad\ lt}/BW_{ad\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{hild}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD	SF	Hazard Index	Cancer Risk
Dioxin TEQ	4 24E 05	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	1 5E+05	NA	6 9E 8
PCB 1248	1 2	1E 6	0 04	0 14	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E+00	3 1E 2	6 1E 8
															Total	3 1E 2	1 3E 7

Attachment A 2 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	4 24E 05	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	1 5E+05	NA	3 7E 6
PCB 1248	1 2	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E+00	3 8E 1	6 9E 7
													Total	3 8E 1	4 4E 6

Attachment A-2-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 0053	0 094	1 5E 9	6 0E 8
	Ingestion	0 0094	0 075	8 9E 9	1 2E 7
	Total	0 015	0 17	1 0E 8	1 8E 7
Future Industrial/Commercial Worker					
	Dermal	0 0049	0 15	1 5E 8	2 9E 6
	Ingestion	0 029	0 16	2 6E 7	6 1E 6
	Total	0 034	0 31	2 8E 7	9 0E 6
Current Trespasser/Site Visitor					
	Dermal	0 00016	0 011	8 7E 10	2 5E 7
	Ingestion	0 00070	0 0077	1 1E 8	3 5E 7
	Total	0 00086	0 018	1 2E 8	6 0E 7
Hypothetical Future Resident					
	Dermal	0 031	0 85	1 3E 7	9 7E 6
	Ingestion	0 38	2 1	4 4E 6	2 7E 5
	Total	0 41	3 0	4 5E 6	3 7E 5

Attachment A-2-19

Excavation Worker Building 2
Central Tendency Exposure to Lead
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R vi w W kgroup f L d Adult Le d C mmittee

V slo d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1		Using Equation 2	
					GSD_i Hom	GSD_i H t	GSD_i H m	GSD_i Het
PbS	X	X	S il/lead ce tr ti	g/g ppm	35 0	35 0	35 0	35 0
$R_{tal/maternal}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Sl pe F cto	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	Geom tri tandard d vi ti PbB	--	2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR	X		S il gesti rate (l d g l d ed ind d t)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal gesti rate f tdoo l and doo dus	g/d y		--	0 100	0 100
W_S		X	W ghti g fact fracti f IR p ingested as tdoo so l	--			1 0	1 0
K_{SD}		X	Mas fraction f il dust		--		0 7	0 7
$AF_{S D}$	X	X	Absorpti fracti (sam f so l and dust)		0 12	0 12	0 12	0 12
$EF_{S, D}$	X	X	Exp re freq en y (am f l and dust)	d ys/y	30	30	30	30
$AT_{S, D}$	X	X	A raging tim (am f s l and dust)	d ys/yr	365	365	365	365
PbB_{adul}			PbB f d lt w rk geom tri me n	g/dL	1.5	1.5	1.5	1 5
$PbB_{f tal, 0.95}$			95th perce til PbB am ng f tuses f dult workers	g/dL	5 0	5 0	5 0	5 0
PbB_{T}			Targ t PbB le el f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} \geq PbB_T)$			Pr b bility th t fetal PbB PbB assumi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Eq ti l does t pp rti expo re be wee l and dust gesti (ex l des W K_{SD})
Wh IR IR_{S+} and W l 0 th eq ti y id h am PbB_{fetal}

Equati 1 based Eq 1 2 l USEPA (1996)

PbB_{adul} =	(PbS BKSF IR_{S+D} AF EF_S/AT) PbB
$PbB_{fetal, 95}$ =	PbB_{adul} ($GSD_i^{.64}$ R)

Eq ti 2 lt rn t ppro h b sed Eq 1 2 and A 19 l USEPA (1996)

PbB_{adul} =	PbS BKSF*([(IR_{S+D}) AF_S EF W]+[K_D (IR_{S+D}) (1 W_S) AF_D EF])/365+PbB
$PbB_{fetal, 95}$ =	PbB_{adul} ($GSD_i^{.645}$ R)

S urce U.S EPA (1996) Recomm d ti ns f th Technical R vi w W kg p f Lead
f I terim App ch t Assessi g Risks Associ ted with Ad lt Exposures to Lead i S il

Attachment A 2 20

Excavation Worker Building 2
Reasonable Maximum Exposure to Lead
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U.S EPA Technical R i w W kgroup f Lead Adult Lead Committ

Versi date 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSD Hom	Using Equation 1 GSD Het	Using Equation 2 GSD Hom	Using Equation 2 GSD Het
PbS	X	X	S il l d ce tra	g/g ppm	35 0	35 0	35 0	35 0
$R_{tal/maternal}$	X	X	Fetal/m ternal PbB ratu		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Sl pe Fact	g/dL p g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	G m tri tandard d u PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas l PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ingestu rate (in l d g il deri d d d t)	g/d y	0 330	0 330		
$IR_{S\ D}$		X	T tal gestu rate f tdoo so l and do d t	g/d y			0 330	0 330
W_S		X	W ghtu g fac fra tu f IR_{S+D} gested as td l				1 0	1 0
K_{SD}		X	Mas fra u f so l dus				0 7	0 7
$AF_{S,D}$	X	X	Absorp f actu (sam f l and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq y (am f l and d t)	d ys/yr	60	60	60	60
$AT_{S,D}$	X	X	A raging tim (am f l and dust)	d ys/yr	365	365	365	365
PbB_{adult}			PbB f adult w rk geom tri mean	g/dL	1 6	1 6	1 6	1 6
$PbB_{f\ tal,0\ 95}$			95th pe ce til PbB am g f tuses f d lt work rs	g/dL	5.3	5.3	5.3	5.3
PbB			Targ t PbB le el f concern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > PbB_t)$			Prob bility th t f tal PbB > PbB assumi g l gn rmal distrib ti	%	0 7%	0 7%	0 7%	0 7%

Equa l does t app rtu p re be wee l and dust gest (l des W K)
Wh IR IR_{S+} and W 1 0 th eq yield th am PbB_{fetal}

Equati n 1 based o Eq 1 2 i USEPA (1996)

PbB_{dul} =	(PbS BKSF IR AF_D EF /AT_D) + PbB
$PbB_{tal,}$ =	PbB_{adu} (GSD ^{645} R)

Equati 2 alt rnat approach b s d Eq 1 2 and A 19 in USEPA (1996)

PbB_{dul} =	PbS BKSF*([(IR_{S+D}) AF EF W]+[K_{SD} (IR_{S+D}) (1 W) AF_D EF_D])/365+PbB
$PbB_{fetal,\ 95}$ =	PbB_{adult} (GSD_i ^{645} R)

S ce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kgr p f Le d
f App ch to Assessi g Risks Associ ted with Adult Exposu es to L d i S il

Attachment A-2-21

Site Worker Building 2
Central Tendency Exposure to Lead
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U.S EPA Technical Review Wo kgro p for Lead Adult Lead Committee

V rsi d te 05/19/03

Exposure Variable	PbB Equation[1] 1[a]	2[a,b]	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario			
					Using Equation 1		Using Equation 2	
					GSD Hom	GSD Het	GSD B m	GSD Het
PbS	X	X	S il lead centrati	g/g ppm	73 9	73 9	73 9	73 9
$R_{etal/maternal}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri tandard d u PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il inges rate (l d g l d d d d t)	g/d y	0 050	0 050		
IR_{S+D}		X	T tal ingesti rate f td il and d d t	g/d y			0 050	0 050
W_S		X	W ghti g facto frac f IR p gested as td so l				1 0	1 0
K_{SD}		X	Mass frac f so l dus				0 7	0 7
$AF_{S D}$	X	X	Absorp fracti (sam f l and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq y (sam f l and dus)	d ys/y	219	219	219	219
$AT_{S,D}$	X	X	A rag g tim (am f l and dus)	d ys/yr	365	365	365	365
PbB_{adul}			PbB f adult w rk geom tri mean	g/dL	1 6	1 6	1 6	1 6
$PbB_{f tal,0 5}$			95th p ce til PbB am ng f tuses f dult w kers	g/dL	5.3	5.3	5.3	5.3
PbB			Targ t PbB l l f co cern (e.g. 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{tal} > PbB_t)$			Pr b bility that f tal PbB > PbB ass mi g l g ormal distrib ti	%	0 7%	0 7%	0 7%	0 7%

Equati l does t apporti expo re betwee il and dust ing ti (ex l d W K_D)
Wh IR IR_{S+} and W 1 0 the eq ati ns y ld th sam PbB_{fetal}

Equati n 1 based Eq 1 2 l USEPA (1996)

PbB_{dul} =	(PbS BKSF IR_{S+} AF EF /AT) + PbB
$PbB_{tal,}$ =	PbB_{adu} $(GSD_l^{.645}$ R)

Equati 2 lt t ppro ch based Eq 1, 2, d A 19 l USEPA (1996)

$PbB_{ l}$ =	PbS BKSF*((IR_{S+}) AF EF W]+[K (IR_{S+D}) (1 W) AF_D EF])/365+PbB
$PbB_{fetal, s}$ =	PbB_{adult} $(GSD_l^{.645}$ R)

Source U.S EPA (1996) Recomm d ti ns f th Technical R vi w W kg p f Le d
f an I terim Approach to Assessi g Risks Associ ted with Ad lt Exposu es to Lead i S il

Attachment A 2 22

Site Worker Building 2
Reasonable Maximum Exposure to Lead
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re iew W kgroup f Lead Ad lt Le d C mmitte

V rsi d t 05/19/03

Exposure Variable	PbB Equation[1] #1	PbB Equation[1] #2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSD1 = Hom	Using Equation 1 GSD1 = Het	Using Equation 2 GSD1 = Hom	Using Equation 2 GSD1 = Het
PbS	X	X	S il lead ce tr tu	g/g ppm	73 9	73 9	73 9	73 9
$R_{fetal/maternal}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Si pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri tandard d u PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas l PbB	g/dL	1 53	1 53	1 53	1 53
IR	X		S il gestu rate (i d g i d ed i d d t)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal ges rate f td l and d dust	g/d y			0 100	0 100
W_S		X	W ghtu g facto fractu of IR_{S+D} gested as tdoo s l				1 0	1 0
K_{SD}		X	Mas f actu f so l d t				0 7	0 7
$AF_{S D}$	X	X	Absorptu f actu (m f l and dust)		0 12	0 12	0 12	0 12
$EF_{S, D}$	X	X	Expo re freq y (am f l and dus)	d ys/y	250	250	250	250
$AT_{S, D}$	X	X	A rag g tim (am f l and dust)	d ys/y	365	365	365	365
PbB_{dul}			PbB f adult w k geom tri me	g/dL	1.8	1 8	1 8	1 8
PbB_{fetal} 0 5			95th p rce til PbB am ng f tuses f dult w rk rs	g/dL	5 8	5 8	5 8	5.8
PbB			T g t PbB l el f co rn (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_0)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti	%	0 9%	0 9%	0 9%	0 9%

[1] Eq tu l does t apportu exp re b twee l and dust g tu (ex l des W K)
Wh IR IR_{S+} and W 1 0 th eq t y ld th am $PbB_{f al}$

Equati n 1 bas d Eq 1 2 1 USEPA (1996)

PbB_{dul} =	(PbS BKSF IR AF EF /AT) + PbB
$PbB_{fetal, 95}$ =	$PbB_{ad l}$ $(GSD_1^{64}$ R)

Equati 2 alt ate ppr ch b sed Eq 1 2 d A 19 1 USEPA (1996)

PbB_{adul} =	PbS BKSF*(((IR$_{S+}$) AF_S EF W]+[K_D (IR $_D$) (1 W) AF_D EF_D])/365+PbB
$PbB_{f tal, 95}$ =	PbB_{adult} $(GSD_1^{.645}$ R)

S U S EPA (1996) Recomm dati ns f th Technical R i w W kgr p f Lead
f a m App ach t Assessi g Risks Associ t d with Ad lt Expos es to Lead i S il

Attachment A 2-23

Trespasser Building 2
Central Tendency Exposure to Lead
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re iew W kgro p f Le d Ad lt Lead Committee

V rsi date 05/19/03

Exposure Variable	PbB Equation 1*	PbB Equation 2**	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi Hom	Using Equation 1 GSDi Het	Using Equation 2 GSDi Hom	Using Equation 2 GSDi Het
PbS	X	X	S il l d ce tra	g/g ppm	73 9	73 9	73 9	73 9
$R_{etal/maternal}$	X	X	F tal/m ternal PbB ra	--	0 9	0 9	0 9	0 9
BKSF	X	X	B kin ti Sl pe Fac	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Ge m tri tandard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas l ne PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (in l d g l-d ed d dus)	g/d y	0 050	0 050		
$IR_{S\ D}$		X	T tal ingesti rate f tdoo il and ind dus	g/d y			0 050	0 050
W_S		X	W ghti g fact frac f IR_{S+} gested as doo l	--			1 0	1 0
K_{SD}		X	Mass fracti f il in dust				0 7	0 7
$AF_{S,D}$	X	X	Absorpti fracti (sam f soil and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exposure freq en y (am f l and dus)	d ys/yr	6	6	6	6
$AT_{S,D}$	X	X	A eraging tim (sam f l and dust)	d ys/y	365	365	365	365
PbB_{adul}			PbB f adult w rk geom tri mean	g/dL	1.5	1.5	1 5	1 5
$PbB_{f\ tal,\ 0.95}$			95th perce til PbB am ng f tuses f dult w rk	g/dL	5 0	5 0	5 0	5 0
PbB			Targ t PbB l el f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{tal} > PbB_t)$			Pr b bility th t f tal PbB PbB ass mi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Equati l does t pporti exp ure betwee l and dust gesti (l des W K)
Wh IR IR_{S+} and W l 0 th eq ti ns y eld th am PbB_{fetal}

Equati 1 bas d o Eq 1 2 l USEPA (1996)

PbB_{adul} =	(PbS BKSF IR AF EF /AT) + PbB
$PbB_{etal,\ 5}$ =	$PbB_{adu\ t}$ ($GSD_i^{.64}$ R)

Equati 2, lt ate pp ch bas d o Eq 1 2 d A 19 l USEPA (1996)

PbB_{adul} =	PbS BKSF*([(IR_{S+D}) AF EF_S W]+[K_D (IR_D) (1 W) AF EF])/365+PbB
$PbB_{fetal,\ 5}$ =	PbB_{adult} ($GSD_i^{.645}$ R)

S ce U.S EPA (1996) Recommend ti ns f th Technical R vi w W kg p f Lead
f an I terim App ach to Assessi g Risks Associ ted with Ad lt Exposures to Lead i S ll

Pri ted 03/15/2004 4 02 PM

Attachment A 2 24

Trespasser Building 2
Reasonable Maximum Exposure to Lead
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re i w W kg oup fo L d Adult Lead Committee

V i d te 05/19/03

Exposure Variable	PbB Equation 1		Description of Exposure Variable	Units	Values for Non Residential Exposure Scenarios Using Equation 1		Using Equation 2	
	1	2			GSD = Hom	GSD = Het	GSD = B m	GSD = H t
PbS	X	X	S il lead ce tratio	g/g ppm	73 9	73 9	73 9	73 9
$R_{f\ tal/maternal}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe Facto	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri tandard d PbB		2 18	2 18	2 18	2 18
PbB	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ges rate (l ding l d d d d)	g/d y	0 100	0 100		
$IR_{S\ D}$		X	T tal gesti rate f tdoo l and doo d	g/d y			0 100	0 100
W_S		X	W ghti g fact fracti f $IR_{S\ D}$ ingested as tdoo so l				1 0	1 0
K_{SD}		X	Mass fracti f l d				0 7	0 7
$AF_{S\ D}$	X	X	Absorpti fracti (m f so l and d st)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo re freq ency (am f l and dust)	d ys/yr	12	12	12	12
$AT_{S,D}$	X	X	A rag g tim (am f l and dus)	d ys/y	365	365	365	365
PbB_{adult}			PbB f ad lt w k g m tri mean	g/dL	1.5	1.5	1.5	1 5
$PbB_{fetal,\ 0.95}$			95th p rce til PbB am ng f tuses f dult w rk rs	g/dL	5 0	5 0	5 0	5 0
PbB			T g t PbB l el f co cern (g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{fetal} > PbB_t)$			Pr bability th t f tal PbB PbB ass ml g l gn rmal distrib ti	%	0 6%	0 6%	0.6%	0 6%

Eq ti l does pporti pos re betwee l and d t g ti (l des W K)
Wh IR IR_{S+} d W l 0 th eq ti yi ld th m PbB_{fetal}

Equati 1, b sed Eq 1 2 l USEPA (1996)

PbB_{dul} =	(PbS BKSF $IR_{S\ D}$ $AF_{S,}$ EF /AT) + PbB
$PbB_{tal,}$ =	$PbB_{adu\ t}$ (GSD_i^{64} R)

Equatio 2 ltern t ppro ch based Eq 1 2 d A 19 l USEPA (1996)

PbB_{dul} =	PbS BKSF*(((IR) AF EF_S W]+[K_D (IR_{S+D}) (1 W) AF EF])/365 PbB
$PbB_{tal,\ S}$ =	$PbB_{ad\ l}$ (GSD_i^{645} R)

S ur U S EPA (1996) Recomm d ti ns f th Technical R i w W kg p f L d
f lo im App ach t Assessi g Risks Associ ted w th Ad lt Expos es t Lead i S il

Attachment A-2-25

Building 2 Area
Residential Exposure to Lead
Calculated Blood Lead and Lead Uptakes from IEUBK Model Software
St Louis Army Ammunition Plant
St Louis Missouri

Age (years)	Air (ug/dL)	Diet (ug/dL)	Alternate (ug/dL)	Water (ug/dL)	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
5 1	0 021	2 623	0	0 379	1 626	4 65	**2 5**
1 2	0 034	2 736	0	0 947	2 577	6 294	**2 7**
2 3	0 062	3 088	0	0 99	2 59	6 73	**2 5**
3 4	0 067	2 992	0	1 016	2 61	6 685	**2 4**
4 5	0 067	2 909	0	1 065	1 952	5 993	**2 1**
5 6	0 093	3 08	0	1 127	1 763	6 063	**1 9**
6 7	0 093	3 405	0	1 148	1 667	6 313	**1 8**

Attachment A 3 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Building 4 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD ral (mg/kg day)	SF ral (mg/kg day) [1]	Background
Arsenic	mg/kg	1 1	5 5	10/10	4 8	4	0 03	NE	NE	13 22
Beryllium	mg/kg	0 088	1 4	10/10	0 88	0 65	0	2 0E-03	NTV	1 01
Chromium	mg/kg	2	36	10/10	27	21	0	3 0E-03	NTV	25 46

Building 4 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF ral (mg/kg day)	Background
Arsenic	mg/kg	1 1	6 7	22/22	4 6	4	0 03	NE	NE	13 22
Beryllium	mg/kg	0 088	1 9	22/22	0 88	0 71	0	5 0E 03	NTV	1 01
Chromium	mg/kg	2	48	22/22	28 5	23 9	0	2 0E 02	NTV	25 46
Benzo(a)anthracene	mg/kg	0 002	0 65	14/22	0 15	0 097	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 002	0 48	13/22	0 078	0 041	0 13	NTV	73	0 74
Benzo(b)fluoranthene	mg/kg	0 003	0 7	13/22	0 16	0 11	0 13	NTV	0 73	0 63
Dibenz(a h)anthracene	mg/kg	0 004	0 17	4/22	0 045	0 034	0 13	NTV	73	0 3

[1] Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A 3 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	$RfD_{\ ral}$	$SF_{o\ l}$	Hazard Index	Cancer Risk
Beryllium	0 88	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	28 5	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 15	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 4E 9
Benzo(a)pyrene	0 078	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	7 4E 9
Benzo(b)fluoranthene	0 16	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 9
Dibenz(a h)anthracene	0 045	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	4 3E 9
												Total	0 0E+0	1 5E 8

Attachment A-3-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT RfD $_{ral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10 ^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT $_c$	AT	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
Beryllium	0 88	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	5 9E 4	NA
Chromium	28 5	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	4 8E 3	NA
Benzo(a)anthracene	0 15	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 2E 9
Benzo(a)pyrene	0 078	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	6 3E 9
Benzo(b)fluoranthene	0 16	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 9
Dibenz(a h)anthracene	0 045	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	3 6E 9
										Total	5 4E 3	1 2E 8

Attachment A-3 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Beryllium	0 71	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	23 9	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 097	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	6 2E 11
Benzo(a)pyrene	0 041	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 6E 10
Benzo(b)fluoranthene	0 11	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	7 0E 11
Dibenz(a h)anthracene	0 034	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 2E 10
												Total	0 0E+0	6 1E 10

Attachment A-3-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 71	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	1 4E 4	NA
Chromium	23 9	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 2E 3	NA
Benzo(a)anthracene	0 097	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 2E 10
Benzo(a)pyrene	0 041	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	5 0E 10
Benzo(b)fluoranthene	0 11	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 3E 10
Dibenz(a h)anthracene	0 034	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	4 2E 10
										Total	1 4E 3	1 2E 9

Attachment A-3-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 88	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	27	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-3-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 88	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	4 3E 4	NA
Chromium	27	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	8 8E 3	NA
										Total	9 2E 3	0 0E+0

Attachment A-3-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED $SF_{o\ al}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 65	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	21	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-3-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 65	1E 6	50	250	5	70	1 825	25 550	2 0E 03	NTV	1 6E 4	NA
Chromium	21	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	3 4E 3	NA
										Total	3 6E 3	0 0E+0

Attachment A-3-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 88	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	27	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-3-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 88	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	2 1E 5	NA
Chromium	27	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4 2E 4	NA
										Total	4 4E 4	0 0E+0

Attachment A-3-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 65	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	21	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-3-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 65	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	3 8E 6	NA
Chromium	21	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	8 2E 5	NA
										Total	8 6E 5	0 0E+0

Attachment A 3 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{child})/(BW_{child} AT RfD $_{oral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED $_{adult}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW $_{adult}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF $_{oral}$ ((SA_{child} ED_{child}/BW_{child})+(SA $_{adult}$ ED $_{adult}$/BW $_{adult}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF $_{oral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA $_{adult}$	EF	ED $_{child}$	ED $_{adult}$	BW $_{child}$	BW $_{adult}$	AT	AT	RfD $_{oral}$	SF $_{oral}$	Hazard Index	Cancer Risk
Beryllium	0 88	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	0	NA
Chromium	27	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
															Total	0 0E+0	0 0E+0

Attachment A 3-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 88	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	5 6E 3	NA
Chromium	27	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 2E 1	NA
													Total	1 2E 1	0 0E+0

Attachment A-3 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 65	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	21	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
															Total	0 0E+0	0 0E+0

Attachment A 3 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{c}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_{c})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 65	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	2 1E 3	NA
Chromium	21	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	4 5E 2	NA
													Total	4 7E 2	0 0E+0

Attachment A-3-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	6 1E 10	1 5E 8
	Ingestion	0 0014	0 0054	1 2E 9	1 2E 8
	Total	0 0014	0 0054	1 8E 9	2 7E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 0036	0 0092	0 0E+0	0 0E+0
	Total	0 0036	0 0092	0 0E+0	0 0E+0
Current Trespasser/Site Visitor					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 000086	0 00044	0 0E+0	0 0E+0
	Total	0 000086	0 00044	0 0E+0	0 0E+0
Hypothetical Future Resident					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 047	0 12	0 0E+0	0 0E+0
	Total	0 047	0 12	0 0E+0	0 0E+0

Attachment A 4-1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 5 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day)[1]	Background
4 4 DDE	mg/kg	0 0011	65	15/16	11 2	4 1	0 03	5 0E 04	3 4E-01	
4 4 DDT	mg/kg	0 012	1100	16/16	189	69	0 03	5 0E-04	3 4E-01	
Arsenic*	mg/kg	3 2	8 5	16/16	4 9	4 4	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 35	0 82	16/16	0 63	0 57	0	NE	NE	1 01
Chromium	mg/kg	18	151	16/16	44 7	30 6	0	3 0E 03	NTV	25 46
Lead	mg/kg	8 6	1790	16/16	333	140	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0 002	25	15/16	4 3	1 6	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 002	19	15/16	3 3	1 2	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 003	16	15/16	2 8	1 1	0 13	NTV	7 3E-01	0 63
Benzo(k)fluoranthene	mg/kg	0 002	19	15/16	3 3	1 2	0 13	NTV	7 3E-02	0 46
Dibenz(a h)anthracene	mg/kg	0 002	7 1	8/16	1 24	0 47	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	0 001	11	15/16	0 37	0 18	0 13	NTV	7 3E-01	0 41

Building 5 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day)[1]	Background
4 4 DDE	mg/kg	0 0006	65	22/32	5 5	2 1	0 03	5 0E 04	3 4E-01	
4 4 DDT	mg/kg	0 0009	1100	29/32	92 8	34 5	0 03	5 0E-04	3 4E 01	
Arsenic*	mg/kg	1 9	8 5	32/32	4 65	4 28	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 35	0 88	32/32	0 64	0 6	0	NE	NE	1 01
Chromium	mg/kg	14	151	32/32	34 5	27 9	0	2 0E-02	NTV	25 46
Lead	mg/kg	5 7	1790	32/32	173	79 4	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0 002	25	21/32	2 2	0 87	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 002	19	21/32	1 64	0 64	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 003	16	21/32	1 44	0 6	0 13	NTV	7 3E 01	0 63
Benzo(k)fluoranthene	mg/kg	0 002	19	22/32	1 67	0 67	0 13	NTV	7 3E 02	0 46
Dibenz(a h)anthracene	mg/kg	0 002	7 1	12/32	0 62	0 25	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	0 001	11	22/32	1	0 42	0 13	NTV	7 3E-01	0 41

*Present at background level

Lead has no RfD or SF and is evaluated separately

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-4 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{al})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	5 5	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	5 0E 04	3 4E 01	1 0E 2	5 6E 9
4 4 DDT	92 8	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	5 0E 04	3 4E 01	1 7E 1	9 4E 8
Chromium	34 5	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	2 2	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 1E 8
Benzo(a)pyrene	1 64	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 6E 7
Benzo(b)fluoranthene	1 44	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 4E 8
Benzo(k)fluoranthene	1 67	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 02	NA	1 6E 9
Dibenz(a h)anthracene	0 62	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	5 9E 8
Indeno(1 2 3 cd)pyrene	1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	9 5E 9
												Total	1 8E 1	3 6E 7

Attachment A-4 3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	5 5	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	3 7E 2	2 1E 8
4 4 DDT	92 8	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	6 2E 1	3 5E 7
Chromium	34 5	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 8E 3	NA
Benzo(a)anthracene	2 2	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 8E 8
Benzo(a)pyrene	1 64	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 3E 7
Benzo(b)fluoranthene	1 44	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 2E 8
Benzo(k)fluoranthene	1 67	1E 6	330	60	1	70	84	25 550	NTV	7 3E 02	NA	1 3E 9
Dibenz(a h)anthracene	0 62	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	5 0E 8
Indeno(1 2 3-cd)pyrene	1	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	8 1E 9
										Total	6 7E 1	5 9E 7

Attachment A 4 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{al} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF ral	Hazard Index	Cancer Risk
4 4 DDE	2 1	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E 04	3 4E 01	5 1E 4	1 4E 10
4 4 DDT	34 5	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E 04	3 4E 01	8 4E 3	2 4E 9
Chromium	27 9	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 87	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	5 5E 10
Benzo(a)pyrene	0 64	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	4 1E 9
Benzo(b)fluoranthene	0 6	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	3 8E 10
Benzo(k)fluoranthene	0 67	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 02	NA	4 3E 11
Dibenz(a h)anthracene	0 25	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 6E 9
Indeno(1 2 3 cd)pyrene	0 42	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 7E 10
												Total	9 0E 3	9 4E 9

Attachment A-4 5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDE	2 1	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	4 3E 3	1 2E 9
4 4 DDT	34 5	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	7 0E 2	2 0E 8
Chromium	27 9	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 4E 3	NA
Benzo(a)anthracene	0 87	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 1E 9
Benzo(a)pyrene	0 64	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	7 8E 9
Benzo(b)fluoranthene	0 6	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	7 3E 10
Benzo(k)fluoranthene	0 67	1E 6	100	30	1	70	42	25 550	NTV	7 3E 02	NA	8 2E 11
Dibenz(a h)anthracene	0 25	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 1E 9
Indeno(1 2 3-cd)pyrene	0 42	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 1E 10
										Total	7 6E 2	3 4E 8

Attachment A 4 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{al})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{al})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	11 2	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E 04	3 4E 01	4 3E 3	2 6E 7
4 4 DDT	189	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E 04	3 4E 01	7 3E 2	4 4E 6
Chromium	44 7	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	4 3	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	9 4E 7
Benzo(a)pyrene	3 3	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	7 2E 6
Benzo(b)fluoranthene	2 8	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	6 1E 7
Benzo(k)fluoranthene	3 3	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 02	NA	7 2E 8
Dibenz(a h)anthracene	1 24	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 7E 6
Indeno(1 2 3 cd)pyrene	0 37	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	8 1E 8
												Total	7 8E 2	1 6E 5

Attachment A 4 7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{ral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{ral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD $_{l}$	SF $_{ral}$	Hazard Index	Cancer Risk
4 4 DDE	11 2	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	2 2E 2	1 3E 6
4 4 DDT	189	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	3 7E 1	2 2E 5
Chromium	44 7	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 5E 2	NA
Benzo(a)anthracene	4 3	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 1E 6
Benzo(a)pyrene	3 3	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	8 4E 6
Benzo(b)fluoranthene	2 8	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 1E 7
Benzo(k)fluoranthene	3 3	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 02	NA	8 4E 8
Dibenz(a h)anthracene	1 24	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 2E 6
Indeno(1 2 3-cd)pyrene	0 37	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	9 4E 8
										Total	4 1E 1	3 7E 5

Attachment A 4 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} $RfD_{or\ l}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{al})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{oral}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	4 1	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	5 0E 04	3 4E 01	1 4E 4	1 8E 9
4 4 DDT	69	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	5 0E 04	3 4E 01	2 4E 3	3 0E 8
Chromium	30 6	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 6	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 4E 9
Benzo(a)pyrene	1 2	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 8
Benzo(b)fluoranthene	1 1	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 4E 9
Benzo(k)fluoranthene	1 2	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 02	NA	4 8E 10
Dibenz(a h)anthracene	0 47	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 9E 8
Indeno(1 2 3 cd)pyrene	0 18	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	7 2E 10
												Total	2 6E 3	1 1E 7

Attachment A 4 9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $_c$ RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD $_{ral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF $_{ral}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD $_i$	SF $_i$	Hazard Index	Cancer Risk
4 4 DDE	4 1	1E 6	50	250	5	70	1 825	25 550	5 0E 04	3 4E 01	4 0E 3	4 9E 8
4 4 DDT	69	1E 6	50	250	5	70	1 825	25 550	5 0E 04	3 4E 01	6 8E 2	8 2E 7
Chromium	30 6	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 0E 3	NA
Benzo(a)anthracene	1 6	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 1E 8
Benzo(a)pyrene	1 2	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 1E 7
Benzo(b)fluoranthene	1 1	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 8E 8
Benzo(k)fluoranthene	1 2	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 02	NA	3 1E 9
Dibenz(a h)anthracene	0 47	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 2E 7
Indeno(1 2 3 cd)pyrene	0 18	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 6E 9
										Total	7 7E 2	1 4E 6

Attachment A 4 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{al})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{al} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	11 2	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E 04	3 4E 01	3 1E 4	2 3E 8
4 4 DDT	189	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E 04	3 4E 01	5 3E 3	3 8E 7
Chromium	44 7	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	4 3	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	8 1E 8
Benzo(a)pyrene	3 3	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	6 2E 7
Benzo(b)fluoranthene	2 8	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	5 3E 8
Benzo(k)fluoranthene	3 3	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 02	NA	6 2E 9
Dibenz(a h)anthracene	1 24	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 3E 7
Indeno(1 2 3-cd)pyrene	0 37	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	7 0E 9
												Total	5 6E 3	1 4E 6

Attachment A 4-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_c\ RfD_{ral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{ral})/(BW\ AT)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	11 2	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	1 1E 3	7 7E 8
4 4 DDT	189	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	1 8E 2	1 3E 6
Chromium	44 7	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	7 0E 4	NA
Benzo(a)anthracene	4 3	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	6 3E 8
Benzo(a)pyrene	3 3	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 8E 7
Benzo(b)fluoranthene	2 8	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 1E 8
Benzo(k)fluoranthene	3 3	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 02	NA	4 8E 9
Dibenz(a h)anthracene	1 24	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 8E 7
Indeno(1 2 3 cd)pyrene	0 37	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	5 4E 9
										Total	2 0E 2	2 2E 6

Attachment A 4 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{al} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	4 1	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	3 4E 01	4 6E 6	1 0E 10
4 4 DDT	69	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	3 4E 01	7 8E 5	1 7E 9
Chromium	30 6	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 6	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 7E 10
Benzo(a)pyrene	1 2	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 8E 9
Benzo(b)fluoranthene	1 1	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 5E 10
Benzo(k)fluoranthene	1 2	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 02	NA	2 8E 11
Dibenz(a h)anthracene	0 47	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 1E 9
Indeno(1 2 3 cd)pyrene	0 18	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	4 1E 11
												Total	8 2E 5	6 3E 9

Attachment A 4 13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	4 1	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	9 6E 5	2 1E 9
4 4 DDT	69	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	1 6E 3	3 5E 8
Chromium	30 6	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 2E 4	NA
Benzo(a)anthracene	1 6	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 8E 9
Benzo(a)pyrene	1 2	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 3E 8
Benzo(b)fluoranthene	1 1	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 2E 9
Benzo(k)fluoranthene	1 2	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 02	NA	1 3E 10
Dibenz(a h)anthracene	0 47	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5 2E 9
Indeno(1 2 3 cd)pyrene	0 18	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 0E 10
										Total	1 8E 3	5 9E 8

Attachment A 4 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adu} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{ld} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{ld} = Body Weight for a Child (kg)
BW_{ad} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R\ D_{ral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ra}\ ((SA_c\ \ ED_{ld}/BW_{hl}\ )+(SA_{ad}\ \ ED\ \ /BW_{d}\ )))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	$ED_{h\ ld}$	$ED_{d\ l}$	$BW_{h\ ld}$	$BW_{d\ l}$	AT_{nc}	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	11 2	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	2 5E 2	8 9E 7
4 4 DDT	189	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	4 2E 1	1 5E 5
Chromium	44 7	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	4 3	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 2E 6
Benzo(a)pyrene	3 3	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 4E 5
Benzo(b)fluoranthene	2 8	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 1E 6
Benzo(k)fluoranthene	3 3	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 02	NA	2 4E 7
Dibenz(a h)anthracene	1 24	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	9 2E 6
Indeno(1 2 3 cd)pyrene	0 37	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 7E 7
															Total	4 4E 1	5 5E 5

Attachment A 4 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI – Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{ad} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{ral}((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	11 2	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	2 9E 1	6 0E-6
4 4 DDT	189	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E-04	3 4E 01	4 8E+0	1 0E 4
Chromium	44 7	1E-6	200	100	350	6	24	15	70	2 190	25 550	3 0E-03	NTV	1 9E 1	NA
Benzo(a)anthracene	4 3	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	4 9E 6
Benzo(a)pyrene	3 3	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 8E 5
Benzo(b)fluoranthene	2 8	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 2E 6
Benzo(k)fluoranthene	3 3	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 02	NA	3 8E 7
Dibenz(a h)anthracene	1 24	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 5
Indeno(1 2 3-cd)pyrene	0 37	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	4 2E 7
													Total	5 3E+0	1 7E 4

Attachment A 4 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF AD AB SA_c EF ED_{id})/(BW_{id} AT_{nc} RfD_{ra})
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{ra} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF ((SA_{child} ED_{child}/BW_{child})+(SA_{adult} ED_{adult}/BW_{adult})))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	$SA_{c\ id}$	SA_{adul}	EF	ED_{child}	$ED_{d\ l}$	BW_{id}	BW_{d}	AT_{nc}	AT	RfD_{ral}	SF_{ra}	Hazard Index	Cancer Risk
4 4 DDE	4 1	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	9 1E 4	1 5E 8
4 4 DDT	69	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	1 5E 2	2 6E 7
Chromium	30 6	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 6	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	5 5E 8
Benzo(a)pyrene	1 2	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	4 1E 7
Benzo(b)fluoranthene	1 1	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 8E 8
Benzo(k)fluoranthene	1 2	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 02	NA	4 1E 9
Dibenz(a h)anthracene	0 47	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 7
Indeno(1 2 3 cd)pyrene	0 18	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	6 2E 9
															Total	1 6E 2	9 5E 7

Attachment A 4 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ IR_{hild}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ l}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ l}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1 $x10^{-6}$ kg/mg)
$IR_{c\ lid}$ = Soil Ingestion Rate for a Child (mg/day)
$IR_{d\ lt}$ = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{ra} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{ral}\ ((IR_{hild}\ ED_{hild}/BW_{child})+(IR_{d\ l}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR_{hild}	$IR_{d\ lt}$	EF	ED_{hild}	ED_{l}	BW_{hild}	$BW_{d\ l}$	AT	AT	RfD_{l}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	4 1	1E-6	100	50	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	5 2E 2	8 0E 7
4 4 DDT	69	1E 6	100	50	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	8 8E 1	1 4E 5
Chromium	30 6	1E-6	100	50	350	6	3	15	70	2 190	25 550	3 0E-03	NTV	6 5E 2	NA
Benzo(a)anthracene	1 6	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	6 7E 7
Benzo(a)pyrene	1 2	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	5 1E 6
Benzo(b)fluoranthene	1 1	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	4 6E 7
Benzo(k)fluoranthene	1 2	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 02	NA	5 1E 8
Dibenz(a h)anthracene	0 47	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 0E 6
Indeno(1 2 3-cd)pyrene	0 18	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	7 6E 8
													Total	1 0E+0	2 3E 5

Attachment A-4-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 0090	0 18	9 4E 9	3 6E 7
	Ingestion	0 076	0 67	3 4E 8	5 9E 7
	Total	0 085	0 85	4 4E 8	9 5E 7
Future Industrial/Commercial Worker					
	Dermal	0 0026	0 078	1 1E 7	1 6E 5
	Ingestion	0 077	0 41	1 4E 6	3 7E 5
	Total	0 079	0 48	1 5E 6	5 4E 5
Current Trespasser/Site Visitor					
	Dermal	0 000082	0 0056	6 3E 9	1 4E 6
	Ingestion	0 0018	0 020	5 9E 8	2 2E 6
	Total	0 0019	0 025	6 6E 8	3 6E 6
Hypothetical Future Resident					
	Dermal	0 016	0 44	9 5E 7	5 5E 5
	Ingestion	1 0	5 3	2 3E 5	1 7E 4
	Total	1 0	5 8	2 4E 5	2 2E 4

Attachment A-4 19

Excavation Worker Building 5
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgro p f L d Ad lt Lead C mmitte

V rsi d te 05/19/03

Exposure Variable	PbB Equation[1] 1	PbB Equation[1] 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi H m	Using Equation 1 GSDi Het	Using Equation 2 GSDi H m	Using Equation 2 GSDi Het
PbS	X	X	Soil lead centrati	g/g ppm	79 4	79 4	79 4	79 4
$R_{fetal/maternal}$	X	X	Fetal/m ternal PbB rati	–	0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d iati PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baseli PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ingesti rate (l di g il d ed indoo dust)	g/d y	0 100	0 100	--	
IR_{S+D}		X	T tal ingesti rate f td il and ind dust	g/d y			0 100	0 100
W_S		X	W ghting fact fracti f IR_{S+} gested as td soil				1 0	1 0
K_{SD}		X	Mass fracti f so l dust				0 7	0 7
$AF_{,D}$	X	X	Absorpti fracti (same f soil and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq en y (am f il and dus)	d ys/yr	30	30	30	30
$AT_{S,D}$	X	X	A eraging tim (am f l and dust)	d ys/yr	365	365	365	365
PbB_{dul}			PbB f ad lt w k geom tri mean	g/dL	1 6	1 6	1 6	1 6
$PbB_{f\ tal,}$			95th perce til PbB am ng f tuses f dult workers	g/dL	5 1	5 1	5 1	5 1
PbB			Targ t PbB le el f concern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{tal} > PbB_t)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Eq ti l d es t pp rti pos re betwee l and d t g ti (ex l des W K)
Wh IR IR and W 1 0 the eq ti y ld th am $PbB_{fetal,0.9}$

Equatio 1 based Eq 1 2 l USEPA (1996)

PbB_{dul} =	(PbS BKSF IR AF_D EF_S/AT_D) PbB
$PbB_{fetal,\ 5}$ =	PbB_{adult} (GSD_i^{64} R)

Equati n 2 altern te approach based Eq 1 2, d A 19 l USEPA (1996)

PbB_{adult} =	PbS BKSF ([(IR_{S+}) AF EF W]+[K_D (IR_{S+D}) (1 W) AF_D EF])/365+PbB
$PbB_{f\ tal,\ 5}$ =	PbB_{adult} (GSD_i^{645} R)

S urce U.S EPA (1996) R commend ti ns f th Techni l R vi w W kg p f Le d
f I terim App ach to Assessi g Risks Associ ted with Ad lt Expos res to L d i S il

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Attachment A-4 20

Excavation Worker Building 5
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U.S EPA Technical Re iew W kg p for Lead Adult Lead Committee

V i d t 05/19/03

Exposure Variable	PbB Equation 1*	PbB Equation 2**	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi = Hom	Using Equation 1 GSDi = Het	Using Equation 2 GSDi = Hom	Using Equation 2 GSDi = Het
PbS	X	X	S il l d tra	g/g ppm	79 4	79 4	79 4	79 4
$R_{f\ tal/matern}$	X	X	F tal/m ternal PbB		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Slop Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	G m tri andard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gest rate (l d g l de ved doo d t)	g/d y	0 330	0 330		
$IR_{S\ D}$		X	T tal gesti rate f tdoo l and d d t	g/d y			0 330	0 330
W_S		X	W ghti g fact fract f $IR_{S\ D}$ ges ed as td so l				1 0	1 0
K_{SD}		X	Mas fra ti f so l dust				0 7	0 7
$AF_{S,D}$	X	X	Ab rp fracti (sam f soil and d)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq y (am f il and d t)	d ys/y	60	60	60	60
$AT_{S,D}$	X	X	A rag g m (am f l and dust)	d ys/y	365	365	365	365
PbB_{dul}			PbB f ad lt w k g om tri mean	g/dL	1 7	1 7	1 7	1 7
$PbB_{f\ tal\ 0.95}$			95th p ce til PbB among f tuses f dult workers	g/dL	5 6	5 6	5 6	5 6
PbB			Targ t PbB l el f conc rn (e.g. 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{fetal} > PbB_t)$			Pr b bility th t f tal PbB PbB assumi g l g rmal distrib ti	%	0 9%	0 9%	0 9%	0 9%

Equati l does t pporti p re b wee l and d st gesti (l des W K_{SD})
Wh IR IR_{S+} and W l 0 the eq ti ns y ld th am $PbB_{f\ al}$

Equati 1 based Eq 1 2 i USEPA (1996)

PbB_{dul} =	(PbS BKSF IR_{S+} AF EF /AT) PbB
$PbB_{ta,}$ =	PbB_{ad} (GSD_i^{64} R)

Eq ti 2 lt t ppro h based Eq 1 2 d A 19 i USEPA (1996)

PbB_{ul} =	PbS BKSF*([(IR) AF EF W]+[K (IR $_D$) (1 W) AF_D EF])/365 PbB
$PbB_{ta,\ 5}$ =	$PbB_{adu\ i}$ (GSD_i^{645} R)

S ur U.S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f Lead
f In App ch to Assessi g Risks Associ ted with Ad lt Expos res to Le d i S il

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Attachment A 4-21

Site Worker Building 5
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA T chnical R vi w W kgro p f Le d Adult L d C mmitte

V rsio d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario			
					Using Equation 1		Using Equation 2	
					GSD Hom	GSD Het	GSD H m	GSD Hat
PbS	X	X	S il l ad ce trati	g/g ppm	140 1	140 1	140 1	140 1
$R_{f\ tal/maternal}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard de PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ges rate (l d g l d ved ind d)	g/d y	0 050	0 050		
IR_{S+}		X	T tal i gesti rate f td l and d dust	g/d y			0 050	0 050
W_S		X	W ghti g fac fra ti f IR_{S+} gested as td so l				1 0	1 0
K_S		X	Mas frac f so l d				0 7	0 7
$AF_{S\ D}$	X	X	Absorpti f acti (m f l and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo re freq y (am f l and dust)	d ys/y	219	219	219	219
$AT_{S,D}$	X	X	A rag g tim (am f l and dust)	d ys/y	365	365	365	365
PbB_{dul}			PbB f ad lt w rk geom tri me	g/dL	1 7	1 7	1 7	1 7
$PbB_{tal\ 0.95}$			95th perce til PbB am ng f tuses f d lt w rk rs	g/dL	5 6	5 6	5 6	5 6
PbB			Targ t PbB l el f co rn (e.g. 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{tal} > PbB_t)$			Pr b bility th t f tal/PbB PbB assumi g l gn rmal distrib ti	%	0 9%	0 9%	0 9%	0 9%

Eq l does t app rti po ure betwee il and dust gesti (l des W K)
Wh IR = IR_{S+} and W 1 0 th eq ns y ld th am PbB_{tal}

Equatio 1 based Eq 1 2 1 USEPA (1996)

PbB_{dul} =	(PbS BKSF IR_{S+} AF EF_S/AT) + PbB
$PbB_{tal,}$ =	$PbB_{ad\ t}$ ($GSD_i^{.64}$ R)

Eq atio 2 alt rnate ppro ch based o Eq 1 2 d A 19 1 USEPA (1996)

PbB_{adul} =	PbS BKSF*([(IR_{S+}) AF EF W]+[K (IR_{S+}) (1 W) AF_D EF])/365+PbB
$PbB_{f\ tal,\ .95}$ =	PbB_{adult} ($GSD_i^{.64}$ R)

S urce U.S EPA (1996). R commend ti ns f th Technical R i w W kg p f Lead f an I terim App ach to Assessi g Risks Associ ted with Ad lt Exposu es to Le d i S il

Attachment A-4-22

Site Worker Building 5
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgro p f r Lead Ad lt Le d C mmitt

V rsi d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSDi = Hom	Using Equation 1 GSDi = Het	Using Equation 2 GSDi = Hom	Using Equation 2 GSDi = Het
PbS	X	X	S il lead ce trati	g/g ppm	140 1	140 1	140 1	140 1
$R_{etal/maternal}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B kineti Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d vi ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas lin PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l ding l d ved doo dust)	g/d y	0 050	0 050		
IR_{S+D}		X	T tal ingesti rate f tdoo oil and d o dust	g/d y			0 050	0 050
W_S		X	W ghti g fac fracti f IR_{S+D} i gested as td l				1 0	1 0
K_{SD}		X	Mas fracti f so l dust				0 7	0 7
$AF_{S D}$	X	X	Absorpti fra (m f l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq y (am f l and d t)	d ys/y	250	250	250	250
$AT_{S,D}$	X	X	A rag g tim (am f l and d t)	d ys/yr	365	365	365	365
PbB_{adul}			PbB f adult w rk geom tri mean	g/dL	1 8	1 8	1 8	1 8
$PbB_{f tal 0 95}$			95th p ce til PbB am ng f tuses f dult work rs	g/dL	5 7	5 7	5 7	5 7
PbB_t			Targ t PbB l of co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_t)$			Pr b bility th t f tal PbB > PbB assumi g l gn mal distributi	%	0 9%	0 9%	0 9%	0 9%

Eq ti l does t app rti po re betwee so l and dust gesti (l des W K_S)
When IR IR and W 1 0 th eq ti ns y ld th m PbB_{fetal}

Equatio 1 based Eq 1 2 l USEPA (1996)

PbB_{adul} =	(PbS BKSF IR D AF EF /AT) + PbB
$PbB_{fetal, 95}$ =	PbB_{adult} $(GSD_i^{1.64}$ R)

Eq tio 2 alt rnat appro ch based Eq 1 2 d A 19 l USEPA (1996)

PbB_{adul} =	PbS BKSF*([(IR_{S+D}) AF EF W]+[K (IR D) (1 W) AF_D EF_D])/365+PbB
$PbB_{fetal, 5}$ =	PbB_{adult} $(GSD_i^{1.64}$ R)

S urce U.S EPA (1996) R comm d ti ns f th T chnical R vi w W kgr p f Lead
f an I App ach t Assessi g Risks Associ ted with Ad lt Exposures to Lead i S il

Attachment A 4-23

Trespasser Building 5
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U.S EPA Technical Re i w Wo kgro p f Le d Adult Lead Committee

V rsi date 05/19/03

Exposure Variable	PbB Equation 1*	PbB Equation 2**	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSD1 = Hom	Using Equation 1 GSD1 = Het	Using Equation 2 GSD1 = Hom	Using Equation 2 GSD1 = Het
PbS	X	X	S il lead ce trati	g/g ppm	140 1	140 1	140 1	140 1
$R_{f\ tal/maternal}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe Facto	g/dL p g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baseline PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ges rate (in l di g il-d ed d dust)	g/d y	0 050	0 050		
IR_{S+D}		X	T tal gesti rate f tdoo l and doo dust	g/d y			0 050	0 050
W_S		X	W ghting facto fracti f IR ingested as td so l				1 0	1 0
K_{SD}		X	Mass fracti f soil d t				0 7	0 7
$AF_{S,D}$	X	X	Absorpti fracti (sam f soil and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo re freq en y (am f il and dus)	d ys/y	6	6	6	6
$AT_{S,D}$	X	X	A ragingtim (am f l and dust)	d ys/y	365	365	365	365
PbB_{dul}			PbB f ad lt w rk geometri mean	g/dL	1.5	1 5	1.5	1.5
PbB_{fetal_95}			95th p rcentil PbB am ng f tuses f dult w rk rs	g/dL	5 0	5 0	5 0	5 0
PbB			Targ t PbB l l f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{fetal} \geq PbB_0)$			Pr b bility that fetal PbB PbB assumi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

* Eq ti l does t apporti p re be wee l and d t g (l d W K)
Whe IR IR and W 1 0 th eq ti y ld h am PbB_{fetal}

Equati 1 bas d Eq 1 2 in USEPA (1996)

PbB_{ul} =	(PbS BKSF IR AF EF /AT) + PbB
$PbB_{etal,\ 5}$ =	PbB_{adult} $(GSD_i^{64}$ R)

Equatio 2 lt rnat ppro ch b sed Eq 1 2 and A 19 in USEPA (1996)

PbB_{ul} =	PbS BKSF*(((IR) AF_S EF W]+[K_D (IR) (1 W) AF EF_D])/365+PbB
$PbB_{etal,\ 5}$ =	PbB_{adult} $(GSD_i^{64}$ R)

S ce U.S EPA (1996) Recomm d ti ns f th T chnical R vi w W kg p f Le d
f an I terim App ch to Assessi g Risks Associ ted with Ad lt Exposures to Lead i S il

Attachment A-4 24

Trespasser Building 5
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Tech ical R i w W kg p f Le d Ad lt Lead Committee

V rsi d te 05/19/03

Exposure Variable	PbB Equation 1*	PbB Equation 2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario			
					Using Equation 1		Using Equation 2	
					GSDi = Hom	GSDi = Het	GSDi = Hom	GSDi = Het
PbS	X	X	S il l d ce trati	g/g ppm	140 1	140 1	140 1	140 1
$R_{f\ tal/maternal}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki Sl pe Fact	g/dL p g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri tandard d PbB		2 18	2 18	2 18	2 18
PbB	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il i gesti rate (in l d g l d ed d dus)	g/d y	0 100	0 100		
$IR_{S\ D}$		X	Total gestu rate f td l and d d t	g/d y			0 100	0 100
W_S		X	W ghtu g fac frac f IR_{S+D} gested as d so l				1 0	1 0
K_{SD}		X	Mass frac f so l d t				0 7	0 7
$AF_{S\ D}$	X	X	Ab rptu fra t (s m f l and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq y (am f l and dus)	d ys/yr	12	12	12	12
$AT_{S,D}$	X	X	A rag g tim (am f l and d t)	d ys/y	365	365	365	365
PbB^{k}_{adul}			PbB f d lt w rk geom tri mean	g/dL	1 6	1 6	1 6	1 6
$PbB_{f\ tal\ .95}$			95th p rcentil PbB am ng f tuses f dult w k rs	g/dL	5 0	5 0	5 0	5 0
PbB			T g t PbB l l f co (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{etal} > PbB_t)$			Pr b bility th t f t l PbB PbB assumi g l gn rmal distrib d	%	0 6%	0 6%	0 6%	0 6%

Eq ti l does t apportu p re betwee l and dus gestu (ex l des W K)
Wh IR IR d W l 0 th eq ti ns yn ld th am PbB_{fetal}

Equati 1 based Eq 1 2 l USEPA (1996)

PbB_{ul} =	(PbS BKSF IR AF EF /AT) + PbB
$PbB_{tal,0\ 95}$ =	PbB_{ad} $(GSD_i^{64}$ R)

Eq ti 2 lt t pp ch based Eq 1 2 d A 19 l USEPA (1996)

PbB_{dul} =	PbS BKSF ([(IR D) AF EF W] [K D (IR_{S+D}) (1 W) AF EF_D])/365+PbB
$PbB_{fetal,\ .95}$ =	PbB_{adult} $(GSD_i^{645}$ R)

S ce U S EPA (1996) R comm d ti ns f th Technical R i w W kg p f Le d
f I App ch t Assessi g Risks Associ t d with Ad lt Exposures to Le d l S il

Attachment A-4-25

Building 5 Area
Residential Exposure to Lead
Calculated Blood Lead and Lead Uptakes from IEUBK Model Software
St Louis Army Ammunition Plant
St Louis Missouri

Year	Air (ug/dL)	Diet (ug/dL)	Alternate (ug/dL)	Water (ug/dL)	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
5 1	0 021	2 586	0	0 374	2 921	5 902	**3 2**
1 2	0 034	2 688	0	0 93	4 615	8 268	**3 5**
2 3	0 062	3 042	0	0 975	4 65	8 729	**3 2**
3 4	0 067	2 953	0	1 003	4 695	8 718	**3 1**
4 5	0 067	2 885	0	1 056	3 527	7 535	**2 6**
5 6	0 093	3 059	0	1 119	3 191	7 462	**2 3**
6 7	0 093	3 384	0	1 141	3 02	7 639	**2 2**

Attachment A 5 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Building 6 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{ral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
DDT	mg/kg	0 005	4	13/14	0 36	0 18	0 03	5 00E 04	3 4E 01	
Arsenic	mg/kg	3 6	5 7	14/14	4 6	4 4	0 03	NE	NE	13 22
Beryllium	mg/kg	0 74	1 6	14/14	1	0 89	0	2 00E 03	NTV	1 01
Mercury	mg/kg	0 015	1 5	13/14	0 62	0 38	0	3 00E 04	NTV	0 15

Building 6 Combined Surface and Subsurface Soil (0 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{ral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
DDT	mg/kg	0 0006	21	23/28	2 21	0 93	0 03	5 00E-04	3 4E-01	
Arsenic	mg/kg	3 1	5 7	28/28	4 4	4 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 66	1 6	28/28	1 02	0 93	0	5 00E-03	NTV	1 01
Chromium	mg/kg	16	31	28/28	24 5	23 3	0	2 0E 02	NTV	25 46
Mercury	mg/kg	0 01	1 5	22/28	0 36	0 23	0	3 00E-03	NTV	0 15

[1] Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-5-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED $SF_{o\ al}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	2 21	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	5 0E 04	3 4E 01	4 0E 3	2 2E 9
Beryllium	1 02	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	24 5	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Mercury	0 36	1E 6	0 9	0	3 300	60	1	70	84	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	4 0E 3	2 2E 9

Attachment A-5-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	2 21	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	1 5E 2	8 3E 9
Beryllium	1 02	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	6 9E 4	NA
Chromium	24 5	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	4 1E 3	NA
Mercury	0 36	1E 6	330	60	1	70	84	25 550	3 0E 03	NTV	4 0E 4	NA
										Total	2 0E 2	8 3E 9

Attachment A-5-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 93	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E 04	3 4E 01	2 3E 4	6 4E 11
Beryllium	0 93	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	23 3	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Mercury	0 23	1E 6	0 2	0	2 000	30	1	70	42	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	2 3E 4	6 4E 11

Attachment A-5-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 93	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	1 9E 3	5 3E 10
Beryllium	0 93	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	1 9E 4	NA
Chromium	23 3	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 2E 3	NA
Mercury	0 23	1E 6	100	30	1	70	42	25 550	3 0E 03	NTV	7 8E 5	NA
										Total	3 4E 3	5 3E 10

Attachment A-5-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 36	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E 04	3 4E 01	1 4E 4	8 5E 9
Beryllium	1	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 62	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 04	NTV	0 0E+0	NA
												Total	1 4E 4	8 5E 9

Attachment A-5-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 36	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	7 0E 4	4 3E 8
Beryllium	1	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	4 9E 4	NA
Mercury	0 62	1E 6	100	250	25	70	9 125	25 550	3 0E 04	NTV	2 0E 3	NA
										Total	3 2E 3	4 3E 8

Attachment A-5-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 18	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	5 0E 04	3 4E 01	6 3E 6	7 7E 11
Beryllium	0 89	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 38	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 04	NTV	0 0E+0	NA
												Total	6 3E 6	7 7E 11

Attachment A-5-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 18	1E 6	50	250	5	70	1 825	25 550	5 0E 04	3 4E 01	1 8E 4	2 1E 9
Beryllium	0 89	1E 6	50	250	5	70	1 825	25 550	2 0E 03	NTV	2 2E 4	NA
Mercury	0 38	1E 6	50	250	5	70	1 825	25 550	3 0E 04	NTV	6 2E 4	NA
										Total	1 0E 3	2 1E 9

Attachment A-5-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	$RfD_{o\ al}$	$SF_{o\ al}$	Hazard Index	Cancer Risk
DDT	0 36	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E 04	3 4E 01	1 0E 5	7 3E 10
Beryllium	1	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 62	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 04	NTV	0 0E+0	NA
												Total	1 0E 5	7 3E 10

Attachment A-5-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 36	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	3 4E 5	2 5E 9
Beryllium	1	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	2 3E 5	NA
Mercury	0 62	1E 6	100	12	30	70	10 950	25 550	3 0E 04	NTV	9 7E 5	NA
										Total	1 5E 4	2 5E 9

Attachment A-5-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 18	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	3 4E 01	2 0E 7	4 4E 12
Beryllium	0 89	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 38	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 04	NTV	0 0E+0	NA
												Total	2 0E 7	4 4E 12

Attachment A-5-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 18	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	4 2E 6	9 2E 11
Beryllium	0 89	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	5 2E 6	NA
Mercury	0 38	1E 6	50	6	9	70	3 285	25 550	3 0E 04	NTV	1 5E 5	NA
										Total	2 4E 5	9 2E 11

Attachment A-5 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{al})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
$SA_{ch\,ld}$ = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\,lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
$ED_{h\,ld}$ = Exposure Duration for a Child (years)
$ED_{d\,lt}$ = Exposure Duration for an Adult (years)
$BW_{h\,ld}$ = Body Weight for a Child (kg)
$BW_{d\,lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{ch\,ld}\ ED_{child}/BW_{hild})+(SA_{d\,lt}\ ED_{d\,lt}/BW_{d\,lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
$SF_{or\,l}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\,lt}$	EF	ED_{hild}	$ED_{d\,lt}$	BW_{hild}	$BW_{d\,lt}$	AT	AT	RfD_{oral}	SF_{al}	Hazard Index	Cancer Risk
DDT	0 36	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	0 00079245	2 9E 8
Beryllium	1	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	0	NA
Mercury	0 62	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 04	NTV	0	NA
															Total	7 9E 4	2 9E 8

Attachment A 5 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
$BW_{ch\ ld}$ = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
$IR_{ad\ lt}$ = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{ral}\ ((IR_{hild}\ ED_{child}/BW_{hild})+(IR_{ad\ lt}\ ED_{ad\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	$IR_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD_{ral}	$SF_{\ i}$	Hazard Index	Cancer Risk
DDT	0 36	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	9 2E 3	1 9E 7
Beryllium	1	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	6 4E 3	NA
Mercury	0 62	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 04	NTV	2 6E 2	NA
													Total	4 2E 2	1 9E 7

Attachment A 5 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 18	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	4 0E 5	6 7E 10
Beryllium	0 89	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 38	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 04	NTV	0 0E+0	NA
															Total	4 0E 5	6 7E 10

Attachment A 5 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0 18	1E 6	100	50	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	2 3E 3	3 5E 8
Beryllium	0 89	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	2 8E 3	NA
Mercury	0 38	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 04	NTV	8 1E 3	NA
													Total	1 3E 2	3 5E 8

Attachment A-5-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 00023	0 0040	6 4E 11	2 2E 9
	Ingestion	0 0034	0 020	5 3E 10	8 3E 9
	Total	0 0036	0 024	5 9E 10	1 1E 8
Future Industrial/Commercial Worker					
	Dermal	0 0000063	0 00014	7 7E 11	8 5E 9
	Ingestion	0 0010	0 0032	2 1E 9	4 3E 8
	Total	0 0010	0 0034	2 2E 9	5 1E 8
Current Trespasser/Site Visitor					
	Dermal	0 00000020	0 000010	4 4E 12	7 3E 10
	Ingestion	0 000024	0 00015	9 2E 11	2 5E 9
	Total	0 000025	0 00016	9 7E 11	3 2E 9
Hypothetical Future Resident					
	Dermal	0 000040	0 00079	6 7E 10	2 9E 8
	Ingestion	0 013	0 042	3 5E 8	1 9E 7
	Total	0 013	0 043	3 6E 8	2 2E 7

Attachment A 6 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Building 7 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day)	Background
PCB 1254	mg/kg	0 016	0 34	8/16	0 12	0 089	0 14	2 0E 05	2/1*	
Arsenic	mg/kg	3 2	7 3	16/16	6 1	5 6	0 03	NE	NE	13 22
Beryllium	mg/kg	0 33	0 88	16/16	0 61	0 55	0	NE	NE	1 01
Chromium	mg/kg	16	42	16/16	31 8	28 8	0	3 0E-03	NTV	25 46
Lead	mg/kg	10	900	16/16	136	82	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0 006	3 8	15/16	1 54	0 84	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 008	2 8	15/16	1 16	0 66	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 01	4	15/16	1 54	0 87	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 009	0 25	14/16	0 14	0 07	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 004	1 7	15/16	0 75	0 44	0 13	NTV	7 3E-01	0 41

Building 7 Combined Surface and Subsurface Soil (0 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day)	Background
PCB-1254	mg/kg	0 016	0 34	8/44	0 11	0 096	0 14	5 0E 05	2/1*	
Arsenic*	mg/kg	1 1	7 3	44/44	4 9	4 5	0 03	NE	NE	13 22
Beryllium	mg/kg	0 33	1 3	44/44	0 71	0 66	0	5 0E 03	NTV	1 01
Chromium	mg/kg	16	55	44/44	32	30	0	2 0E 02	NTV	25 46
Lead*	mg/kg	5 3	900	44/44	80	47	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0 002	3 8	30/44	0 56	0 36	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 002	2 8	34/44	0 35	0 21	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 004	4	32/44	0 57	0 36	0 13	NTV	7 3E-01	0 63
Dibenz(a h)anthracene	mg/kg	0 004	0 25	21/44	0 053	0 042	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 001	1 7	29/44	0 26	0 19	0 13	NTV	7 3E-01	0 41

Present at background level

Lead has no RfD or SF and is evaluated separately

IRIS recommends using a slope factor of 2 0 for RME and 1 0 for CTE

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A 6 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 11	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	9 3E 3	3 1E 9
Beryllium	0 71	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	32	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 56	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	5 3E 9
Benzo(a)pyrene	0 35	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 3E 8
Benzo(b)fluoranthene	0 57	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	5 4E 9
Dibenz(a h)anthracene	0 053	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	5 0E 9
Indeno(1 2 3 cd)pyrene	0 26	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 5E 9
												Total	9 3E 3	5 4E 8

Attachment A 6-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{al})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{al})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
$SF_{o\,al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{ral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 11	1E 6	330	60	1	70	84	25 550	5 0E 05	2 0E+00	7 4E 3	2 4E 9
Beryllium	0 71	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	4 8E 4	NA
Chromium	32	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 4E 3	NA
Benzo(a)anthracene	0 56	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	4 5E 9
Benzo(a)pyrene	0 35	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 8E 8
Benzo(b)fluoranthene	0 57	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	4 6E 9
Dibenz(a h)anthracene	0 053	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	4 3E 9
Indeno(1 2 3 cd)pyrene	0 26	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 1E 9
										Total	1 3E 2	4 6E 8

Attachment A 6 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
PCB 1254	0 096	1E 6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E 05	1 0E+00	1 1E 3	9 0E 11
Beryllium	0 66	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	30	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 36	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 3E 10
Benzo(a)pyrene	0 21	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 3E 9
Benzo(b)fluoranthene	0 36	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 3E 10
Dibenz(a h)anthracene	0 042	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 7E 10
Indeno(1 2 3 cd)pyrene	0 19	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 2E 10
												Total	1 1E 3	2 3E 9

Attachment A-6-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10 ^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT $_{c}$ = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF $_{i}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD $_{i}$	SF $_{i}$	Hazard Index	Cancer Risk
PCB 1254	0 096	1E 6	100	30	1	70	42	25 550	5 0E 05	1 0E+00	2 0E 3	1 6E 10
Beryllium	0 66	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	1 3E 4	NA
Chromium	30	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 5E 3	NA
Benzo(a)anthracene	0 36	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 4E 10
Benzo(a)pyrene	0 21	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	2 6E 9
Benzo(b)fluoranthene	0 36	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 4E 10
Dibenz(a h)anthracene	0 042	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	5 1E 10
Indeno(1 2 3 cd)pyrene	0 19	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 3E 10
										Total	3 6E 3	4 4E 9

Attachment A 6 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
PCB 1254	0 12	1E 6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E 05	2 0E+00	5 4E 3	7 7E 8
Chromium	31 8	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 54	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 4E 7
Benzo(a)pyrene	1 16	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 5E 6
Benzo(b)fluoranthene	1 54	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 4E 7
Dibenz(a h)anthracene	0 14	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 1E 7
Indeno(1 2 3 cd)pyrene	0 75	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 6E 7
												Total	5 4E 3	3 8E 6

Attachment A-6-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 12	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	5 9E 3	8 4E 8
Chromium	31 8	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 0E 2	NA
Benzo(a)anthracene	1 54	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 9E 7
Benzo(a)pyrene	1 16	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 0E 6
Benzo(b)fluoranthene	1 54	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 9E 7
Dibenz(a h)anthracene	0 14	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 6E 7
Indeno(1 2 3 cd)pyrene	0 75	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 9E 7
										Total	1 6E 2	4 4E 6

Attachment A 6 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
PCB 1254	0 089	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E 05	1 0E+00	3 7E 4	5 2E 10
Chromium	28 8	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	0 84	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 3E 9
Benzo(a)pyrene	0 66	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 6E 8
Benzo(b)fluoranthene	0 87	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 5E 9
Dibenz(a h)anthracene	0 07	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 8E 9
Indeno(1 2 3-cd)pyrene	0 44	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 8E 9
												Total	3 7E 4	3 8E 8

Attachment A-6-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT RfD $_{al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_lD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF $_l$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT_c	RfD $_l$	SF $_{ral}$	Hazard Index	Cancer Risk
PCB 1254	0 089	1E 6	50	250	5	70	1 825	25 550	2 0E 05	1 0E+00	2 2E 3	3 1E 9
Chromium	28 8	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	4 7E 3	NA
Benzo(a)anthracene	0 84	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 1E 8
Benzo(a)pyrene	0 66	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 7E 7
Benzo(b)fluoranthene	0 87	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 2E 8
Dibenz(a h)anthracene	0 07	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 8E 8
Indeno(1 2 3 cd)pyrene	0 44	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 1E 8
										Total	6 9E 3	2 4E 7

Attachment A 6 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD $_{ral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF $_{ral}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD $_{ral}$	SF $_{ral}$	Hazard Index	Cancer Risk
PCB 1254	0 12	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2 0E+00	3 9E 4	6 7E 9
Chromium	31 8	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 54	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 9E 8
Benzo(a)pyrene	1 16	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 2E 7
Benzo(b)fluoranthene	1 54	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 9E 8
Dibenz(a h)anthracene	0 14	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 6E 8
Indeno(1 2 3 cd)pyrene	0 75	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 4E 8
												Total	3 9E 4	3 2E 7

Attachment A-6-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{o\ l})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{c} = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{c}	AT_c	$RfD_{o\ l}$	$SF_{o\ al}$	Hazard Index	Cancer Risk
PCB 1254	0 12	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2 0E+00	2 8E 4	4 8E 9
Chromium	31 8	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	5 0E 4	NA
Benzo(a)anthracene	1 54	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 3E 8
Benzo(a)pyrene	1 16	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 7E 7
Benzo(b)fluoranthene	1 54	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 3E 8
Dibenz(a h)anthracene	0 14	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 1E 8
Indeno(1 2 3 cd)pyrene	0 75	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 1E 8
										Total	7 8E 4	2 5E 7

Attachment A 6 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
PCB 1254	0 089	1E 6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1 2E 5	3 0E 11
Chromium	28 8	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	0 84	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 9E 10
Benzo(a)pyrene	0 66	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 5E 9
Benzo(b)fluoranthene	0 87	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 0E 10
Dibenz(a h)anthracene	0 07	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 6E 10
Indeno(1 2 3 cd)pyrene	0 44	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 0E 10
												Total	1 2E 5	2 2E 9

Attachment A-6-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT_c	RfD_{al}	SF_{ral}	Hazard Index	Cancer Risk
PCB 1254	0 089	1E 6	50	6	9	70	3 285	25 550	2 0E 05	1 0E+00	5 2E 5	1 3E 10
Chromium	28 8	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 1E 4	NA
Benzo(a)anthracene	0 84	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	9 3E 10
Benzo(a)pyrene	0 66	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	7 3E 9
Benzo(b)fluoranthene	0 87	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	9 6E 10
Dibenz(a h)anthracene	0 07	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	7 7E 10
Indeno(1 2 3 cd)pyrene	0 44	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	4 8E 10
										Total	1 6E 4	1 1E 8

Attachment A 6-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT\ \ RfD_{\ i})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = *Concentration of Chemical in Soil (mg/kg)*
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ t}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ t}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ t}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non-Carcinogens (days)
$R_fD_{\ ral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{\ i}\ ((SA_{child}\ ED_{hild}/BW_{hild})+(SA_{ad\ t}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
$SF_{\ i}$ = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{hild}	$ED_{ad\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ ral}$	$SF_{\ ral}$	Hazard Index	Cancer Risk
PCB 1254	0 12	1E 6	0 3	0 14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	0 03081764	2 6E 7
Chromium	31 8	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
Benzo(a)anthracene	1 54	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 6
Benzo(a)pyrene	1 16	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 6E 6
Benzo(b)fluoranthene	1 54	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 6
Dibenz(a h)anthracene	0 14	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 0E 6
Indeno(1 2 3-cd)pyrene	0 75	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	5 5E 7
															Total	3 1E 2	1 3E 5

Attachment A 6 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hld} = Exposure Duration for a Child (years)
ED_{dlt} = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
BW_{dlt} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{dult} = Soil Ingestion Rate for an Adult (mg/day)
$R_fD_{or\ l}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{ral}\ ((IR_{child}\ ED_{hld}/BW_{hld})+(IR_{dlt}\ ED_{dlt}/BW_{dlt})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	IR_{dlt}	EF	ED_{hild}	ED_{dlt}	BW_{hild}	BW_{dlt}	AT	AT	RfD_{l}	SF_{l}	Hazard Index	Cancer Risk
PCB 1254	0 12	1E-6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	7 7E 2	3 8E 7
Chromium	31 8	1E-6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 4E 1	NA
Benzo(a)anthracene	1 54	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 8E 6
Benzo(a)pyrene	1 16	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 3E 5
Benzo(b)fluoranthene	1 54	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	1 8E 6
Dibenz(a h)anthracene	0 14	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 6
Indeno(1 2 3-cd)pyrene	0 75	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	8 6E 7
													Total	2 1E 1	2 0E 5

Attachment A 6 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{hild})/(BW_{ad} AT RfD $_{l}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ l}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ l}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_lD_{ra} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF $_{l}$ ((SA_{child} $ED_{h\ d}$/BW_{ild})+($SA_{ad\ l}$ $ED_{d\ lt}$/$BW_{d\ ld}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{ad\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
PCB 1254	0 089	1E-6	0 04	0 14	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E-05	1 0E+00	2 3E 3	4 5E 9
Chromium	28 8	1E-6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	0 84	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	2 9E 8
Benzo(a)pyrene	0 66	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 3E 7
Benzo(b)fluoranthene	0 87	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 0E 8
Dibenz(a h)anthracene	0 07	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 4E 8
Indeno(1 2 3 cd)pyrene	0 44	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 5E 8
															Total	2 3E 3	3 3E 7

Attachment A 6 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ IR_{hild}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
BW_{dult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non-Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
$IR_{d\ lt}$ = Soil Ingestion Rate for an Adult (mg/day)
$R_lD_{\ l}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{hild}/BW_{hild})+(IR_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	$IR_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
PCB 1254	0 089	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E+00	2 8E 2	5 1E 8
Chromium	28 8	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	6 1E 2	NA
Benzo(a)anthracene	0 84	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 5E 7
Benzo(a)pyrene	0 66	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 8E 6
Benzo(b)fluoranthene	0 87	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 7E 7
Dibenz(a h)anthracene	0 07	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 0E 7
Indeno(1 2 3-cd)pyrene	0 44	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 9E 7
													Total	9 0E 2	4 0E 6

Attachment A-6-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 0011	0 0093	2 3E 9	5 4E 8
	Ingestion	0 0036	0 013	4 4E 9	4 6E 8
	Total	0 0047	0 023	6 6E 9	1 0E 7
Future Industrial/Commercial Worker					
	Dermal	0 00037	0 0054	3 8E 8	3 8E 6
	Ingestion	0 0069	0 016	2 4E 7	4 4E 6
	Total	0 0072	0 022	2 8E 7	8 1E 6
Current Trespasser/Site Visitor					
	Dermal	0 000012	0 00039	2 2E 9	3 2E 7
	Ingestion	0 00016	0 00078	1 1E 8	2 5E 7
	Total	0 00018	0 0012	1 3E 8	5 8E 7
Hypothetical Future Resident					
	Dermal	0 0023	0 031	3 3E 7	1 3E 5
	Ingestion	0 090	0 21	4 0E 6	2 0E 5
	Total	0 092	0 24	4 4E 6	3 2E 5

Attachment A 6-19

Excavation Worker Building 7
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re i w Wo kgro p fo L d Adult Lead Committee

Versio d te 05/19/03

Exposure Variable	PbB Equation[1] 1[2]	2[3]	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi H m	Using Equation 1 GSDi H t	Using Equation 2 GSDi H m	Using Equation 2 GSDi Het
PbS	X	X	S il lead tr	g/g ppm	46 5	46 5	46 5	46 5
$R_{etal/maternal}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B kin u Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d u PbB	--	2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gestu rate (ncl ding l d ed ind dus)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal gestu rate f tdoo l and ind dust	g/d y			0 100	0 100
W_S		X	W ghting fact fractu f $IR_{S p}$ gested as td soil				1 0	1 0
K_{SD}		X	Mas fra u f il dust				0 7	0 7
$AF_{S,D}$	X	X	Ab rptu fractu (same f l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp ure freq y (am f l and dust)	d ys/y	30	30	30	30
$AT_{S,D}$	X	X	A er ging tim (sam f l and dust)	d ys/y	365	365	365	365
PbB_{dul}			PbB f d lt w rk geom tri me	g/dL	1.5	1 5	1.5	1 5
$PbB_{fetal,0.95}$			95th p rce til PbB am g f tuses f d lt work rs	g/dL	5 0	5 0	5 0	5 0
PbB			Targ t PbB l el f co ce (g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_t)$	Pr b bility th t f tal PbB > PbB assumi g l gn rmal distrib ti			%	0 6%	0 6%	0 6%	0 6%

Eq l does ot pp rtu p ure betwee l and d t gestu (l des W K)
Wh IR IR_{S+} and W 1 0 th q ti ns y ld th m PbB_{fetal}

Equati 1 based o Eq 1 2 1 USEPA (1996)

PbB ul =	(PbS BKSF IR AF EF /AT) + PbB
PbB te , =	PbB_{adult} $(GSD_i^{64}$ R)

Equ ti 2 lt rn t approach b d Eq 1 2, and A 19 1 USEPA (1996)

PbB dul =	PbS BKSF*(((IR) AF_S EF W]+[K (IR_{S+D}) (1 W) AF EF_D))/365 PbB
PbB fetal, s =	PbB_{adult} $(GSD_i^{645}$ R)

S urce U.S EPA (1996) R comm d ti ns f th T chnical R vi w W kg p f Lead
f an I terim App ch t Assessi g Risks Associ ted with Ad lt Exposu es to Le d i S il

Attachment A 6 20

Excavation Worker Building 7
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w Wo kgro p f Le d Adult Lead C mmitt

V slo d t 05/19/03

Exposure Variable	PbBs Equation 1	PbBs Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSD = Hom	Using Equation 1 GSD = H t	Using Equation 2 GSD = Hom	Using Equation 2 GSD = H t
PbS	X	X	S il lead ce tra	g/g ppm	46 5	46 5	46 5	46 5
$R_{f\ tal/matern}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Sl pe F t	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tr tand d d PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gest rate (l d g l d ed d dust)	g/d y	0 330	0 330		
$IR_{S\ D}$		X	T tal gestu rate f td l and doo d t	g/d y			0 330	0 330
W_S		X	W ghti g fac frac f IR_S gested as tdoo l				1 0	1 0
K_{SD}		X	Mass f tu f l d				0 7	0 7
$AF_{S\ D}$	X	X	Absorptu fra tu (sam f so l and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo re freq en y (am f il d dust)	d ys/yr	60	60	60	60
$AT_{S,D}$	X	X	A raging um (am f l d dust)	d ys/y	365	365	365	365
PbB_{adul}			PbB f ad lt w rk geometri mea	g/dL	1 7	1 7	1 7	1 7
$PbB_{f\ tal\ 0.95}$			95th perce til PbB am ng f tuses f dult w rk rs	g/dL	5 4	5 4	5 4	5 4
PbB			T g t PbB le el f co cern (g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > PbB_t)$			Pr b bility th t f tal PbB > PbB_t assumi g logn rmal distrib tio	%	0 7%	0 7%	0 7%	0 7%

[1] Eq l does t pp rtu posure betwee il and dust gestu (ex l de W K)
Wh IR IR_{S+} and W 1 0 th eq tu y eld th am PbB_{fetal}

Equation 1 based Eq 1 2 in USEPA (1996)

PbB_{adul} =	(PbS BKSF*IR_{S+D} AF $_D$ EF /AT) + PbB
$PbB_{fetal,\ 5}$ =	PbB_{adul} (GSD_i^{64} R)

Equ ti 2 lt rn t pproach based Eq 1 2 and A 19 i USEPA (1996)

PbB_{adul} =	PbS BKSF*(([IR_{S+}) AF EF_S W]+[K (IR) (1 W) AF_D EF])/365+PbB
$PbB_{fetal,\ 5}$ =	PbB_{adul} (GSD_i^{645} R)

S urce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kgr p f L ad
f Int m App ch to Assessi g Risks Associ ted with Ad lt Exposu es to Lead i S il

Attachment A-6 21

Site Worker Building 7
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re i w Wo kgro p fo L d Adult L d C mmittee

V rsio d te 05/19/03

Exposure Variable	PbB Equation 1st	PbB Equation 2nd	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSDi Hom	Using Equation 1 GSDi Het	Using Equation 2 GSDi H m	Using Equation 2 GSDi Het
PbS	X	X	S il l d trati	g/g ppm	82 0	82 0	82 0	82 0
$R_{fetal/maternal}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Sl pe Facto	g/dL p g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard de PbB		2 18	2 18	2 18	2 18
PbB	X	X	Basel ne PbB	g/dL	1 53	1 53	1 53	1 53
IR	X		S il ges rate (l d g l d ed doo dus)	g/d y	0 050	0 050		
IR_{S+D}		X	T tal ges rate f td l and d dus	g/d y			0 050	0 050
W_S		X	W ghti g factor fracti f IR_{S+} gested as tdoo so l				1 0	1 0
K_D		X	Mass fracti f soil dus				0 7	0 7
$AF_{S,D}$	X	X	Ab rpti f ti (am f l and dus)	--	0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expos re freq y (sam f l and d t)	d ys/y	219	219	219	219
$AT_{S,D}$	X	X	A raging tim (am f l and d)	d ys/yr	365	365	365	365
PbB_{dul}			PbB f ad lt w rk geom tri mean	g/dL	1 6	1 6	1 6	1 6
$PbB_{fetal,0.95}$			95th p rcentil PbB am ng f tuses f dult w k rs	g/dL	5.3	5.3	5 3	5.3
PbB			Targ t PbB l el f concern (e.g. 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_t)$			Pr bability that f tal PbB PbB assumi g l g rmal distrib ti	%	0 7%	0 7%	0 7%	0 7%

Eq ti f does t pp rti p re betwee l and dust gesti (ex f des W K)
Wh IR IR_{S+} and W 1 0 th eq ti ns y ld th sam PbB_{fetal}

Equati 1 based Eq 1 2 i USEPA (1996)

PbB_{ul} =	(PbS BKSF IR_{S+} AF EF_S/AT) + PbB
PbB_{fetal} =	PbB_{adult} ($GSD_i^{.64}$ R)

Eq ti n 2, lt te ppro ch based o Eq 1, 2 and A 19 in USEPA (1996)

PbB_{dul} =	PbS BKSF*([(IR_{S+}) AF EF_S W]+[K (IR_{S+}) (1 W) AF_D EF])/365+PbB
$PbB_{tal,95}$ =	PbB_{adult} ($GSD_i^{.645}$ R)

S urce U.S EPA (1996) R commend ti ns f th Technical R vi w W kgr p f Le d
f an I terim Approach to Assessing Risks Associ ted with Ad lt Exposures to Lead i S il

Attachment A 6 22

Site Worker Building 7
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Tech ical R i w W kg p f L d Ad lt Lead C mmitte

Ve ion d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi = H m	Using Equation 1 GSDi = Het	Using Equation 2 GSDi = Hom	Using Equation 2 GSDi = Het
PbS	X	X	S il lead co centr ti	g/g ppm	82 0	82 0	82 0	82 0
$R_{fetal/maternal}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B kin ti Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas l PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l d g il de ed ind dust)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal ges rate f d l and d d t	g/d y			0 100	0 100
W_S		X	W ghti g facto f acti f IR_S gested as td so l				1 0	1 0
K_{SD}		X	Mass f acti f soil d t				0 7	0 7
AF_D	X	X	Absorp fra ti (sam f l and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expos re freq cy (sam f so l and dust)	d ys/yr	250	250	250	250
$AT_{S,D}$	X	X	A rag g tim (am f l and dust)	d ys/y	365	365	365	365
PbB_{dul}	PbB f ad lt w rk geom tri me			g/dL	1 8	1 8	1 8	1 8
$PbB_{etal\ 0.95}$	95th p ce til PbB am ng f tuses f dult w rk rs			g/dL	5 8	5 8	5 8	5 8
PbB	Targ t PbB l el f co cern (g 10 g/dL)			g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > PbB_t)$	Pr b bility that f tal PbB_t > PbB assuming l gn rmal distrib ti			%	1 0%	1 0%	1 0%	1 0%

Eq ti l does t pporti posure betwee s l and dust g ti (ex l des W K)
Wh IR IR d W 1 0 th equati ns yi ld th sam PbB_{fetal}

Equatio 1 bas d on Eq 1 2 i USEPA (1996)

PbB_{dul} =	(PbS BKSF IR AF EF /AT_D) + PbB
$PbB_{f\ tal,\ 5}$ =	PbB_{adult} ($GSD_i^{.64}$ R)

Equati 2 lt rn t pproach based Eq 1 2 d A 19 i USEPA (1996)

PbB_{dul} =	PbS BKSF*([(IR_{S+D}) AF_S EF W]+[K_{SD} (IR_{S+}) (1 W) AF EF])/365+PbB
$PbB_{f\ tal,\ 5}$ =	$PbB_{adu\ t}$ ($GSD_i^{.645}$ R)

S urce U.S EPA (1996) Recomm d ti ns f th T ch ical R i w W kg p f L ad
f I App ch to Assessi g Risks Associ ted with Ad lt Exposures to Le d i S il

P n 5/2004 05 PM

Attachment A 6-23

Trespasser Building 7
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R I w W kgroup f Le d Ad lt Lead Committ

V rsi dat 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario			
					Using Equation 1		Using Equation 2	
					GSD1 H m	GSD1 H 1	GSD1 H m	GSD1 H 1
PbS	X	X	S il lead centrati	g/g ppm	82 0	82 0	82 0	82 0
$R_{f\ tal/maternal}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe F to	g/dL pe g/day	0 4	0 4	0 4	0 4
GSD_i	X	X	Geom tri tandard d ia PbB	--	2 18	2 18	2 18	2 18
PbB_0	X	X	Baselin PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il inges rate (l di g il deri ed d dust)	g/d y	0 050	0 050		
$IR_{S\ D}$		X	T tal ges rate f tdoo l and d dust	g/d y			0 050	0 050
W_S		X	W ghti g fact fracti f IR_{S+} gested as td soil		--		1 0	1 0
K_S		X	Mass f acti f so l d				0 7	0 7
$AF_{S\ D}$	X	X	Absorpti fra (am f l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expos re freq cy (am f l and dust)	d ys/y	6	6	6	6
$AT_{S,D}$	X	X	A erag g um (am f l and dust)	d ys/y	365	365	365	365
$\widetilde{PbB}_{adul}$			$\widetilde{PbB}$ f adult w rker geom tri mean	g/dL	1.5	1.5	1 5	1 5
$PbB_{f\ t,\ .95}$			95th p ce til PbB am ng f tuses f dult work rs	g/dL	5 0	5 0	5 0	5 0
$\widetilde{PbB}$			T g t PbB l l of co ce (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > \widetilde{PbB}_t)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Eq ti l doe pporti exp re betwee l and dust ges (l des W K)
Wh IR IR_{S+} and W l 0 th eq ti ns y ld th am PbB_f

Equati 1 based Eq 1 2 i USEPA (1996)

PbB_{adul} =	(PbS BKSF IR_{S+} AF EF /AT) + PbB
PbB_{fetal} =	PbB_{adult} $(GSD_i^{.64}$ R)

Eq ti 2 lt rn t ppro ch b sed Eq 1 2, d A 19 i USEPA (1996)

PbB_{dul} =	PbS BKSF*([(IR) AF EF W]+[K (IR) (1 W_S) AF EF])/365+PbB_0
$PbB_{fetal,\ S}$ =	PbB_{adult} $(GSD_i^{.645}$ R)

S urce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f Le d
f I terim App ch to Assessi g Risks Associ ted with Ad lt Expos es to Le d i S il

Attachment A-6 24

Trespasser Building 7
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re i w W kgro p f Lead Ad lt L d C mmittee

Versi d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSDi Hom	Using Equation 1 GSDi Het	Using Equation 2 GSDi Hom	Using Equation 2 GSDi Het
PbS	X	X	S il l d trati	g/g ppm	82 0	82 0	82 0	82 0
$R_{f\ tal/maternal}$	X	X	F tal/m ternal PbB rat		0 9	0 9	0 9	0 9
BKSF	X	X	B oku tu Slop Facto	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri tandard d tu PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ges rate (l d g l d ved d d)	g/d y	0 100	0 100		
$IR_{S\ D}$		X	T tal i gestu rate f tdoo l and ind dus	g/d y			0 100	0 100
W_S		X	W ght g fact fra tu f IR p gest d as td l				1 0	1 0
K_S		X	Mas fractu f l d t				0 7	0 7
$AF_{S\ D}$	X	X	Ab rptu fra (sam f so l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo ure freq y (am f l and d t)	d ys/y	12	12	12	12
$AT_{S,D}$	X	X	Averag g tim (am f l and d t)	d ys/y	365	365	365	365
PbB_{adult}			PbB f ad lt wo k geometri mean	g/dL	1.5	1 5	1 5	1.5
$PbB_{f\ tal\ 0\ 95}$			95th p ce til PbB am ng f tuses f dult w rk rs	g/dL	5 0	5 0	5 0	5 0
PbB			Targ t PbB l el f co er (g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{fetal} > PbB_0)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Equatu l doe t app rtu po re b twee l and d st gestu (ex l des W K)
Whe IR IR$_{S+}$ and W l 0 th eq t y ld the sam PbB$_{f\ a9}$

Equatio 1 based Eq 1 2 in USEPA (1996)

PbB_{dul} =	(PbS BKSF IR_{S+D} AF EF /$AT_{S\ D}$) + PbB
$PbB_{f\ tal,\ .95}$ =	PbB_{adult} ($GSD_i^{.64}$ R)

Eq tio 2 lt rn t ppro h b ed Eq 1 2 and A 19 in USEPA (1996)

PbB_{dul} =	PbS BKSF*([(IR_{S+D}) AF EF_S W_S] [K_D (IR_{S+}) (1 W) AF EF])/365+PbB
$PbB_{tal,\ s}$ =	PbB_{adult} ($GSD_i^{.645}$ R)

Attachment A-6-25

Building 7 Area
Residential Exposure to Lead
Calculated Blood Lead and Lead Uptakes from IEUBK Model Software
St Louis Army Ammunition Plant
St Louis Missouri

Year	Air (ug/dL)	Diet (ug/dL)	Alternate (ug/dL)	Water (ug/dL)	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
5 1	0 021	2 619	0	0 379	1 786	4 805	**2 6**
1 2	0 034	2 73	0	0 945	2 83	6 539	**2 8**
2 3	0 062	3 082	0	0 988	2 846	6 978	**2 6**
3 4	0 067	2 987	0	1 015	2 868	6 937	**2 4**
4 5	0 067	2 906	0	1 064	2 146	6 183	**2 1**
5 6	0 093	3 077	0	1 126	1 939	6 235	**1 9**
6 7	0 093	3 402	0	1 147	1 833	6 476	**1 8**

Attachment A 7 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Building 8 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day)	Background
Arsenic	mg/kg	2.5	9.8	20/20	7.6	7	0.03	NE	NE	13.22
Beryllium	mg/kg	0.29	0.94	20/20	0.66	0.59	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.003	0.21	18/20	0.075	0.049	0.13	NTV	7.3E+00	0.74

Building 8 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	2.5	9.8	60/60	7.3	6.9	0.03	NE	NE	13.22
Beryllium	mg/kg	0.22	0.94	60/60	0.63	0.6	0	NE	NE	1.01
Chromium	mg/kg	12	30	60/60	20	19	0	2.0E-02	NTV	25.46
Benzo(a)anthracene	mg/kg	0.002	2	33/60	0.21	0.16	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.003	0.99	34/60	0.1	0.07	0.13	NTV	7.3E+00	0.74
Dibenz(a,h)anthracene	mg/kg	0.001	0.14	20/60	0.036	0.03	0.13	NTV	7.3E+00	0.3

[1] Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-7 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
Chromium	20	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 21	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 0E 9
Benzo(a)pyrene	0 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	9 5E 9
Dibenz(a h)anthracene	0 036	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 4E 9
												Total	0 0E+0	1 5E 8

Attachment A-7-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	20	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	3 4E 3	NA
Benzo(a)anthracene	0 21	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 7E 9
Benzo(a)pyrene	0 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	8 1E 9
Dibenz(a h)anthracene	0 036	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 9E 9
										Total	3 4E 3	1 3E 8

Attachment A-7-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	19	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 16	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 0E 10
Benzo(a)pyrene	0 07	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	4 5E 10
Dibenz(a h)anthracene	0 03	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 9E 10
												Total	0 0E+0	7 4E 10

Attachment A-7-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	19	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	9 7E 4	NA
Benzo(a)anthracene	0 16	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 0E 10
Benzo(a)pyrene	0 07	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	8 6E 10
Dibenz(a h)anthracene	0 03	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 7E 10
										Total	9 7E 4	1 4E 9

Attachment A-7-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} $RfD_{o\ al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 075	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 6E 7
												Total	0 0E+0	1 6E 7

Attachment A-7-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 075	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 9E 7
										Total	0 0E+0	1 9E 7

Attachment A-7-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 049	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 0E 9
												Total	0 0E+0	2 0E 9

Attachment A-7-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 049	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 3E 8
										Total	0 0E+0	1 3E 8

Attachment A-7-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 075	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 4E 8
												Total	0 0E+0	1 4E 8

Attachment A-7-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 075	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 1E 8
										Total	0 0E+0	1 1E 8

Attachment A-7-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 049	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 1E 10
												Total	0 0E+0	1 1E 10

Attachment A-7-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 049	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5 4E 10
										Total	0 0E+0	5 4E 10

Attachment A 7 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF $ED_{ch\ ld}$)/(BW_{child} AT_{nc} RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
$SA_{ch\ ld}$ = Surface Area of Exposed Skin for a Child (cm^2/day)
SA $_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED $_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW $_{d\ lt}$ = Body Weight for an Adult (kg)
AT $_c$ = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF $_{ral}$ (($SA_{ch\ ld}$ ED $_{hild}$/BW $_{hild}$)+(SA $_{d\ lt}$ ED $_{d\ lt}$/BW $_{d\ lt}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA $_{d\ lt}$	EF	ED $_{hild}$	ED $_{d\ lt}$	BW $_{hild}$	BW $_{d\ lt}$	AT	AT	RfD $_l$	SF $_l$	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 075	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	5 5E 7
															Total	0 0E+0	5 5E 7

Attachment A-7-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{c}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 075	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 6E 7
													Total	0 0E+0	8 6E 7

Attachment A 7 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{child})/(BW_{child} AT RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA $_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED $_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW $_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF_{oral} ((SA_{child} ED_{child}/BW_{child})+($SA_{ad\ lt}$ $ED_{ad\ lt}$/BW $_{d\ lt}$)))/(AT_c)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA $_{d\ lt}$	EF	ED $_{hild}$	ED $_{d\ lt}$	BW $_{hild}$	BW $_{d\ lt}$	AT $_c$	AT_c	RfD $_{al}$	SF $_l$	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 049	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 7E 8
															Total	0 0E+0	1 7E 8

Attachment A 7 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 049	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 1E 7
													Total	0 0E+0	2 1E 7

Attachment A-7-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	7 4E 10	1 5E 8
	Ingestion	0 00097	0 0034	1 4E 9	1 3E 8
	Total	0 0010	0 0034	2 2E 9	2 8E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	2 0E 9	1 6E 7
	Ingestion	0	0	1 3E 8	1 9E 7
	Total	0	0	1 4E 8	3 6E 7
Current Trespasser/Site Visitor					
	Dermal	0	0	1 1E 10	1 4E 8
	Ingestion	0	0	5 4E 10	1 1E 8
	Total	0	0	6 5E 10	2 5E 8
Hypothetical Future Resident					
	Dermal	0	0	1 7E 8	5 5E 7
	Ingestion	0	0	2 1E 7	8 6E 7
	Total	0	0	2 2E 7	1 4E 6

Attachment A 8 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Northeast Parking Area Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD $_{rel}$ (mg/kg day)	SF $_{rel}$ (mg/kg-day) [1]	Background
Arsenic	mg/kg	2 6	9 8	8/8	8 7	7 1	0 03	NE	NE	13 22
Beryllium	mg/kg	0 23	0 94	8/8	0 85	0 7	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 013	2 2	8/8	0 5	0 23	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 016	1 8	8/8	0 42	0 19	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 023	2 5	8/8	0 55	0 25	0 13	NTV	7 3E-01	0 63
Dibenz(a h)anthracene	mg/kg	0 012	0 19	4/8	0 086	0 048	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 008	1 1	8/8	0 26	0 12	0 13	NTV	7 3E 01	0 41

Northeast Parking Area Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD $_{rel}$ (mg/kg day)	SF_{oral} (mg/kg day)	Background
Arsenic	mg/kg	2 1	9 8	24/24	6 5	5 7	0 03	NE	NE	13 22
Beryllium	mg/kg	0 18	0 94	24/24	0 7	0 65	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 008	2 2	14/24	0 34	0 2	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 008	1 8	14/24	0 25	0 12	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 016	2 5	14/24	0 39	0 21	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 004	0 19	7/24	0 046	0 035	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 004	1 1	14/24	0 21	0 13	0 13	NTV	7 3E 01	0 41

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A 8 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 34	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	3 2E 9
Benzo(a)pyrene	0 25	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	2 4E 8
Benzo(b)fluoranthene	0 39	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	3 7E 9
Dibenz(a h)anthracene	0 046	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	4 3E 9
Indeno(1 2 3 cd)pyrene	0 21	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 0E 9
												Total	0 0E+0	3 7E 8

Attachment A-8-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{ral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 34	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 7E 9
Benzo(a)pyrene	0 25	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 0E 8
Benzo(b)fluoranthene	0 39	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	3 2E 9
Dibenz(a h)anthracene	0 046	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	3 7E 9
Indeno(1 2 3 cd)pyrene	0 21	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 7E 9
										Total	0 0E+0	3 2E 8

Attachment A-8-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{o\ al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	$RfD_{o\ al}$	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 2	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 3E 10
Benzo(a)pyrene	0 12	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	7 6E 10
Benzo(b)fluoranthene	0 21	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 3E 10
Dibenz(a h)anthracene	0 035	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 2E 10
Indeno(1 2 3 cd)pyrene	0 13	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 3E 11
												Total	0 0E+0	1 3E 9

Attachment A-8-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 2	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 4E 10
Benzo(a)pyrene	0 12	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 5E 9
Benzo(b)fluoranthene	0 21	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 6E 10
Dibenz(a h)anthracene	0 035	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	4 3E 10
Indeno(1 2 3 cd)pyrene	0 13	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 6E 10
										Total	0 0E+0	2 6E 9

Attachment A 8-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{al} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	RfD	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 5	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 1E 7
Benzo(a)pyrene	0 42	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	9 2E 7
Benzo(b)fluoranthene	0 55	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 2E 7
Dibenz(a h)anthracene	0 086	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 9E 7
Indeno(1 2 3 cd)pyrene	0 26	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	5 7E 8
												Total	0 0E+0	1 4E 6

Attachment A-8-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 5	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 3E 7
Benzo(a)pyrene	0 42	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 1E 6
Benzo(b)fluoranthene	0 55	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 4E 7
Dibenz(a h)anthracene	0 086	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 2E 7
Indeno(1 2 3 cd)pyrene	0 26	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	6 6E 8
										Total	0 0E+0	1 6E 6

Attachment A-8 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 23	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	9 2E 10
Benzo(a)pyrene	0 19	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 6E 9
Benzo(b)fluoranthene	0 25	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	9 9E 10
Dibenz(a h)anthracene	0 048	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 9E 9
Indeno(1 2 3 cd)pyrene	0 12	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 8E 10
												Total	0 0E+0	1 2E 8

Attachment A-8-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 23	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	5 9E 9
Benzo(a)pyrene	0 19	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 8
Benzo(b)fluoranthene	0 25	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 4E 9
Dibenz(a h)anthracene	0 048	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 2E 8
Indeno(1 2 3 cd)pyrene	0 12	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 1E 9
										Total	0 0E+0	7 6E 8

Attachment A 8 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 5	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	9 5E 9
Benzo(a)pyrene	0 42	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	7 9E 8
Benzo(b)fluoranthene	0 55	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 0E 8
Dibenz(a h)anthracene	0 086	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 6E 8
Indeno(1 2 3 cd)pyrene	0 26	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 9E 9
												Total	0 0E+0	1 2E 7

Attachment A-8-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	$RfD_{o\ al}$	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 5	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	7 3E 9
Benzo(a)pyrene	0 42	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	6 2E 8
Benzo(b)fluoranthene	0 55	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	8 1E 9
Dibenz(a h)anthracene	0 086	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 3E 8
Indeno(1 2 3 cd)pyrene	0 26	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 8E 9
										Total	0 0E+0	9 4E 8

Attachment A-8 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 23	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 3E 11
Benzo(a)pyrene	0 19	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 4E 10
Benzo(b)fluoranthene	0 25	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 7E 11
Dibenz(a h)anthracene	0 048	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 1E 10
Indeno(1 2 3 cd)pyrene	0 12	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 8E 11
												Total	0 0E+0	6 8E 10

Attachment A-8-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 23	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 5E 10
Benzo(a)pyrene	0 19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 1E 9
Benzo(b)fluoranthene	0 25	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 8E 10
Dibenz(a h)anthracene	0 048	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5 3E 10
Indeno(1 2 3 cd)pyrene	0 12	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 3E 10
										Total	0 0E+0	3 3E 9

Attachment A 8 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{i})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
$ED_{h\ ld}$ = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
$BW_{h\ ld}$ = Body Weight for a Child (kg)
BW_{dult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{\ i}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{ch\ ld}\ ED_{h\ ld}/BW_{h\ ld})+(SA_{d\ lt}\ ED_{ad\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
$SF_{o\ \ j}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	$RfD_{\ i}$	$SF_{\ ral}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 5	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 7E 7
Benzo(a)pyrene	0 42	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 1E 6
Benzo(b)fluoranthene	0 55	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	4 1E 7
Dibenz(a h)anthracene	0 086	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	6 4E 7
Indeno(1 2 3-cd)pyrene	0 26	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 9E 7
															Total	0 0E+0	4 7E 6

Attachment A 8 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_c	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 5	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	5 7E 7
Benzo(a)pyrene	0 42	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	4 8E 6
Benzo(b)fluoranthene	0 55	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	6 3E 7
Dibenz(a h)anthracene	0 086	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	9 8E 7
Indeno(1 2 3 cd)pyrene	0 26	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 0E 7
													Total	0 0E+0	7 3E 6

Attachment A 8 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{hild})/(BW_{hild} AT_{nc} $RfD_{\ i}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ l}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
$R_fD_{or\ i}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF_{ral} (($SA_{ch\ ld}$ ED_{child}/BW_{hild})+($SA_{d\ lt}$ $ED_{d\ lt}$/$BW_{d\ lt}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD_{rel}	$SF_{\ i}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 23	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	7 9E 9
Benzo(a)pyrene	0 19	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	6 5E 8
Benzo(b)fluoranthene	0 25	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 6E 9
Dibenz(a h)anthracene	0 048	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 7E 8
Indeno(1 2 3 cd)pyrene	0 12	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	4 1E 9
															Total	0 0E+0	1 0E 7

Attachment A 8 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 23	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	9 7E 8
Benzo(a)pyrene	0 19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	8 0E 7
Benzo(b)fluoranthene	0 25	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 7
Dibenz(a h)anthracene	0 048	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 0E 7
Indeno(1 2 3 cd)pyrene	0 12	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	5 1E 8
													Total	0 0E+0	1 3E 6

Attachment A-8-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	1 3E 9	3 7E 8
	Ingestion	0	0	2 6E 9	3 2E 8
	Total	0	0	3 9E 9	6 8E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	1 2E 8	1 4E 6
	Ingestion	0	0	7 6E 8	1 6E 6
	Total	0	0	8 8E 8	3 0E 6
Current Trespasser/Site Visitor					
	Dermal	0	0	6 8E 10	1 2E 7
	Ingestion	0	0	3 3E 9	9 4E 8
	Total	0	0	4 0E 9	2 1E 7
Hypothetical Future Resident					
	Dermal	0	0	1 0E 7	4 7E 6
	Ingestion	0	0	1 3E 6	7 3E 6
	Total	0	0	1 4E 6	1 2E 5

Attachment A 9 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Rail Line Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	4.5	9.5	11/11	7.2	6.2	0.03	NE	NE	13.22
Beryllium	mg/kg	0.48	0.9	11/11	0.68	0.62	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.011	0.083	6/11	0.066	0.037	0.13	NTV	7.3E+00	0.74

Rail Line Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	2.7	9.5	33/33	6.1	5.5	0.03	NE	NE	13.22
Beryllium	mg/kg	0.47	1.3	33/33	0.72	0.65	0	5.0E-03	NTV	1.01
Chromium	mg/kg	14	48	33/33	26.7	23.9	0	2.0E-02	NTV	25.5
Benzo(a)pyrene	mg/kg	0.006	0.19	11/33	0.046	0.037	0.13	NTV	7.3E+00	0.74

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-9-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 72	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	26 7	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)pyrene	0 046	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	4 3E 9
												Total	0 0E+0	4 3E 9

Attachment A-9-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 72	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	4 8E 4	NA
Chromium	26 7	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	4 5E 3	NA
Benzo(a)pyrene	0 046	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	3 7E 9
										Total	5 0E 3	3 7E 9

Attachment A-9-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil-
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 65	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	23 9	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)pyrene	0 037	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 4E 10
												Total	0 0E+0	2 4E 10

Attachment A-9-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 65	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	1 3E 4	NA
Chromium	23 9	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 2E 3	NA
Benzo(a)pyrene	0 037	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	4 5E 10
										Total	1 4E 3	4 5E 10

Attachment A-9-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 066	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 4E 7
												Total	0 0E+0	1 4E 7

Attachment A-9-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 066	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 7E 7
										Total	0 0E+0	1 7E 7

Attachment A-9-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 037	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 5E 9
												Total	0 0E+0	1 5E 9

Attachment A-9-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 037	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	9 4E 9
										Total	0 0E+0	9 4E 9

Attachment A-9-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 066	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 2E 8
												Total	0 0E+0	1 2E 8

Attachment A-9-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 066	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	9 7E 9
										Total	0 0E+0	9 7E 9

Attachment A-9-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 037	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	8 5E 11
												Total	0 0E+0	8 5E 11

Attachment A-9-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 037	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 1E 10
										Total	0 0E+0	4 1E 10

Attachment A 9 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 066	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	4 9E 7
															Total	0 0E+0	4 9E 7

Attachment A-9-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_c	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 066	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	7 5E 7
													Total	0 0E+0	7 5E 7

Attachment A 9 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{c}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT_{c})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 037	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 3E 8
															Total	0 0E+0	1 3E 8

Attachment A 9-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 037	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 7
													Total	0 0E+0	1 6E 7

Attachment A-9-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	2 4E 10	4 3E 9
	Ingestion	0 0014	0 0050	4 5E 10	3 7E 9
	Total	0 0014	0 0050	6 9E 10	8 1E 9
Future Industrial/Commercial Worker					
	Dermal	0	0	1 5E 9	1 4E 7
	Ingestion	0	0	9 4E 9	1 7E 7
	Total	0	0	1 1E 8	3 1E 7
Current Trespasser/Site Visitor					
	Dermal	0	0	8 5E 11	1 2E 8
	Ingestion	0	0	4 1E 10	9 7E 9
	Total	0	0	4 9E 10	2 2E 8
Hypothetical Future Resident					
	Dermal	0	0	1 3E 8	4 9E 7
	Ingestion	0	0	1 6E 7	7 5E 7
	Total	0	0	1 7E 7	1 2E 6

Attachment A 10 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Roadway Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day)	Background
Antimony	mg/kg	2 1	34	10/32	11 1	9 6	0	4 0E-04	NTV	
Arsenic	mg/kg	0 67	11	32/32	6 8	6 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 54	6 7	32/32	1 17	0 85	0	2 0E-03	NTV	1 01
Chromium	mg/kg	17	37	32/32	24	23	0	3 0E-03	NTV	25 46
Benzo(a)pyrene	mg/kg	0 002	0 48	24/32	0 14	0 09	0 13	NTV	7 3E+00	0 74
Dibenz(a,h)anthracene	mg/kg	0 003	0 084	13/32	0 037	0 031	0 13	NTV	7 3E+00	0 3

Roadway Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day)	Background
Antimony	mg/kg	1 8	34	30/96	9 6	8 8	0	4 0E-04	NTV	
Arsenic	mg/kg	0 67	11	96/96	5 6	5 3	0 03	NE	NE	13 22
Beryllium	mg/kg	0 46	6 7	96/96	0 85	0 75	0	5 0E 03	NTV	1 01
Chromium	mg/kg	15	37	96/96	24 4	23 7	0	2 0E-02	NTV	25 46
Benzo(a)anthracene	mg/kg	0 002	1 2	48/96	0 17	0 13	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 002	1 1	49/96	0 078	0 056	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 003	1 5	51/96	0 16	0 13	0 13	NTV	7 3E-01	0 63
Dibenz(a,h)anthracene	mg/kg	0 001	0 16	21/96	0 034	0 03	0 13	NTV	7 3E+00	0 3

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A 10 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD $_{al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD $_{l}$	SF $_{ral}$	Hazard Index	Cancer Risk
Antimony	9 6	1E 6	0 9	0	3 300	60	1	70	84	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	0 85	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	24 4	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 17	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 6E 9
Benzo(a)pyrene	0 078	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	7 4E 9
Benzo(b)fluoranthene	0 16	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 9
Dibenz(a h)anthracene	0 034	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 2E 9
												Total	0 0E+0	1 4E 8

Attachment A-10 3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $RfD_{o\ al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED $SF_{o\ al}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD	SF	Hazard Index	Cancer Risk
Antimony	9 6	1E 6	330	60	1	70	84	25 550	4 0E 04	NTV	8 1E 2	NA
Beryllium	0 85	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	5 7E 4	NA
Chromium	24 4	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	4 1E 3	NA
Benzo(a)anthracene	0 17	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 4E 9
Benzo(a)pyrene	0 078	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	6 3E 9
Benzo(b)fluoranthene	0 16	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 9
Dibenz(a h)anthracene	0 034	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 7E 9
										Total	8 5E 2	1 2E 8

Attachment A 10 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{l} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{l}	SF_{ral}	Hazard Index	Cancer Risk
Antimony	8 8	1E 6	0 2	0	2 000	30	1	70	42	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	0 75	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	23 7	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 13	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 3E 11
Benzo(a)pyrene	0 056	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 6E 10
Benzo(b)fluoranthene	0 13	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 3E 11
Dibenz(a h)anthracene	0 03	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 9E 10
												Total	0 0E+0	7 1E 10

Attachment A-10-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	8 8	1E 6	100	30	1	70	42	25 550	4 0E 04	NTV	2 2E 2	NA
Beryllium	0 75	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	1 5E 4	NA
Chromium	23 7	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 2E 3	NA
Benzo(a)anthracene	0 13	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 6E 10
Benzo(a)pyrene	0 056	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	6 9E 10
Benzo(b)fluoranthene	0 13	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 6E 10
Dibenz(a h)anthracene	0 03	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 7E 10
										Total	2 4E 2	1 4E 9

Attachment A-10-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{ral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT	RfD_{al}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	11 1	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	1 17	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	24	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 14	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 1E 7
Dibenz(a h)anthracene	0 037	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	8 1E 8
												Total	0 0E+0	3 9E 7

Attachment A-10-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	11 1	1E 6	100	250	25	70	9 125	25 550	4 0E 04	NTV	2 7E 2	NA
Beryllium	1 17	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	5 7E 4	NA
Chromium	24	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	7 8E 3	NA
Benzo(a)pyrene	0 14	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 6E 7
Dibenz(a h)anthracene	0 037	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	9 4E 8
										Total	3 6E 2	4 5E 7

Attachment A-10 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED $SF_{o al}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o al}$	Hazard Index	Cancer Risk
Antimony	9 6	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	0 85	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	23	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 09	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 6E 9
Dibenz(a h)anthracene	0 031	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 2E 9
												Total	0 0E+0	4 8E 9

Attachment A-10-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	9 6	1E 6	50	250	5	70	1 825	25 550	4 0E 04	NTV	1 2E 2	NA
Beryllium	0 85	1E 6	50	250	5	70	1 825	25 550	2 0E 03	NTV	2 1E 4	NA
Chromium	23	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	3 8E 3	NA
Benzo(a)pyrene	0 09	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 3E 8
Dibenz(a h)anthracene	0 031	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 9E 9
										Total	1 6E 2	3 1E 8

Attachment A-10-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT\ )$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	11 1	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	1 17	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	24	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 14	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 6E 8
Dibenz(a h)anthracene	0 037	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	7 0E 9
												Total	0 0E+0	3 3E 8

Attachment A-10-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	11 1	1E 6	100	12	30	70	10 950	25 550	4 0E 04	NTV	1 3E 3	NA
Beryllium	1 17	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	2 7E 5	NA
Chromium	24	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	3 8E 4	NA
Benzo(a)pyrene	0 14	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 1E 8
Dibenz(a h)anthracene	0 037	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	5 4E 9
										Total	1 7E 3	2 6E 8

Attachment A-10 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	9 6	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	0 85	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	23	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 09	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 1E 10
Dibenz(a h)anthracene	0 031	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	7 1E 11
												Total	0 0E+0	2 8E 10

Attachment A-10-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	9 6	1E 6	50	6	9	70	3 285	25 550	4 0E 04	NTV	2 8E 4	NA
Beryllium	0 85	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	5 0E 6	NA
Chromium	23	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	9 0E 5	NA
Benzo(a)pyrene	0 09	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	9 9E 10
Dibenz(a h)anthracene	0 031	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	3 4E 10
										Total	3 8E 4	1 3E 9

Attachment A 10 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT\ \ RfD_{\ i})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
$ED_{h\ ld}$ = Exposure Duration for a Child (years)
ED_{dult} = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{\ ral}\ ((SA_{child}\ ED_{hild}/BW_{hild})+(SA_{d\ lt}\ ED_{dult}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
$SF_{\ ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{d\ lt}$	EF	ED_{hild}	ED_{dult}	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	$RfD_{\ i}$	$SF_{\ i}$	Hazard Index	Cancer Risk
Antimony	11 1	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4 0E 04	NTV	0	NA
Beryllium	1 17	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	0	NA
Chromium	24	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
Benzo(a)pyrene	0 14	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 0E 6
Dibenz(a h)anthracene	0 037	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 7E 7
															Total	0 0E+0	1 3E 6

Attachment A 10 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{al})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
$BW_{h\ ld}$ = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{hild} = Soil Ingestion Rate for a Child (mg/day)
IR_{dult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{hild}/BW_{hild})+(IR_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	$IR_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Antimony	11 1	1E 6	200	100	350	6	24	15	70	2 190	25 550	4 0E 04	NTV	3 5E 1	NA
Beryllium	1 17	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	7 5E 3	NA
Chromium	24	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 0E 1	NA
Benzo(a)pyrene	0 14	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 6
Dibenz(a h)anthracene	0 037	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	4 2E 7
													Total	4 6E 1	2 0E 6

Attachment A 10 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{ch\ ld}\ EF\ ED_{h\ ld})/(BW_{hild}\ AT_{nc}\ RfD_{\ i})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
$SA_{ch\ ld}$ = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
ED_{dult} = Exposure Duration for an Adult (years)
$BW_{h\ ld}$ = Body Weight for a Child (kg)
BW_{dul} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
$R_fD_{\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{or\ l}\ ((SA_{child}\ ED_{hild}/BW_{hild})+(SA_{d\ lt}\ ED_{dult}/BW_{d\ lt})))/(AT\ )$
(cancer nsk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	$RfD_{\ i}$	SF_{rel}	Hazard Index	Cancer Risk
Antimony	9 6	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	0 85	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	23	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 09	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 1E 8
Dibenz(a h)anthracene	0 031	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 1E 8
															Total	0 0E+0	4 2E 8

Attachment A 10 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{hild}\ EF\ ED_{hild})/(BW_{hild}\ AT\ \ RfD_{al})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{ad\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
$IR_{ch\ ld}$ = Soil Ingestion Rate for a Child (mg/day)
$IR_{d\ lt}$ = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{h\ ld}\ ED_{hild}/BW_{h\ ld})+(IR_{dult}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	$IR_{d\ lt}$	EF	ED_{child}	$ED_{d\ lt}$	BW_{hild}	BW_{dult}	AT	AT_c	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
Antimony	9 6	1E 6	100	50	350	6	3	15	70	2 190	25 550	4 0E 04	NTV	1 5E 1	NA
Beryllium	0 85	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	2 7E 3	NA
Chromium	23	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	4 9E 2	NA
Benzo(a)pyrene	0 09	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 8E 7
Dibenz(a h)anthracene	0 031	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 3E 7
													Total	2 1E 1	5 1E 7

Attachment A-10-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	7 1E 10	1 4E 8
	Ingestion	0 024	0 085	1 4E 9	1 2E 8
	Total	0 024	0 085	2 1E 9	2 5E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	4 8E 9	3 9E 7
	Ingestion	0 016	0 036	3 1E 8	4 5E 7
	Total	0 016	0 036	3 6E 8	8 4E 7
Current Trespasser/Site Visitor					
	Dermal	0	0	2 8E 10	3 3E 8
	Ingestion	0 00038	0 0017	1 3E 9	2 6E 8
	Total	0 00038	0 0017	1 6E 9	5 9E 8
Hypothetical Future Resident					
	Dermal	0	0	4 2E 8	1 3E 6
	Ingestion	0 21	0 46	5 1E 7	2 0E 6
	Total	0 21	0 46	5 5E 7	3 3E 6

Attachment A 11 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 1A Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day) [1]	Background
PCB 1254	mg/kg	0 35	0 35	1/4	0 35	0 35	0 14	2 00E 05	2/1[a]	
Arsenic	mg/kg	4.5	4.5	1/1	4.5	4 5	0.03	NE	NE	13.22
Beryllium[2]	mg/kg	0.57	0 57	1/1	0.57	0.57	0	NE	NE	1.01

Hotspot 1A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg day) [1]	Background
PCB 1254	mg/kg	0 35	0 35	1/6	0 21	0 10	0 14	5 00E 05	2/1[a]	
Arsenic	mg/kg	4.5	5.8	3/3	5.8	5.10	0.03	NE	NE	13.22
Beryllium	mg/kg	0.38	0.66	3/3	0.66	0 54	0	NE	NE	1.01

[a] Present at background level

[1] IRIS recommends using a slope factor of 2 0 for RME and 1 0 for CTE

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-11-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)[1]
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)[1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 21	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	1 8E 2	5 8E 9
												Total	1 8E 2	5 8E 9

Attachment A-11-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 21	1E 6	330	60	1	70	84	25 550	5 0E 05	2 0E+00	1 4E 2	4 6E 9
										Total	1 4E 2	4 6E 9

Attachment A-11-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 10	1E 6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E 05	1 0E+00	1 2E 3	9 5E 11
												Total	1 2E 3	9 5E 11

Attachment A-11-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 10	1E 6	100	30	1	70	42	25 550	5 0E 05	1 0E+00	2 1E 3	1 7E 10
										Total	2 1E 3	1 7E 10

Attachment A-11-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E 05	2	1 6E 2	2 3E 7
												Total	1 6E 2	2 3E 7

Attachment A-11-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2	1 7E 2	2 4E 7
										Total	1 7E 2	2 4E 7

Attachment A-11-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E 05	1	1 4E 3	2 1E 9
												Total	1 4E 3	2 1E 9

Attachment A-11-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	50	250	5	70	1 825	25 550	2 0E 05	1	8 6E 3	1 2E 8
										Total	8 6E 3	1 2E 8

Attachment A-11-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2	1 1E 3	2 0E 8
												Total	1 1E 3	2 0E 8

Attachment A-11-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2	8 2E 4	1 4E 8
										Total	8 2E 4	1 4E 8

Attachment A-11-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1	4 6E 5	1 2E 10
												Total	4 6E 5	1 2E 10

Attachment A-11-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	50	6	9	70	3 285	25 550	2 0E 05	1	2 1E 4	5 3E 10
										Total	2 1E 4	5 3E 10

Attachment A-11 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = *Concentration of Chemical in Soil (mg/kg)*
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = *Exposure Duration for a Child (years)*
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{ad\ lt}$ = Body Weight for an Adult (kg)
AT_{c} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{ad\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD_{l}	SF_{l}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	0 3	0 14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 05	2	9 0E 2	7 6E 7
															Total	9 0E 2	7 6E 7

Attachment A-11-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2	2 2E 1	1 1E 6
													Total	2 2E 1	1 1E 6

Attachment A-11 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hld} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{ch\ ld}\ ED_{ch\ ld}/BW_{child})+(SA_{d\ lt}\ ED_{ad\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD_{l}	SF_{l}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	0 04	0 14	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 05	1	9 0E 3	1 8E 8
															Total	9 0E 3	1 8E 8

Attachment A 11 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 35	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 05	1	1 1E 1	2 0E 7
													Total	1 1E 1	2 0E 7

Attachment A-11-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 0012	0 018	9 5E 11	5 8E 9
	Ingestion	0 0021	0 014	1 7E 10	4 6E 9
	Total	0 0032	0 031	2 7E 10	1 0E 8
Future Industrial/Commercial Worker					
	Dermal	0 0014	0 016	2 1E 9	2 3E 7
	Ingestion	0 0086	0 017	1 2E 8	2 4E 7
	Total	0 010	0 033	1 4E 8	4 7E 7
Current Trespasser/Site Visitor					
	Dermal	0 000046	0 0011	1 2E 10	2 0E 8
	Ingestion	0 00021	0 00082	5 3E 10	1 4E 8
	Total	0 00025	0 0020	6 5E 10	3 4E 8
Hypothetical Future Resident					
	Dermal	0 0090	0 090	1 8E 8	7 6E 7
	Ingestion	0 11	0 22	2 0E 7	1 1E 6
	Total	0 12	0 31	2 2E 7	1 9E 6

Attachment A 12 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot 1B Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD $_{oral}$ (mg/kg-day)	SF$_{oral}$ (mg/kg day) [1]	Background
Arsenic	mg/kg	5.7	8.7	2/2	8.7	7.20	0 03	NE	NE	13.22
Beryllium	mg/kg	0 6	0 63	2/2	0 63	0 62	0	NE	NE	1.01
Chromium	mg/kg	21	46	2/2	46	34	0	3 0E-03	NTV	25 46
Copper	mg/kg	15	1260	2/2	1260	638	0	4 0E 02	NTV	59 1
Benzo(a)anthracene	mg/kg	0 71	1 7	2/2	1 7	1 21	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 53	1 2	2/2	1 2	0 87	0 13	NTV	7 3	0 74
Benzo(b)fluoranthene	mg/kg	0 7	1 7	2/2	1 7	1 20	0 13	NTV	0 73	0 63
Dibenz(a h)anthracene	mg/kg	0 090	0 29	2/2	0 29	0 19	0 13	NTV	7 3	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	0 28	0 7	2/2	0 7	0 49	0 13	NTV	0 73	0 41

Hotspot 1B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD$_{oral}$ (mg/kg day)	SF $_{oral}$ (mg/kg day) [1]	Background
Arsenic	mg/kg	3.4	8.7	6/6	7.2	5.60	0.03	NE	NE	13.22
Beryllium	mg/kg	0.53	0.63	6/6	0.61	0.59	0	NE	NE	1.01
Chromium	mg/kg	18	46	6/6	33 9	25 5	0	2 0E-02	NTV	25 46
Copper	mg/kg	9 6	1260	6/6	640	221	0	4 0E-02	NTV	59 1
Benzo(a)anthracene	mg/kg	0 065	1 7	3/6	0 96	0 46	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 053	1 2	3/6	0 71	0 31	0 13	NTV	7 3	0 74
Benzo(b)fluoranthene	mg/kg	0 045	1 7	3/6	0 99	0 47	0 13	NTV	0 73	0 63
Dibenz(a h)anthracene	mg/kg	0.09	0.29	2/6	0.17	0.084	0.13	NTV	7.3	0.3
Indeno(1 2 3 cd)pyrene	mg/kg	0 035	0 7	3/6	1 4	0 26	0 13	NTV	0 73	0 41

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-12 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{al})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	33 9	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Copper	640	1E 6	0 9	0	3 300	60	1	70	84	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 96	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	9 1E 9
Benzo(a)pyrene	0 71	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	6 7E 8
Benzo(b)fluoranthene	0 99	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	9 4E 9
Dibenz(a h)anthracene	0 17	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 6E 8
Indeno(1 2 3 cd)pyrene	1 4	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 8
												Total	0 0E+0	1 1E 7

Attachment A-12-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $_c$ RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD $_{ral}$	SF $_{al}$	Hazard Index	Cancer Risk
Chromium	33 9	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 7E 3	NA
Copper	640	1E 6	330	60	1	70	84	25 550	4 0E 02	NTV	5 4E 2	NA
Benzo(a)anthracene	0 96	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	7 8E 9
Benzo(a)pyrene	0 71	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	5 7E 8
Benzo(b)fluoranthene	0 99	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	8 0E 9
Dibenz(a h)anthracene	0 17	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 4E 8
Indeno(1 2 3 cd)pyrene	1 4	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 1E 8
										Total	6 0E 2	9 8E 8

Attachment A-12 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{ral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{ral})/(BW\ AT)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
Chromium	25 5	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Copper	221	1E 6	0 2	0	2 000	30	1	70	42	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 46	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 9E 10
Benzo(a)pyrene	0 31	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 0E 9
Benzo(b)fluoranthene	0 47	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	3 0E 10
Dibenz(a h)anthracene	0 084	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	5 3E 10
Indeno(1 2 3 cd)pyrene	0 26	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 7E 10
												Total	0 0E+0	3 3E 9

Attachment A-12-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	25 5	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 3E 3	NA
Copper	221	1E 6	100	30	1	70	42	25 550	4 0E 02	NTV	5 6E 3	NA
Benzo(a)anthracene	0 46	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 6E 10
Benzo(a)pyrene	0 31	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 8E 9
Benzo(b)fluoranthene	0 47	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 8E 10
Dibenz(a h)anthracene	0 084	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 0E 9
Indeno(1 2 3 cd)pyrene	0 26	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	3 2E 10
										Total	6 9E 3	6 3E 9

Attachment A 12 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	RfD	SF	Hazard Index	Cancer Risk
Chromium	46	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	1260	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 7	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 7E 7
Benzo(a)pyrene	1 2	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 6E 6
Benzo(b)fluoranthene	1 7	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 7E 7
Dibenz(a h)anthracene	0 29	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	6 3E 7
Indeno(1 2 3 cd)pyrene	0 7	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 5E 7
												Total	0 0E+0	4 2E 6

Attachment A-12-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{al} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	46	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 5E 2	NA
Copper	1260	1E 6	100	250	25	70	9 125	25 550	4 0E 02	NTV	3 1E 2	NA
Benzo(a)anthracene	1 7	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	4 3E 7
Benzo(a)pyrene	1 2	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 1E 6
Benzo(b)fluoranthene	1 7	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	4 3E 7
Dibenz(a h)anthracene	0 29	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	7 4E 7
Indeno(1 2 3 cd)pyrene	0 7	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 8E 7
										Total	4 6E 2	4 8E 6

Attachment A-12 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD $_{ral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF $_{ral}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
Chromium	33 5	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	638	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 21	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 8E 9
Benzo(a)pyrene	0 87	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 4E 8
Benzo(b)fluoranthene	1 2	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 8E 9
Dibenz(a h)anthracene	0 19	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 6E 9
Indeno(1 2 3 cd)pyrene	0 49	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 0E 9
												Total	0 0E+0	5 4E 8

Attachment A-12-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT RfD $_{al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED $SF_{o\ al}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT $_c$	AT_c	$RfD_{o\ al}$	SF $_i$	Hazard Index	Cancer Risk
Chromium	33 5	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 5E 3	NA
Copper	638	1E 6	50	250	5	70	1 825	25 550	4 0E 02	NTV	7 8E 3	NA
Benzo(a)anthracene	1 21	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 1E 8
Benzo(a)pyrene	0 87	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 2E 7
Benzo(b)fluoranthene	1 2	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 1E 8
Dibenz(a h)anthracene	0 19	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 8
Indeno(1 2 3 cd)pyrene	0 49	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 3E 8
										Total	1 3E 2	3 4E 7

Attachment A-12-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
Chromium	46	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	1260	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 7	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 2E 8
Benzo(a)pyrene	1 2	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 3E 7
Benzo(b)fluoranthene	1 7	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 2E 8
Dibenz(a h)anthracene	0 29	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	5 5E 8
Indeno(1 2 3 cd)pyrene	0 7	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 3E 8
												Total	0 0E+0	3 6E 7

Attachment A-12-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	$RfD_{o\ al}$	SF_{oral}	Hazard Index	Cancer Risk
Chromium	46	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	7 2E 4	NA
Copper	1260	1E 6	100	12	30	70	10 950	25 550	4 0E 02	NTV	1 5E 3	NA
Benzo(a)anthracene	1 7	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 5E 8
Benzo(a)pyrene	1 2	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 8E 7
Benzo(b)fluoranthene	1 7	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 5E 8
Dibenz(a h)anthracene	0 29	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 3E 8
Indeno(1 2 3 cd)pyrene	0 7	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 0E 8
										Total	2 2E 3	2 8E 7

Attachment A-12 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD $_{ral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF $_{ral}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	RfD_o	SF_o	Hazard Index	Cancer Risk
Chromium	33 5	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	638	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 21	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 8E 10
Benzo(a)pyrene	0 87	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 0E 9
Benzo(b)fluoranthene	1 2	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 8E 10
Dibenz(a h)anthracene	0 19	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 4E 10
Indeno(1 2 3 cd)pyrene	0 49	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 1E 10
												Total	0 0E+0	3 1E 9

Attachment A-12-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	33 5	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 3E 4	NA
Copper	638	1E 6	50	6	9	70	3 285	25 550	4 0E 02	NTV	1 9E 4	NA
Benzo(a)anthracene	1 21	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 3E 9
Benzo(a)pyrene	0 87	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	9 5E 9
Benzo(b)fluoranthene	1 2	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 3E 9
Dibenz(a h)anthracene	0 19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 1E 9
Indeno(1 2 3 cd)pyrene	0 49	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 4E 10
										Total	3 2E 4	1 5E 8

Attachment A 12 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{ild}\ AT\ \ RfD_{ra})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{child}\ ED_{hild}/BW_{hild})+(SA_{ad\ l}\ ED_{d\ lt}/BW_{ad\ l})))/(AT\ )$
(cancer nsk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{l} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	RfD_{ral}	SF_{l}	Hazard Index	Cancer Risk
Chromium	46	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E-03	NTV	0	NA
Copper	1260	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4 0E-02	NTV	0	NA
Benzo(a)anthracene	1 7	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 3E 6
Benzo(a)pyrene	1 2	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 9E 6
Benzo(b)fluoranthene	1 7	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 3E 6
Dibenz(a h)anthracene	0 29	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 1E 6
Indeno(1 2 3 cd)pyrene	0 7	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	5 2E 7
															Total	0 0E+0	1 4E 5

Attachment A 12 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF IR_{child} EF ED_{child})/(BW_{child} AT_{nc} RfD $_{oral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED $_{adult}$ = Exposure Duration for an Adult (years)
BW $_{child}$ = Body Weight for a Child (kg)
BW $_{adult}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR $_{adult}$ = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF EF SF $_{oral}$ ((IR_{child} ED_{child}/BW $_{child}$)+(IR $_{adult}$ ED $_{adult}$/BW $_{adult}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR $_{child}$	IR $_{adult}$	EF	ED $_{child}$	ED $_{adult}$	BW $_{child}$	BW $_{adult}$	AT_{nc}	AT	RfD $_{oral}$	SF $_{oral}$	Hazard Index	Cancer Risk
Chromium	46	1E-6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	2 0E 1	NA
Copper	1260	1E-6	200	100	350	6	24	15	70	2 190	25 550	4 0E 02	NTV	4 0E 1	NA
Benzo(a)anthracene	1 7	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	1 9E 6
Benzo(a)pyrene	1 2	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 5
Benzo(b)fluoranthene	1 7	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	1 9E 6
Dibenz(a h)anthracene	0 29	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 3E 6
Indeno(1 2 3-cd)pyrene	0 7	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	8 0E 7
													Total	6 0E 1	2 2E 5

Attachment A 12 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{child})/(BW $_{hild}$ AT_{nc} RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{ad\ t}$ = Exposure Duration for an Adult (years)
BW $_{hild}$ = Body Weight for a Child (kg)
BW $_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD $_{ral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF_{oral} ((SA_{child} ED $_{hild}$/BW $_{hild}$)+($SA_{ad\ lt}$ ED $_{d\ lt}$/BW $_{d\ lt}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ l}$	EF	ED $_{hild}$	ED $_{d\ lt}$	BW $_{hild}$	BW $_{d\ lt}$	AT_{nc}	AT	RfD $_{l}$	SF $_{ra}$	Hazard Index	Cancer Risk
Chromium	33 5	1E-6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E-03	NTV	0 0E+0	NA
Copper	638	1E-6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4 0E-02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 21	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	4 1E 8
Benzo(a)pyrene	0 87	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 0E 7
Benzo(b)fluoranthene	1 2	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	4 1E 8
Dibenz(a h)anthracene	0 19	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	6 5E 8
Indeno(1 2 3-cd)pyrene	0 49	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 7E 8
															Total	0 0E+0	4 6E 7

Attachment A 12 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
$IR_{d\ lt}$ = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{h\ ld}\ ED_{hild}/BW_{hild})+(IR_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	$IR_{ad\ lt}$	EF	ED_{hild}	ED_{dult}	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Chromium	33 5	1E-6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	7 1E 2	NA
Copper	638	1E 6	100	50	350	6	3	15	70	2 190	25 550	4 0E 02	NTV	1 0E 1	NA
Benzo(a)anthracene	1 21	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	5 1E 7
Benzo(a)pyrene	0 87	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 6E 6
Benzo(b)fluoranthene	1 2	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	5 1E 7
Dibenz(a h)anthracene	0 19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	8 0E 7
Indeno(1 2 3 cd)pyrene	0 49	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	2 1E 7
													Total	1 7E 1	5 7E 6

Attachment A-12-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	3 3E 9	1 1E 7
	Ingestion	0 0069	0 060	6 3E 9	9 8E 8
	Total	0 0069	0 060	9 5E 9	2 1E 7
Future Industrial/Commercial Worker					
	Dermal	0	0	5 4E 8	4 2E 6
	Ingestion	0 013	0 046	3 4E 7	4 8E 6
	Total	0 013	0 046	4 0E 7	9 0E 6
Current Trespasser/Site Visitor					
	Dermal	0	0	3 1E 9	3 6E 7
	Ingestion	0 00032	0 0022	1 5E 8	2 8E 7
	Total	0 00032	0 0022	1 8E 8	6 4E 7
Hypothetical Future Resident					
	Dermal	0	0	4 6E 7	1 4E 5
	Ingestion	0 17	0 60	5 7E 6	2 2E 5
	Total	0 17	0 60	6 1E 6	3 6E 5

Attachment A 13 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 1C Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	7 5	14	2/2	14	10 75	0 03	3 0E 04	1 5	13 22
Beryllium	mg/kg	0 67	0 67	1/1	0 67	0 67	0	NE	NE	1 01

Hotspot 1C Combined Surface and Subsurface Soil (0 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	7 5	14	4/4	14	9 30	0 03	3 0E-04	1 5	13.22
Beryllium	mg/kg	0 67	0 69	3/3	0 69	0 68	0	NE	NE	1 01

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-13-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	14	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	3 0E 04	1 5E+00	4 2E 2	6 3E 8
												Total	4 2E 2	6 3E 8

Attachment A-13-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	14	1E 6	330	60	1	70	84	25 550	3 0E 04	1 5E+00	1 6E 1	2 3E 7
										Total	1 6E 1	2 3E 7

Attachment A-13-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	9 3	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	3 0E 04	1 5E+00	3 8E 3	2 8E 9
												Total	3 8E 3	2 8E 9

Attachment A-13-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR{*}EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	9 3	1E 6	100	30	1	70	42	25 550	3 0E 04	1 5E+00	3 2E 2	2 3E 8
										Total	3 2E 2	2 3E 8

Attachment A-13-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	14	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	3 0E 04	1 5E+00	9 0E 3	1 5E 6
												Total	9 0E 3	1 5E 6

Attachment A-13-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	14	1E 6	100	250	25	70	9 125	25 550	3 0E 04	1 5E+00	4 6E 2	7 3E 6
										Total	4 6E 2	7 3E 6

Attachment A-13-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	11	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	3 0E 04	1 5E+00	6 3E 4	2 0E 8
												Total	6 3E 4	2 0E 8

Attachment A-13-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	11	1E 6	50	250	5	70	1 825	25 550	3 0E 04	1 5E+00	1 8E 2	5 6E 7
										Total	1 8E 2	5 6E 7

Attachment A-13-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	14	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	3 0E 04	1 5E+00	6 5E 4	1 3E 7
												Total	6 5E 4	1 3E 7

Attachment A-13-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	14	1E 6	100	12	30	70	10 950	25 550	3 0E 04	1 5E+00	2 2E 3	4 2E 7
										Total	2 2E 3	4 2E 7

Attachment A-13-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	11	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	3 0E 04	1 5E+00	2 0E 5	1 2E 9
												Total	2 0E 5	1 2E 9

Attachment A-13-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	11	1E 6	50	6	9	70	3 285	25 550	3 0E 04	1 5E+00	4 2E 4	2 4E 8
										Total	4 2E 4	2 4E 8

Attachment A-13 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{child})/(BW_{child} AT RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA $_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
$ED_{ch\ ld}$ = Exposure Duration for a Child (years)
ED $_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW $_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD $_{ral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF_{oral} ((SA_{child} ED_{child}/BW_{child})+(SA $_{d\ lt}$ $ED_{ad\ lt}$/BW $_{d\ lt}$)))/(AT_c)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED $_{hild}$	ED $_{d\ lt}$	BW $_{hild}$	BW $_{d\ lt}$	AT	AT	RfD $_{l}$	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	14	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 04	1 5E+00	0 05136274	4 9E 6
															Total	5 1E 2	4 9E 6

Attachment A-13-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	14	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 04	1 5E+00	6 0E 1	3 3E 5
													Total	6 0E 1	3 3E 5

Attachment A-13 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{c}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT_{c})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	11	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 04	1 5E+00	4 0E 3	1 8E 7
															Total	4 0E 3	1 8E 7

Attachment A 13-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	11	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 04	1 5E+00	2 3E 1	9 3E 6
													Total	2 3E 1	9 3E 6

Attachment A-13-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 0038	0 042	2 8E 9	6 3E 8
	Ingestion	0 032	0 16	2 3E 8	2 3E 7
	Total	0 035	0 20	2 6E 8	3 0E 7
Future Industrial/Commercial Worker					
	Dermal	0 00063	0 0090	2 0E 8	1 5E 6
	Ingestion	0 018	0 046	5 6E 7	7 3E 6
	Total	0 018	0 055	5 8E 7	8 8E 6
Current Trespasser/Site Visitor					
	Dermal	0 000020	0 00065	1 2E 9	1 3E 7
	Ingestion	0 00042	0 0022	2 4E 8	4 2E 7
	Total	0 00044	0 0028	2 6E 8	5 5E 7
Hypothetical Future Resident					
	Dermal	0 0040	0 051	1 8E 7	4 9E 6
	Ingestion	0 23	0 60	9 3E-6	3 3E 5
	Total	0 23	0 65	9 5E 6	3 8E 5

Attachment A 14 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot 2 Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD (mg/kg-day)	SF_{oral} (mg/kg-day)	Background
Dioxin TEQ	mg/kg	4 90E-07	2 00E 04	17/17	9 00E 05	6 00E 05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0081	14	13/19	2 4	1 2	0 14	2 0E-05	2/1	
Arsenic	mg/kg	5 1	8 7	11/11	7 7	6 4	0 03	NE	NE	13 22
Beryllium	mg/kg	0 47	0 77	11/11	0 67	0 62	0	NE	NE	1 01
Lead	mg/kg	8 5	721	11/11	196	80	0	NE	NE	363

Hotspot 2 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD (mg/kg-day)	SF_{ra} (mg/kg-day)	Background
Dioxin TEQ	mg/kg	4 90E-07	3 00E 04	35/35	8 90E 05	6 00E 05	0 03	NTV	1 5E+05	
PCB-1248	mg/kg	0 0081	14	29/51	1 1	0 56	0 14	5 0E 05	2/1	
Arsenic	mg/kg	3 8	8 7	30/30	6 6	6 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 47	0 97	30/30	0 69	0 66	0	NE	NE	1 01
Lead	mg/kg	5 5	721	30/30	80	40	0	NE	NE	363

Present at background level

Lead has no RfD or SF and is evaluated separately

The RfD for PCB-1254 was used to evaluate PCB 1248

NE Not evaluated quantitatively

NTV No toxicity value

IRIS recommends using a slope factor of 2 0 for RME and 1 0 for CTE

Attachment A-14-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000089	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	NTV	1 5E+05	NA	4 0E 8
PCB 1248	1 1	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	9 3E 2	3 1E 8
												Total	9 3E 2	7 1E 8

Attachment A-14-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000089	1E 6	330	60	1	70	84	25 550	NTV	1 5E+05	NA	1 5E 7
PCB 1248	1 1	1E 6	330	60	1	70	84	25 550	5 0E 05	2 0E+00	7 4E 2	2 4E 8
										Total	7 4E 2	1 7E 7

Attachment A-14-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	NTV	1 5E+05	NA	1 8E 9
PCB 1248	0 56	1E 6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E 05	1 0E+00	6 4E 3	5 3E 10
												Total	6 4E 3	2 3E 9

Attachment A-14-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	100	30	1	70	42	25 550	NTV	1 5E+05	NA	1 5E 8
PCB 1248	0 56	1E 6	100	30	1	70	42	25 550	5 0E 05	1 0E+00	1 1E 2	9 4E 10
										Total	1 1E 2	1 6E 8

Attachment A-14-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000090	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	NTV	1 5E+05	NA	9 3E 7
PCB 1248	2 4	1E 6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 1E 1	1 5E 6
												Total	1 1E 1	2 5E 6

Attachment A-14-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000090	1E 6	100	250	25	70	9 125	25 550	NTV	1 5E+05	NA	4 7E 6
PCB 1248	2 4	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 2E 1	1 7E 6
										Total	1 2E 1	6 4E 6

Attachment A-14-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	NTV	1 5E+05	NA	1 1E 8
PCB 1248	1 2	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E 05	1 0E+00	4 9E 3	7 0E 9
												Total	4 9E 3	1 8E 8

Attachment A-14-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	50	250	5	70	1 825	25 550	NTV	1 5E+05	NA	3 1E 7
PCB 1248	1 2	1E 6	50	250	5	70	1 825	25 550	2 0E 05	1 0E+00	2 9E 2	4 2E 8
										Total	2 9E 2	3 6E 7

Attachment A-14-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where *HI = Hazard Index (unitless)*
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000090	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	NTV	1 5E+05	NA	8 1E 8
PCB 1248	2 4	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2 0E+00	7 8E 3	1 3E 7
												Total	7 8E 3	2 1E 7

Attachment A-14-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000090	1E 6	100	12	30	70	10 950	25 550	NTV	1 5E+05	NA	2 7E 7
PCB 1248	2 4	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2 0E+00	5 6E 3	9 7E 8
										Total	5 6E 3	3 7E 7

Attachment A-14-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	NTV	1 5E+05	NA	6 5E 10
PCB 1248	1 2	1E 6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1 6E 4	4 1E 10
												Total	1 6E 4	1 1E 9

Attachment A-14-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	50	6	9	70	3 285	25 550	NTV	1 5E+05	NA	1 4E 8
PCB 1248	1 2	1E 6	50	6	9	70	3 285	25 550	2 0E 05	1 0E+00	7 0E 4	1 8E 9
										Total	7 0E 4	1 5E 8

Attachment A-14 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
$ED_{ch\ ld}$ = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{ch\ ld}\ ED_{child}/BW_{child})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{hild}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{child}	$BW_{d\ lt}$	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000090	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	1 5E+05	NA	3 2E 6
PCB 1248	2 4	1E 6	0 3	0 14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	0 61635288	5 2E 6
															Total	6 2E 1	8 4E 6

Attachment A-14-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000090	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	1 5E+05	NA	2 1E 5
PCB 1248	2 4	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	1 5E+0	7 5E 6
													Total	1 5E+0	2 9E 5

Attachment A-14 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{child}\ ED_{child}/BW_{hild})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{hild}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ }$	$SF_{\ }$	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	1 5E+05	NA	9 8E 8
PCB 1248	1 2	1E 6	0 04	0 14	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E+00	3 1E 2	6 1E 8
															Total	3 1E 2	1 6E 7

Attachment A-14 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{c}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	1 5E+05	NA	5 2E 6
PCB 1248	1 2	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E+00	3 8E 1	6 9E 7
													Total	3 8E 1	5 9E 6

Attachment A-14-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 0064	0 093	2 3E 9	7 1E 8
	Ingestion	0 011	0 074	1 6E 8	1 7E 7
	Total	0 018	0 17	1 8E 8	2 4E 7
Future Industrial/Commercial Worker					
	Dermal	0 0049	0 11	1 8E 8	2 5E 6
	Ingestion	0 029	0 12	3 6E 7	6 4E 6
	Total	0 034	0 23	3 7E 7	8 9E 6
Current Trespasser/Site Visitor					
	Dermal	0 00016	0 0078	1 1E 9	2 1E 7
	Ingestion	0 00070	0 0056	1 5E 8	3 7E 7
	Total	0 00086	0 013	1 6E 8	5 8E 7
Hypothetical Future Resident					
	Dermal	0 031	0 62	1 6E 7	8 4E 6
	Ingestion	0 38	1 5	5 9E 6	2 9E 5
	Total	0 41	2 2	6 0E 6	3 7E 5

Attachment A-14-19

Excavation Worker Building 2 Hotspot
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgroup f Lead Adult Lead Committee

V rsi d t 05/19/03

Exposure Variable	PbB Equation[1] 1[a]	2[a,b]	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSD1 Hom	Using Equation 1 GSD1 Het	Using Equation 2 GSD1 H m	Using Equation 2 GSD1 H t
PbS	X	X	S il l d nce tr tu	g/g ppm	40 0	40 0	40 0	40 0
$R_{f\ al/maiem}$	X	X	F tal/m ternal PbB ra	--	0 9	0 9	0 9	0 9
BKSF	X	X	B ku Sl pe F to	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d tu PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel ne PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ingestu rate (l ding l deri ed ind dust)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal gestu rate f tdoo s l and d dust	g/d y			0 100	0 100
W_S		X	W ghting facto f actu f IR_{S+D} gested as td so l				1 0	1 0
K_S		X	Mass fractu f so l dust				0 7	0 7
$AF_{S\ D}$	X	X	Absorp fractu (sam f l and dust)		0 12	0 12	0 12	0 12
$EF_{S\ D}$	X	X	Expo re freq y (am f l and dus)	d ys/y	30	30	30	30
$AT_{S,D}$	X	X	A erag g tim (sam f l and d t)	d ys/y	365	365	365	365
PbB_{adul}	PbB f ad lt w rk geom tri mean			g/dL	1.5	1 5	1 5	1.5
$PbB_{fetal,\ 0.95}$	95th p rce til PbB am ng f tuses f dult w rkers			g/dL	5 0	5 0	5 0	5 0
PbB	Targ t PbB l el f concern (e.g 10 g/dL)			g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > PbB_{t})$	Pr b bility th t f tal PbB PbB assumi g logn rmal distrib ti			%	0 6%	0 6%	0 6%	0 6%

Eq tu l doe pp rtu p re b twee l and dus g tu (l d W K)
Wh IR IR and W 1 0 th eq ns y ld th am PbB_{fetal}

Equati 1 based Eq 1 2 i USEPA (1996)

$$PbB_{adul} = (PbS\ BKSF\ IR_{D}\ AF\ EF_S/AT\ ) + PbB$$

$$PbB_{tu,} = PbB_{adult}\ (GSD_1^{.645}\ R)$$

Eq ti 2 alternat ppro ch b sed Eq 1 2 d A 19 i USEPA (1996)

$$PbB_{adul} = PbS\ BKSF*([(IR\ ) AF\ EF\ W]+[K\ (IR_{S+}\ ) (1\ W) AF\ EF\ ])/365+PbB_0$$

$$PbB_{etal,\ 5} = PbB_{adult}\ (GSD_1^{.645}\ R)$$

S urce U.S EPA (1996) R commend ti ns f th T chnical R view W kgr p f Lead f an I terim Approach to Assessi g Risks Associ ted with Adult Exposures to Le d i S il

Attachment A-14 20

Excavation Worker Building 2 Hotspot
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re i w W kgro p f Lead Ad It Lead Committe

V rsi date 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSD Hom	Using Equation 1 GSD Het	Using Equation 2 GSD Hom	Using Equation 2 GSD Het
PbS	X	X	S il l d tr u	g/g ppm	40 0	40 0	40 0	40 0
$R_{tal/maternal}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki Sl pe F t	g/dL p g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri tandard d tu PbB	–	2 18	2 18	2 18	2 18
PbB_0	X	X	Bas l PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gestu rate (l d g l d d d dust)	g/d y	0 330	0 330		
$IR_{S D}$		X	T tal gestio rate of td l and doo dust	g/d y			0 330	0 330
W_S		X	W ghtu g fact fractu f IR_S gested as td l				1 0	1 0
K_{SD}		X	Mas f actu f so l d				0 7	0 7
$AF_{S,D}$	X	X	Absorptu fra tu (sam f so l and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo re freq y (am f l and dus)	d ys/y	60	60	60	60
$AT_{S,D}$	X	X	A rag g m (am f l and dust)	d ys/yr	365	365	365	365
PbB_{adul}			PbB f ad lt w rker geom tri mean	g/dL	1 6	1 6	1 6	1 6
$PbB_{f tal 0.95}$			95th p rcentil PbB among f tuses of adult work rs	g/dL	5.3	5.3	5.3	5.3
PbB			T g t PbB l el f co cern (e.g., 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{fetal} > PbB_t)$	Pr b bility th t f tal PbB PbB assuml g l gn rmal distrib ti			%	0 7%	0 7%	0 7%	0 7%

Eq tu l doe t ppo po re betwee so l and d t g stu (l des W K)
Wh IR IR_{S+} and W 1 0 th eq u ns y ld th am $PbB_{f\ 95}$

Equati 1 based Eq 1 2 i USEPA (1996)

$$PbB_{adul} = (PbS\ BKSF*IR_{S+D}\ AF\ EF_S/AT\ ) + PbB$$

$$PbB_{tal,} = PbB_{adu}\ (GSD_i^{.645}\ R)$$

Eq ti 2 alt te pp ach b s d Eq 1 2 d A 19 i USEPA (1996)

$$PbB_{ul} = PbS\ BKSF*([(IR_D)\ AF\ EF\ W\ ]+[K_D\ (IR_{S+D})\ (1\ W\ )\ AF\ EF\ ])/365+PbB$$

$$PbB_{fetal,\ 5} = PbB_{adult}\ (GSD_i^{.645}\ R)$$

S U.S EPA (1996) R comm d ti ns f th Techni al R i w W kg p f Le d
f an In in App ch t Assessi g Ri ks Associ ted with Adult Expos res to Le d i S il

Attachment A-14 21

Site Worker Building 2 Hotspot
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Review W rkgro p for Lead Adult Lead Committee

V rsion date 05/19/03

Exposure Variable	PbB Equation[1] 1**	PbB Equation[1] 2**	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi Hom	Using Equation 1 GSDi Het	Using Equation 2 GSDi Hom	Using Equation 2 GSDi H t
PbS	X	X	So l lead trati	g/g ppm	80 0	80 0	80 0	80 0
$R_{f\ tal/maternal}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe F t	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Ge m tri tandard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baselin PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l d g l d ed doo d t)	g/d y	0 050	0 050		
IR_{S+D}		X	T tal ges rate f d l and d d	g/d y			0 050	0 050
W_S		X	W gh g facto f acti f IR_{S+} gested as td so l			--	1 0	1 0
K_{SD}		X	Mass fracti f so l dus				0 7	0 7
$AF_{S,D}$	X	X	Absorpti fracti (m f l and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo ure freque cy (am f l and dus)	d ys/y	219	219	219	219
$AT_{S,D}$	X	X	A rag g m (am f il and d)	d ys/y	365	365	365	365
PbB_{adul}			***PbB f adult w rk geom tri mean***	g/dL	**1 6**	**1 6**	**1 6**	**1 6**
$PbB_{tal,0.95}$			**95th pe ce til PbB am ng f tuses f dult w rk rs**	g/dL	**5 3**	**5.3**	**5.3**	**5.3**
PbB			**T g t PbB le el f concern (e.g 10 g/dL)**	g/dL	**10 0**	**10 0**	**10 0**	**10 0**
$P(PbB_{f\ tal} > PbB_t)$			**Pr b bility th t f tal PbB PbB assuming l gn rmal distrib ti**	%	**0 7%**	**0 7%**	**0 7%**	**0 7%**

Eq ti l does t apporti exposure betwee soil and dust gesti (l des W K)
Wh IR IR_{S+} and W l 0 th eq ti ns yi ld th am PbB_f

Equati 1 based Eq 1 2 i USEPA (1996)

PbB_{ul} =	(PbS BKSF IR AF EF /AT) + PbB
$PbB_{tal,\ 5}$ =	PbB_{adult} $(GSD_i^{64}$ R)

Eq ti 2 alt rn te ppro h based Eq 1 2 and A 19 i USEPA (1996)

PbB_{adul} =	PbS BKSF*([(IR $_D$) AF EF_S W]+[K_D (IR_{S+}) (1 W) AF_D EF])/365+PbB
$PbB_{fetal,\ 5}$ =	PbB_{adult} $(GSD_i^{645}$ R)

S rce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f Le d
f I terim App ach to Assessi g Risks Associ ted with Ad lt Exposures to L d i S il

Pri ted 03/15/2004 4 02 PM

Attachment A 14 22

Site Worker Building 2 Hotspot
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R l w W kg p f L ad Ad lt Le d C mmittee

V rsi d t 05/19/03

Exposure Variable	PbB Equation 1a	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSD1 Hom	Using Equation 1 GSD1 Het	Using Equation 2 GSD1 Hom	Using Equation 2 GSD1 Het
PbS	X	X	S il l ad ce tra	g/g ppm	80 0	80 0	80 0	80 0
$R_{tal/maternal}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe F t	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_1	X	X	Geom tri tandard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas l e PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l di g l de d d dust)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal ges rate f tdoo l and doo d t	g/d y			0 100	0 100
W_S		X	W gh g facto fracti f IR gested as td so l				1 0	1 0
K_{SD}		X	Mass fracti f so l dust				0 7	0 7
$AF_{S D}$	X	X	Ab rpti f act (sam f l and d)		0 12	0 12	0 12	0 12
$EF_{S, D}$	X	X	E po re freq y (am f l and dust)	days/y	250	250	250	250
$AT_{S, D}$	X	X	A raging tim (am f l and d t)	d ys/y	365	365	365	365
PbB_{adult}			PbB f ad lt w rk geom tri mea	g/dL	1 8	1 8	1 8	1 8
$PbB_{tal\ 0.95}$			95th perce tile PbB am ng f tuses f dult w kers	g/dL	5 8	5 8	5 8	5 8
PbB			T rg t PbB l l f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > PbB_t)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti	%	1 0%	1 0%	1 0%	1 0%

Eq ti l does t pporti pos re betwee l and d gesti (l des W K)
Wh IR_S IR d W 1 0 th eq ti ns y ld th am PbB_{fetal}

Equati 1 b d Eq 1 21 USEPA (1996)

PbB_{dul} =	(PbS BKSF IR AF EF /AT) + PbB
$PbB_{tal,\ 95}$ =	$PbB_{ad\ l}$ $(GSD_1^{64}$ R)

Equati n 2 lternate pproach based Eq 1 2 and A 19 1 USEPA (1996)

PbB_{adul} =	PbS BKSF*([(IR_S) AF EF_S W]+[K (IR) (1 W) AF EF_D])/365+PbB
$PbB_{fetal,\ 0\ 95}$ =	PbB_{adult} $(GSD_1^{645}$ R)

S ce U.S EPA (1996) Rec mm d ti ns f th Technical R l w W kgr p f Le d
f m App ch to Assessi g Risks Associ ted with Ad lt Exposu es to Le d i S il

Attachment A 14-23

Trespasser Building 2 Hotspot
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgroup fo Lead Ad lt Lead C mmittee

V rsion date 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSD1 Hom	Using Equation 1 GSD1 H 1	Using Equation 2 GSD1 Hom	Using Equation 2 GSD1 Het 3
PbS	X	X	S il lead ce trati	g/g ppm	80 0	80 0	80 0	80 0
$R_{etal/maternal}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B kin ti Sl pe Fact	g/dL per g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l di g l-d ed ind dus)	g/day	0 050	0 050		
IR_{S+D}		X	T tal gest rate f td il and d dust	g/d y	--		0 050	0 050
W_S		X	W ghtng facto fracti f IR_{S+} i gested as tdoo l	--			1 0	1 0
K_{SD}		X	Mass f acti f l dust	--			0 7	0 7
$AF_{S,D}$	X	X	Absorpti fracti (sam f so l and dus)	--	0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo re freq y (am f il and dus)	d ys/yr	6	6	6	6
$AT_{S,D}$	X	X	A erag g tim (am f il and dust)	d ys/yr	365	365	365	365
$PbB_{adul f}$			PbB f ad lt w rk geometri mean	g/dL	1.5	1.5	1 5	1.5
$PbB_{fetal, .95}$			95th p ce til PbB am ng f tuses f adult w rkers	g/dL	5 0	5 0	5 0	5 0
PbB			T g t PbB l l f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{tal} > \bar{P}bB_t)$			Pr b bility that f tal PbB PbB assumi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Eq ti l doe t app rti p re betwee l and dust ing (l des W K)
When IR IR_{S+} and W 1 0 th eq t ns y ld th am PbB_f

Equati n 1 based Eq 1 2 i USEPA (1996)

PbB_{dul} =	(PbS BKSF IR_{S+} AF EF /AT $_D$) + PbB
$PbB_{tal, s}$ =	PbB_{adlt} $(GSD_i^{.645}$ R)

Equati 2 lt rn t ppro ch based Eq 1 2 d A 19 i USEPA (1996)

PbB_{dul} =	PbS BKSF (([IR_{S+}) AF EF W_S]+[K (IR_D) (1 W) AF EF_D])/365 PbB
$PbB_{tal, s}$ =	PbB_{adult} $(GSD_i^{.64}$ R)

S ce U S EPA (1996) R comm d ti ns f th Technical R i w W kg p f Le d
f I terim App ch to Assessi g Risks Associ ted with Ad lt Expos res to L d i S l

P ted 03/15/2004 4:02 PM

Attachment A 14 24

Trespasser Building 2 Hotspot
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgro p f Le d Ad lt Lead C mmittee

V sio date 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSD1 Hom	Using Equation 1 GSD1 Het	Using Equation 2 GSD1 Hom	Using Equation 2 GSD1 Het
PbS	X	X	S il l ad ce trat	g/g ppm	80 0	80 0	80 0	80 0
$R_{etal/maternal}$	X	X	F tal/m ternal PbB rat i		0 9	0 9	0 9	0 9
BKSF	X	X	B ku u Sl pe F c	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	Geom tric tand d d u PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ges rate (l d g il d d d dus)	g/d y	0 100	0 100		
IR_{S+D}		X	Total ingestu rate f tdoo s l and d dust	g/d y			0 100	0 100
W_S		X	W gh g fact fractu f IR D gested as td l				1 0	1 0
K_S		X	Mass frac f l dus				0 7	0 7
$AF_{S,D}$	X	X	Absorptu fra tu (m f l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	E p re freq y (m f l and dust)	d ys/y	12	12	12	12
$AT_{S,D}$	X	X	A rag g tim (am f s l and dust)	d ys/y	365	365	365	365
PbB_{adult}			PbB f ad lt w rk geom tri mean	g/dL	1.5	1 5	1.5	1 5
$PbB_{f tal 0.95}$			95th percentile PbB am ng f tuses f dult work rs	ug/dL	5 0	5 0	5 0	5 0
PbB			T g t PbB le l f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_t)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Eq ti l d es ot pp rtu p re betwee l and dust g ti (l des W K)
Wh IR IR$_{S+}$ and W 1 0 th eq u y ld th am PbB_{fetal}

Equ ti 1 based Eq 1 2 in USEPA (1996)

PbB $_{dul}$ =	(PbS BKSF IR $AF_{S D}$ EF /AT $_D$) + PbB
PbB $_{eta, 95}$ =	$PbB_{adu t}$ (GSD_i^{64} R)

Eq ti 2 lt rn t ppr h bas d Eq 1 2 and A 19 i USEPA (1996)

PbB $_{ul}$ =	PbS BKSF ([(IR$_{S+}$) AF EF$_S$ W]+[K (IR$_{S+D}$) (1 W) AF EF])/365+PbB
PbB $_{tal, 5}$ =	PbB_{adu} (GSD_i^{645} R)

S urce U.S EPA (1996) R comm d ti ns f th T chnical R vi w W kg p f Le d
f m App ach t Assessi g Ri ks Associ ted with Ad lt E posu es to Le d i S il

Attachment A-14-25

Hotspot 2
Residential Exposure to Lead
Calculated Blood Lead and Lead Uptakes from IEUBK Model Software
St Louis Army Ammunition Plant
St Louis Missouri

Year	Air (ug/dL)	Diet (ug/dL)	Alternate (ug/dL)	Water (ug/dL)	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
5 1	0 021	2 62	0	0 379	1 747	4 767	**2 6**
1 2	0 034	2 732	0	0 945	2 768	6 479	**2 7**
2 3	0 062	3 084	0	0 988	2 783	6 917	**2 6**
3 4	0 067	2 988	0	1 015	2 804	6 875	**2 4**
4 5	0 067	2 907	0	1 064	2 098	6 136	**2 1**
5 6	0 093	3 078	0	1 126	1 895	6 193	**1 9**
6 7	0 093	3 403	0	1 147	1 792	6 436	**1 8**

Attachment A 15 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot 4A Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD ral (mg/kg day)	SF ral (mg/kg day) [1]	Background
Arsenic	mg/kg	5 7	5 7	1/1	5 7	5 7	0 03	NE	NE	13 22
Beryllium	mg/kg	0 7	0 7	1/1	0 7	0 7	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 91	0 91	1/1	0 91	0 91	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 78	0 78	1/1	0 78	0 78	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 92	0 92	1/1	0 92	0 92	0 13	NTV	7 3E-01	0 63
Dibenz(a h)anthracene	mg/kg	0 11	0 11	1/1	0 11	0 11	0 13	NTV	7 3E+00	0 3

Hotspot 4A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD ral (mg/kg day)	SF ral (mg/kg-day) [1]	Background
Arsenic	mg/kg	4 4	5 7	3/3	5 7	4 87	0 03	NE	NE	13 22
Beryllium	mg/kg	0 7	0 95	3/3	0 95	0 83	0	NE	NE	1 01
Chromium	mg/kg	24	34	3/3	34	29	0	2 0E 02	NTV	25 46
Benzo(a)anthracene	mg/kg	0 0030	0 91	3/3	0 91	0 37	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 16	0 78	2/3	0 78	0 32	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 004	0 92	3/3	0 92	0 37	0 13	NTV	7 3E-01	0 63
Dibenz(a h)anthracene	mg/kg	0 028	0 11	2/3	0 11	0 06	0 13	NTV	7 3E+00	0 3

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A 15 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	34	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 91	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	8 6E 9
Benzo(a)pyrene	0 78	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	7 4E 8
Benzo(b)fluoranthene	0 92	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	8 7E 9
Dibenz(a h)anthracene	0 11	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 0E 8
												Total	0 0E+0	1 0E 7

Attachment A-15-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	34	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 7E 3	NA
Benzo(a)anthracene	0 91	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	7 4E 9
Benzo(a)pyrene	0 78	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	6 3E 8
Benzo(b)fluoranthene	0 92	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	7 4E 9
Dibenz(a h)anthracene	0 11	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	8 9E 9
										Total	5 7E 3	8 7E 8

Attachment A-15-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_c\ RfD_{o\ al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT	$RfD_{o\ al}$	$SF_{o\ l}$	Hazard Index	Cancer Risk
Chromium	29	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 37	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 4E 10
Benzo(a)pyrene	0 32	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 1E 9
Benzo(b)fluoranthene	0 37	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 3E 10
Dibenz(a h)anthracene	0 056	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 6E 10
												Total	0 0E+0	2 9E 9

Attachment A-15-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	29	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 5E 3	NA
Benzo(a)anthracene	0 37	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 6E 10
Benzo(a)pyrene	0 32	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	4 0E 9
Benzo(b)fluoranthene	0 37	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 5E 10
Dibenz(a h)anthracene	0 056	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	6 9E 10
										Total	1 5E 3	5 6E 9

Attachment A-15-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 0E 7
Benzo(a)pyrene	0 78	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 7E 6
Benzo(b)fluoranthene	0 92	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 0E 7
Dibenz(a h)anthracene	0 11	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 4E 7
												Total	0 0E+0	2 3E 6

Attachment A-15-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 3E 7
Benzo(a)pyrene	0 78	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 0E 6
Benzo(b)fluoranthene	0 92	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 3E 7
Dibenz(a h)anthracene	0 11	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 8E 7
										Total	0 0E+0	2 7E 6

Attachment A-15-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{o\ al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 6E 9
Benzo(a)pyrene	0 78	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 1E 8
Benzo(b)fluoranthene	0 92	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 7E 9
Dibenz(a h)anthracene	0 11	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 4E 9
												Total	0 0E+0	4 3E 8

Attachment A-15-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ l}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 3E 8
Benzo(a)pyrene	0 78	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 0E 7
Benzo(b)fluoranthene	0 92	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 3E 8
Dibenz(a h)anthracene	0 11	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 8E 8
										Total	0 0E+0	2 7E 7

Attachment A-15-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 7E 8
Benzo(a)pyrene	0 78	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 5E 7
Benzo(b)fluoranthene	0 92	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 7E 8
Dibenz(a h)anthracene	0 11	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 1E 8
												Total	0 0E+0	2 0E 7

Attachment A-15-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 3E 8
Benzo(a)pyrene	0 78	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 1E 7
Benzo(b)fluoranthene	0 92	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 4E 8
Dibenz(a h)anthracene	0 11	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 6E 8
										Total	0 0E+0	1 6E 7

Attachment A-15-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 1E 10
Benzo(a)pyrene	0 78	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 8E 9
Benzo(b)fluoranthene	0 92	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 1E 10
Dibenz(a h)anthracene	0 11	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 5E 10
												Total	0 0E+0	2 5E 9

Attachment A-15-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10 ^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED $SF_{o\ al}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 0E 9
Benzo(a)pyrene	0 78	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	8 6E 9
Benzo(b)fluoranthene	0 92	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 0E 9
Dibenz(a h)anthracene	0 11	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 2E 9
										Total	0 0E+0	1 2E 8

Attachment A-15 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT\ \ RfD_{or\ l})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{dult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ l}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{\ l}((SA_{ch\ ld}\ ED_{h\ ld}/BW_{h\ ld})+(SA_{d\ l}\ ED_{d\ lt}/BW_{d\ l})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	6 7E 7
Benzo(a)pyrene	0 78	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	5 8E 6
Benzo(b)fluoranthene	0 92	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	6 8E 7
Dibenz(a h)anthracene	0 11	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 1E 7
															Total	0 0E+0	7 9E-6

Attachment A-15 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child}) + (IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_{c})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_{c} = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_{c}	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 0E 6
Benzo(a)pyrene	0 78	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 9E 6
Benzo(b)fluoranthene	0 92	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 6
Dibenz(a h)anthracene	0 11	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 3E 6
													Total	0 0E+0	1 2E 5

Attachment A 15 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{ch\ ld}\ EF\ ED_{h\ ld})/(BW_{hild}\ AT\ \ RfD_{or\ l})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{al}\ ((SA_{ch\ ld}\ ED_{hild}/BW_{hild})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{l} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	RfD_{l}	SF_{l}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 1E 8
Benzo(a)pyrene	0 78	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 7E 7
Benzo(b)fluoranthene	0 92	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 2E 8
Dibenz(a h)anthracene	0 11	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 8E 8
															Total	0 0E+0	3 7E 7

Attachment A 15-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_{ca})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_{ca} = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{nc}	AT_{ca}	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 91	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 8E 7
Benzo(a)pyrene	0 78	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 3E 6
Benzo(b)fluoranthene	0 92	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 9E 7
Dibenz(a h)anthracene	0 11	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	4 6E 7
													Total	0 0E+0	4 5E 6

Attachment A-15-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	2 9E 9	1 0E 7
	Ingestion	0 0015	0 006	5 6E 9	8 7E 8
	Total	0 0015	0 006	8 5E 9	1 9E 7
Future Industrial/Commercial Worker					
	Dermal	0	0	4 3E 8	2 3E 6
	Ingestion	0	0	2 7E 7	2 7E 6
	Total	0	0	3 2E 7	5 1E 6
Current Trespasser/Site Visitor					
	Dermal	0	0	2 5E 9	2 0E 7
	Ingestion	0	0	1 2E 8	1 6E 7
	Total	0	0	1 4E 8	3 6E 7
Hypothetical Future Resident					
	Dermal	0	0	3 7E 7	7 9E 6
	Ingestion	0	0	4 5E 6	1 2E 5
	Total	0	0	4 9E 6	2 0E 5

Attachment A 16-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 4B Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD ral (mg/kg day)	SF ral (mg/kg day) [1]	Background
Arsenic	mg/kg	4 6	4 6	1/1	4 6	4 6	0 03	NE	NE	13 22
Beryllium	mg/kg	0 44	0 44	1/1	0 44	0 44	0	NE	NE	1 01
Chromium	mg/kg	31	31	1/1	31	31	0	3 0E 03	NTV	25 46
Benzo(a)anthracene	mg/kg	1 3	3 6	2/2	3 6	2 5	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 91	4 1	2/2	4 1	2 5	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	1 1	4 8	2/2	4 8	3 0	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0.12	0 12	1/1	0 12	0 12	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 87	3 2	2/2	3 2	2 0	0 13	NTV	7 3E-01	0 41

Hotspot 4B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD al (mg/kg day)	SF ral (mg/kg-day) [1]	Background
Arsenic	mg/kg	3 2	5 7	3/3	5 7	4 5	0 03	NE	NE	13 22
Beryllium	mg/kg	0.44	0 84	3/3	0 84	0 68	0	NE	NE	1 01
Chromium	mg/kg	20	32	3/3	32	28	0	2 0E 02	NTV	25 46
Benzo(a)anthracene	mg/kg	0 002	3 6	3/4	3 6	1 3	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 002	4 1	3/4	4 1	1 3	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	1 1	4 8	2/4	4 8	1 6	0 13	NTV	7 3E-01	0 63
Dibenz(a h)anthracene	mg/kg	0.12	0.12	1/3	0 12	0 061	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 002	3 2	3/4	3 2	1 1	0 13	NTV	7 3E 01	0 41

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A 16 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{al})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{ral}	Hazard Index	Cancer Risk
Chromium	32	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	3 6	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	3 4E 8
Benzo(a)pyrene	4 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 9E 7
Benzo(b)fluoranthene	4 8	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	4 5E 8
Dibenz(a h)anthracene	0 12	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 1E 8
Indeno(1 2 3 cd)pyrene	3 2	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	3 0E 8
												Total	0 0E+0	5 1E 7

Attachment A-16-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	32	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 4E 3	NA
Benzo(a)anthracene	3 6	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 9E 8
Benzo(a)pyrene	4 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	3 3E 7
Benzo(b)fluoranthene	4 8	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	3 9E 8
Dibenz(a h)anthracene	0 12	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	9 7E 9
Indeno(1 2 3 cd)pyrene	3 2	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 6E 8
										Total	5 4E 3	4 3E 7

Attachment A-16 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Chromium	28	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 3	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 1E 10
Benzo(a)pyrene	1 3	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	8 0E 9
Benzo(b)fluoranthene	1 6	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	9 9E 10
Dibenz(a h)anthracene	0 061	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 9E 10
Indeno(1 2 3 cd)pyrene	1 1	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	6 7E 10
												Total	0 0E+0	1 1E 8

Attachment A-16-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT = Ave aging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	28	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 4E 3	NA
Benzo(a)anthracene	1 3	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 6E 9
Benzo(a)pyrene	1 3	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 5E 8
Benzo(b)fluoranthene	1 6	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 9E 9
Dibenz(a h)anthracene	0 061	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	7 4E 10
Indeno(1 2 3 cd)pyrene	1 1	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 3E 9
										Total	1 4E 3	2 1E 8

Attachment A-16 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	3 6	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 9E 7
Benzo(a)pyrene	4 1	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	9 0E 6
Benzo(b)fluoranthene	4 8	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 1E 6
Dibenz(a h)anthracene	0 12	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 6E 7
Indeno(1 2 3 cd)pyrene	3 2	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 0E 7
												Total	0 0E+0	1 2E 5

Attachment A-16-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 0E 2	NA
Benzo(a)anthracene	3 6	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	9 2E 7
Benzo(a)pyrene	4 1	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 0E 5
Benzo(b)fluoranthene	4 8	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 2E 6
Dibenz(a h)anthracene	0 12	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 1E 7
Indeno(1 2 3 cd)pyrene	3 2	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	8 2E 7
										Total	1 0E 2	1 4E 5

Attachment A 16 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD ral	SF ral	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	2 5	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	9 8E 9
Benzo(a)pyrene	2 5	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 0E 7
Benzo(b)fluoranthene	3 0	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 2E 8
Dibenz(a h)anthracene	0 12	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 9
Indeno(1 2 3 cd)pyrene	2 0	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	8 1E 9
												Total	0 0E+0	1 3E 7

Attachment A-16-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{\ l})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
$SF_{\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	$AT_{\ c}$	AT_c	$RfD_{o\ l}$	$SF_{o\ l}$	Hazard Index	Cancer Risk
Chromium	31	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 1E 3	NA
Benzo(a)anthracene	2 5	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 3E 8
Benzo(a)pyrene	2 5	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	6 4E 7
Benzo(b)fluoranthene	3 0	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	7 5E 8
Dibenz(a h)anthracene	0 12	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 1E 8
Indeno(1 2 3 cd)pyrene	2 0	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	5 2E 8
										Total	5 1E 3	8 6E 7

Attachment A-16 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} $RfD_{o\ al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED $SF_{o\ al}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	3 6	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	6 8E 8
Benzo(a)pyrene	4 1	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	7 8E 7
Benzo(b)fluoranthene	4 8	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	9 1E 8
Dibenz(a h)anthracene	0 12	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 3E 8
Indeno(1 2 3 cd)pyrene	3 2	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	6 1E 8
												Total	0 0E+0	1 0E 6

Attachment A-16-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT_c	$RfD_{o\ l}$	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4 9E 4	NA
Benzo(a)anthracene	3 6	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	5 3E 8
Benzo(a)pyrene	4 1	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	6 0E 7
Benzo(b)fluoranthene	4 8	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	7 1E 8
Dibenz(a h)anthracene	0 12	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 8E 8
Indeno(1 2 3-cd)pyrene	3 2	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 7E 8
										Total	4 9E 4	7 9E 7

Attachment A-16 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	2 5	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 6E 10
Benzo(a)pyrene	2 5	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5 7E 9
Benzo(b)fluoranthene	3 0	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	6 8E 10
Dibenz(a h)anthracene	0 12	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 8E 10
Indeno(1 2 3 cd)pyrene	2 0	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	4 7E 10
												Total	0 0E+0	7 7E 9

Attachment A-16-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $_c$ RfD$_{o\ al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT$_{nc}$ = Averaging Time for Non Carcinogens (days)
R$_f$D$_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF$_{o\ al}$)/(BW AT$_c$)

Where CR = Cancer Risk (unitless)
AT$_c$ = Averaging Time for Carcinogens (25 550 days)
SF$_{oral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT$_{nc}$	AT$_c$	RfD$_{oral}$	SF$_{oral}$	Hazard Index	Cancer Risk
Chromium	31	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 2E 4	NA
Benzo(a)anthracene	2 5	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 7E 9
Benzo(a)pyrene	2 5	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 8E 8
Benzo(b)fluoranthene	3 0	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 3E 9
Dibenz(a h)anthracene	0 12	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 3E 9
Indeno(1 2 3 cd)pyrene	2 0	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 2E 9
										Total	1 2E 4	3 7E 8

Attachment A 16 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{child})/(BW_{child} AT_{nc} RfD_{i})
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF_{oral} ((SA_{child} ED_{child}/BW_{child})+(SA_{adult} ED_{adult}/BW))))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{o} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{o}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
Benzo(a)anthracene	3 6	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 7E 6
Benzo(a)pyrene	4 1	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 0E 5
Benzo(b)fluoranthene	4 8	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 6E 6
Dibenz(a h)anthracene	0 12	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 9E 7
Indeno(1 2 3 cd)pyrene	3 2	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 4E 6
															Total	0 0E+0	4 0E 5

Attachment A 16 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{al})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adul} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{dult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{al}\ ((IR_{child}\ ED_{hild}/BW_{child})+(IR_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	$IR_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{child}	$BW_{d\ lt}$	AT	AT	$RfD_{\ l}$	SF_{ral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 3E 1	NA
Benzo(a)anthracene	3 6	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	4 1E 6
Benzo(a)pyrene	4 1	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	4 7E 5
Benzo(b)fluoranthene	4 8	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	5 5E 6
Dibenz(a h)anthracene	0 12	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 6
Indeno(1 2 3 cd)pyrene	3 2	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 7E 6
													Total	1 3E 1	6 1E 5

Attachment A 16 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{d}\ AT\ RfD\ )$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{d} = Exposure Duration for an Adult (years)
BW_{h} = Body Weight for a Child (kg)
BW_{d} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{d}/BW_{d}))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{l} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{d\ lt}$	EF	ED_{child}	$ED_{d\ lt}$	BW_{child}	$BW_{d\ lt}$	AT_{nc}	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	2 5	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 4E 8
Benzo(a)pyrene	2 5	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	8 6E 7
Benzo(b)fluoranthene	3 0	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 0E 7
Dibenz(a h)anthracene	0 12	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	4 1E 8
Indeno(1 2 3 cd)pyrene	2 0	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	7 0E 8
															Total	0 0E+0	1 2E 6

Attachment A 16 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult lifetime exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	6 6E 2	NA
Benzo(a)anthracene	2 5	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 0E 6
Benzo(a)pyrene	2 5	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 1E 5
Benzo(b)fluoranthene	3 0	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 2E 6
Dibenz(a h)anthracene	0 12	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	5 1E 7
Indeno(1 2 3 cd)pyrene	2 0	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 6E 7
													Total	6 6E 2	1 4E 5

Attachment A-16-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	1 1E 8	5 1E 7
	Ingestion	0 0014	0 0054	2 1E 8	4 3E 7
	Total	0 0014	0 0054	3 2E 8	9 4E 7
Future Industrial/Commercial Worker					
	Dermal	0	0	1 3E 7	1 2E 5
	Ingestion	0 0051	0 010	8 6E 7	1 4E 5
	Total	0 0051	0 010	9 9E 7	2 6E 5
Current Trespasser/Site Visitor					
	Dermal	0	0	7 7E 9	1 0E 6
	Ingestion	0 00012	0 00049	3 7E 8	7 9E 7
	Total	0 00012	0 00049	4 5E 8	1 8E 6
Hypothetical Future Resident					
	Dermal	0	0	1 2E 6	4 0E 5
	Ingestion	0 066	0 13	1 4E 5	6 1E 5
	Total	0 066	0 13	1 5E 5	1 0E 4

Attachment A 17 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 4C Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day)	Background
Arsenic	mg/kg	1.1	1.1	1/1	1.1	1.1	0.03	NE	NE	13.22
Beryllium	mg/kg	0.088	0.088	1/1	0.088	0.088	0	NE	NE	1.01

Hotspot 4C Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day)[1]	Background
Arsenic	mg/kg	1.1	1.2	2/2	1.2	1.2	0.03	NE	NE	13.22
Beryllium*	mg/kg	0.088	0.1	2/2	0.1	0.094	0	NE	NE	1.01
Benzo(a)anthracene*	mg/kg	0.008	0.65	2/2	0.65	0.33	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene*	mg/kg	0.009	0.48	2/2	0.48	0.24	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.014	0.7	2/2	0.7	0.36	0.13	NTV	7.3E-01	0.63
Dibenz(a,h)anthracene*	mg/kg	0.17	0.17	1/2	0.17	0.10	0.13	NTV	7.3E+00	0.3

* Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-17 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 65	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	6 1E 9
Benzo(a)pyrene	0 48	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	4 5E 8
Benzo(b)fluoranthene	0 70	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	6 6E 9
Dibenz(a h)anthracene	0 17	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 6E 8
												Total	0 0E+0	7 4E 8

Attachment A-17-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 65	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	5 3E 9
Benzo(a)pyrene	0 48	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	3 9E 8
Benzo(b)fluoranthene	0 70	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	5 7E 9
Dibenz(a h)anthracene	0 17	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 4E 8
										Total	0 0E+0	6 3E 8

Attachment A-17-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 33	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 1E 10
Benzo(a)pyrene	0 24	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 6E 9
Benzo(b)fluoranthene	0 36	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 3E 10
Dibenz(a h)anthracene	0 10	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	6 4E 10
												Total	0 0E+0	2 6E 9

Attachment A-17-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 33	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 0E 10
Benzo(a)pyrene	0 24	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 0E 9
Benzo(b)fluoranthene	0 36	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 4E 10
Dibenz(a h)anthracene	0 10	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 2E 9
										Total	0 0E+0	5 1E 9

Attachment A-17-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	2 6E 9	7 4E 8
Ingestion	0	0	5 1E 9	6 3E 8
Total	0	0	7 7E 9	1 4E 7

Attachment A 18 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 4D Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	4.1	5.3	3/3	5.3	4.7	0.03	NE	NE	13 22
Beryllium	mg/kg	0 92	1 4	3/3	1 4	1 1	0	2 0E-03	NTV	1 01
Chromium	mg/kg	25	31	3/3	31	28	0	3 0E 03	NTV	25 46

Hotspot 4D Combined Surface and Subsurface Soil (0 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day) [1]	Background
Arsenic	mg/kg	4.1	6.7	6/6	5.8	5.1	0.03	NE	NE	13.22
Beryllium	mg/kg	0 92	1 9	6/6	1 6	1 3	0	5 0E-03	NTV	1 01
Chromium	mg/kg	25	48	6/6	39	32	0	2 0E 02	NTV	25 46

[1] Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-18-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 6	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	39	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{o\ al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 6	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	1 1E 3	NA
Chromium	39	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	6 6E 3	NA
										Total	7 6E 3	0 0E+0

Attachment A-18-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	32	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	2 7E 4	NA
Chromium	32	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 6E 3	NA
										Total	1 9E 3	0 0E+0

Attachment A-18-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	31	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT\ )$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	6 8E 4	NA
Chromium	31	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 0E 2	NA
										Total	1 1E 2	0 0E+0

Attachment A-18-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	28	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	50	250	5	70	1 825	25 550	2 0E 03	NTV	2 7E 4	NA
Chromium	28	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	4 6E 3	NA
										Total	4 8E 3	0 0E+0

Attachment A-18-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	31	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	3 3E 5	NA
Chromium	31	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4 9E 4	NA
										Total	5 2E 4	0 0E+0

Attachment A-18-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	28	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	6 5E 6	NA
Chromium	28	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 1E 4	NA
										Total	1 2E 4	0 0E+0

Attachment A-18 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	0	NA
Chromium	31	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
															Total	0 0E+0	0 0E+0

Attachment A 18-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	8 9E 3	NA
Chromium	31	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 3E 1	NA
													Total	1 4E 1	0 0E+0

Attachment A-18 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hld} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{child}\ ED_{chld}/BW_{chld})+(SA_{ad\ lt}\ ED_{ad\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{dult}	EF	ED_{hild}	$ED_{d\ lt}$	BW_{child}	$BW_{d\ lt}$	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	28	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
															Total	0 0E+0	0 0E+0

Attachment A 18 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	3 5E 3	NA
Chromium	28	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	6 0E 2	NA
													Total	6 3E 2	0 0E+0

Attachment A-18-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 0019	0 0076	0 0E+0	0 0E+0
	Total	0 0019	0 0076	0 0E+0	0 0E+0
Future Industrial/Commercial Worker					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 0048	0 011	0 0E+0	0 0E+0
	Total	0 0048	0 011	0 0E+0	0 0E+0
Current Trespasser/Site Visitor					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 00012	0 00052	0 0E+0	0 0E+0
	Total	0 00012	0 00052	0 0E+0	0 0E+0
Hypothetical Future Resident					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 063	0 14	0 0E+0	0 0E+0
	Total	0 063	0 14	0 0E+0	0 0E+0

Attachment A 19 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot 5A Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
4 4' DDE	mg/kg	65	65	1/1	65	65	0 03	5 0E 04	3 4E 01	
4 4 DDT	mg/kg	1100	1100	1/1	1100	1100	0 03	5 0E 04	3 4E 01	
Arsenic	mg/kg	8 5	8 5	1/1	8 5	8 5	0 03	NE	NE	13 22
Beryllium *	mg/kg	0 82	0 82	1/1	0 82	0 82	0	NE	NE	1 01
Chromium	mg/kg	151	151	1/1	151	151	0	3 0E 03	NTV	25 46
Lead	mg/kg	1790	1790	1/1	1790	1790	0	NE	NE	363
Benzo(a)anthracene	mg/kg	25	25	1/1	25	25	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	19	19	1/1	19	19	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	16	16	1/1	16	16	0 13	NTV	7 3E 01	0 63
Benzo(k)fluoranthene	mg/kg	19	19	1/1	19	19	0 13	NTV	7 3E 02	0 46
Dibenz(a h)anthracene	mg/kg	7 1	7 1	1/1	7 1	7 1	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	11	11	1/1	11	11	0 13	NTV	7 3E 01	0 41

Hotspot 5A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
4 4' DDE	mg/kg	0 1	65	2/2	65	33	0 03	5 0E 04	3 4E-01	
4 4 DDT	mg/kg	0 52	1100	2/2	1100	550	0 03	5 0E 04	3 4E-01	
Arsenic	mg/kg	4 5	8 5	2/2	8 5	6 5	0 03	NE	NE	13 22
Beryllium	mg/kg	0.75	0 82	2/2	0 82	0 79	0	NE	NE	1 01
Chromium	mg/kg	23	151	2/2	151	87	0	2 0E 02	NTV	25 46
Lead	mg/kg	20	1790	2/2	1790	905	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0 026	25	2/2	25	13	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 015	19	2/2	19	9 5	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 034	16	2/2	16	8 0	0 13	NTV	7 3E-01	0 63
Benzo(k)fluoranthene	mg/kg	0 01	19	2/2	19	9 5	0 13	NTV	7 3E 02	0 46
Dibenz(a h)anthracene	mg/kg	0 005	7 1	2/2	7 1	3 6	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	0 012	11	2/2	11	5 5	0 13	NTV	7 3E-01	0 41

[1] Present at background level

Lead has no RfD or SF and is evaluated separately

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A 19 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	5 0E 04	3 4E 01	1 2E 1	6 6E 8
4 4 DDT	1100	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	5 0E 04	3 4E 01	4 5E 2	2 5E 8
Chromium	151	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 7
Benzo(a)pyrene	19	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 8E 6
Benzo(b)fluoranthene	16	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 7
Benzo(k)fluoranthene	19	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 02	NA	1 8E 8
Dibenz(a h)anthracene	7 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	6 7E 7
Indeno(1 2 3 cd)pyrene	11	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 0E 7
												Total	1 6E 1	3 0E 6

Attachment A 19 3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT RfD $_{ral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF $_{ral}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF $_{ral}$ = O a Ca ce Slope Fac o (mg/kg/da)^{1}

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	4 4E 1	2 4E 7
4 4 DDT	1100	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	7 4E+0	4 1E 6
Chromium	151	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	2 5E 2	NA
Benzo(a)anthracene	25	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 0E 7
Benzo(a)pyrene	19	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 5E 6
Benzo(b)fluoranthene	16	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 7
Benzo(k)fluoranthene	19	1E 6	330	60	1	70	84	25 550	NTV	7 3E 02	NA	1 5E 8
Dibenz(a h)anthracene	7 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	5 7E 7
Indeno(1 2 3 cd)pyrene	11	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	8 9E 8
										Total	7 9E+0	6 9E 6

Attachment A 19 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{or\ l})/(BW\ AT\ )$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
$SF_{or\ l}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD $_l$	SF $_l$	Hazard Index	Cancer Risk
4 4 DDE	33	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E 04	3 4E 01	8 0E 3	2 2E 9
4 4 DDT	550	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E 04	3 4E 01	1 3E 1	3 8E 8
Chromium	87	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	13	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 0E 9
Benzo(a)pyrene	9 5	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	6 1E 8
Benzo(b)fluoranthene	8 0	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	5 1E 9
Benzo(k)fluoranthene	9 5	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 02	NA	6 1E 10
Dibenz(a h)anthracene	3 6	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 3E 8
Indeno(1 2 3 cd)pyrene	5 5	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	3 5E 9
												Total	1 4E 1	1 4E 7

Attachment A 19 5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_c\ RfD_{al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{ral})/(BW\ AT\ )$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{al} = O a Ca-ce S ope Fac o (mg/kg/day)[1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	33	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	6 6E 2	1 9E 8
4 4 DDT	550	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	1 1E+0	3 1E 7
Chromium	87	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	4 4E 3	NA
Benzo(a)anthracene	13	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 5E 8
Benzo(a)pyrene	9 5	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 2E 7
Benzo(b)fluoranthene	8 0	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	9 8E 9
Benzo(k)fluoranthene	9 5	1E 6	100	30	1	70	42	25 550	NTV	7 3E 02	NA	1 2E 9
Dibenz(a h)anthracene	3 6	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	4 4E 8
Indeno(1 2 3 cd)pyrene	5 5	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	6 7E 9
										Total	1 2E+0	5 3E 7

Attachment A 19 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD $_{al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E 04	3 4E 01	2 5E 2	1 5E 6
4 4 DDT	1100	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E 04	3 4E 01	4 3E 1	2 6E 5
Chromium	151	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	5 5E 6
Benzo(a)pyrene	19	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 2E 5
Benzo(b)fluoranthene	16	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 5E 6
Benzo(k)fluoranthene	19	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 02	NA	4 2E 7
Dibenz(a h)anthracene	7 1	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 6E 5
Indeno(1 2 3 cd)pyrene	11	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 4E 6
												Total	*4 5E 1*	*9 6E 5*

Attachment A 19-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	1 3E 1	7 7E 6
4 4 DDT	1100	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	2 2E+0	1 3E 4
Chromium	151	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	4 9E 2	NA
Benzo(a)anthracene	25	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	6 4E 6
Benzo(a)pyrene	19	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 8E 5
Benzo(b)fluoranthene	16	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	4 1E 6
Benzo(k)fluoranthene	19	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 02	NA	4 8E 7
Dibenz(a h)anthracene	7 1	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 8E 5
Indeno(1 2 3 cd)pyrene	11	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 8E 6
										Total	2 3E+0	2 2E 4

Attachment A 19 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT\ \ RfD_{o\ al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{al})/(BW\ AT)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
$SF_{or\ l}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	$RfD_{o\ l}$	SF_{l}	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	5 0E 04	3 4E 01	2 3E 3	2 8E 8
4 4 DDT	1100	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	5 0E 04	3 4E 01	3 9E 2	4 7E 7
Chromium	151	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	9 9E 8
Benzo(a)pyrene	19	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 6E 7
Benzo(b)fluoranthene	16	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 4E 8
Benzo(k)fluoranthene	19	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 02	NA	7 6E 9
Dibenz(a h)anthracene	7 1	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 8E 7
Indeno(1 2 3 cd)pyrene	11	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 4E 8
												Total	4 1E 2	1 8E 6

Attachment A 19-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $_c$ RfD $_{ral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF $_{ral}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD $_l$	SF $_{ral}$	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	50	250	5	70	1 825	25 550	5 0E 04	3 4E 01	6 4E 2	7 7E 7
4 4 DDT	1100	1E 6	50	250	5	70	1 825	25 550	5 0E 04	3 4E 01	1 1E+0	1 3E 5
Chromium	151	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	2 5E 2	NA
Benzo(a)anthracene	25	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 4E 7
Benzo(a)pyrene	19	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 6
Benzo(b)fluoranthene	16	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 1E 7
Benzo(k)fluoranthene	19	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 02	NA	4 8E 8
Dibenz(a h)anthracene	7 1	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 8E 6
Indeno(1 2 3 cd)pyrene	11	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 8E 7
										Total	1 2E+0	2 2E 5

Attachment A-19 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD $_{i}$)

Where HI = *Hazard Index (unitless)*
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ai} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF $_{ai}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{ai}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD $_{i}$	SF $_{i}$	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E 04	3 4E 01	1 8E 3	1 3E 7
4 4 DDT	1100	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E 04	3 4E 01	3 1E 2	2 2E 6
Chromium	151	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 7E 7
Benzo(a)pyrene	19	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 6E 6
Benzo(b)fluoranthene	16	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 0E 7
Benzo(k)fluoranthene	19	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 02	NA	3 6E 8
Dibenz(a h)anthracene	7 1	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 3E 6
Indeno(1 2 3 cd)pyrene	11	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 1E 7
												Total	3 3E 2	8 3E 6

Attachment A 19 11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD_{l}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	6 1E 3	4 4E 7
4 4 DDT	1100	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	1 0E 1	7 5E 6
Chromium	151	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	2 4E 3	NA
Benzo(a)anthracene	25	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 7E 7
Benzo(a)pyrene	19	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 8E 6
Benzo(b)fluoranthene	16	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 4E 7
Benzo(k)fluoranthene	19	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 02	NA	2 8E 8
Dibenz(a h)anthracene	7 1	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 0E 6
Indeno(1 2 3 cd)pyrene	11	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 6E 7
										Total	1 1E 1	1 3E 5

Attachment A 19 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD $_{al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT $_c$	AT_c	RfD $_l$	SF $_{al}$	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	3 4E 01	7 3E 5	1 6E 9
4 4 DDT	1100	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	3 4E 01	1 2E 3	2 7E 8
Chromium	151	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 7E 9
Benzo(a)pyrene	19	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 4E 8
Benzo(b)fluoranthene	16	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 7E 9
Benzo(k)fluoranthene	19	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 02	NA	4 4E 10
Dibenz(a h)anthracene	7 1	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 6E 8
Indeno(1 2 3 cd)pyrene	11	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 5E 9
												Total	1 3E 3	1 0E 7

Attachment A-19-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	1 5E 3	3 3E 8
4 4 DDT	1100	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	2 6E 2	5 6E 7
Chromium	151	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	5 9E 4	NA
Benzo(a)anthracene	25	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 8E 8
Benzo(a)pyrene	19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 1E 7
Benzo(b)fluoranthene	16	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 8E 8
Benzo(k)fluoranthene	19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 02	NA	2 1E 9
Dibenz(a h)anthracene	7 1	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	7 8E 8
Indeno(1 2 3 cd)pyrene	11	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 2E 8
										Total	2 8E 2	9 5E 7

Attachment A 19 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hld})/(BW_{hld}\ AT_{nc}\ RfD_{r})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{ad} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hld} = Exposure Duration for a Child (years)
ED_{d} = Exposure Duration for an Adult (years)
BW_{hld} = Body Weight for a Child (kg)
$BW_{d\ l}$ = Body Weight for an Adult (kg)
AT_{nc} – Averaging Time for Non Carcinogens (days)
RfD_{ra} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{c\ ld}\ ED_{ld}/BW_{hl}) + (SA_{ad}\ ED_{d\ r}/BW_{lt})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ora} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	$SA_{ch\ ld}$	SA_{adul}	EF	$ED_{h\ l}$	$ED_{d\ t}$	$BW_{h\ d}$	$BW_{d\ lt}$	AT_{nc}	AT	RfD_{ral}	SF_{ra}	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	0 1430819	5 2E 6
4 4 DDT	1100	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	2 4213863	8 7E 5
Chromium	151	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
Benzo(a)anthracene	25	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 8E 5
Benzo(a)pyrene	19	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 4
Benzo(b)fluoranthene	16	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 2E 5
Benzo(k)fluoranthene	19	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 02	NA	1 4E 6
Dibenz(a h)anthracene	7 1	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	5 3E 5
Indeno(1 2 3 cd)pyrene	11	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	8 1E 6
															Total	2 6E+0	3 3E 4

Attachment A 19 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF IR_{child} EF ED_{child})/(BW_{child} AT_{nc} RfD_{oral})
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF EF SF_{oral} ((IR_{child} ED_{child}/BW_{child})+(IR_{adult} ED_{adult}/BW_{adult})))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (5 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{nc}	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	1 7E+0	3 5E 5
4 4 DDT	1100	1E-6	200	100	350	6	24	15	70	2 190	25 550	5 0E-04	3 4E 01	2 8E+1	5 9E 4
Chromium	151	1E-6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	6 4E 1	NA
Benzo(a)anthracene	25	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 9E 5
Benzo(a)pyrene	19	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 2E 4
Benzo(b)fluoranthene	16	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	1 8E 5
Benzo(k)fluoranthene	19	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-02	NA	2 2E 6
Dibenz(a h)anthracene	7 1	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 1E 5
Indeno(1 2 3 cd)pyrene	11	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 3E 5
													Total	3 0E+1	9 8E 4

Attachment A 19 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED $_{d}$)/(BW $_{hild}$ AT_{nc} RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI – Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{a} – Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED $_{d\ lt}$ = Exposure Duration for an Adult (years)
BW $_{ild}$ = Body Weight for a Child (kg)
BW $_{lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R D $_{ral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF $_{ra}$ ((SA_{child} ED $_{d}$/BW $_{hl}$)+(SA_{ad} ED $_{d}$ /BW)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ora} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{ch}	SA $_{d\ l}$	EF	ED $_{h\ l}$	ED $_{dul}$	BW $_{ld}$	BW $_{d\ l}$	AT	AT	RfD $_{ra}$	SF $_{ra}$	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	5 0E-04	3 4E 01	1 4E 2	2 4E 7
4 4 DDT	1100	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	2 4E 1	4 1E 6
Chromium	151	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 6E 7
Benzo(a)pyrene	19	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	6 5E 6
Benzo(b)fluoranthene	16	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	5 5E 7
Benzo(k)fluoranthene	19	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 02	NA	6 5E 8
Dibenz(a h)anthracene	7 1	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 00	NA	2 4E 6
Indeno(1 2 3-cd)pyrene	11	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	3 8E 7
															Total	2 6E 1	1 5E 5

Attachment A 19 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non-Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogen (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{nc}	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDE	65	1E-6	100	50	350	6	3	15	70	2 190	25 550	5 0E-04	3 4E-01	8 3E 1	1 3E 5
4 4 DDT	1100	1E-6	100	50	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	1 4E+1	2 2E 4
Chromium	151	1E-6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	3 2E 1	NA
Benzo(a)anthracene	25	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	1 1E 5
Benzo(a)pyrene	19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	8 0E 5
Benzo(b)fluoranthene	16	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	6 7E 6
Benzo(k)fluoranthene	19	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 02	NA	8 0E 7
Dibenz(a h)anthracene	7 1	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 0E 5
Indeno(1 2 3-cd)pyrene	11	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	4 6E 6
													Total	1 5E+1	3 6E 4

Attachment A-19-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 14	0 16	1 4E 7	3 0E 6
	Ingestion	1 2	7 9	5 3E 7	6 9E 6
	Total	1 3	8 0	6 7E 7	9 9E 6
Future Industrial/Commercial Worker					
	Dermal	0 041	0 45	1 8E 6	9 6E 5
	Ingestion	1 2	2 3	2 2E 5	2 2E 4
	Total	1 2	2 8	2 4E 5	3 2E 4
Current Trespasser/Site Visitor					
	Dermal	0 0013	0 033	1 0E 7	8 3E 6
	Ingestion	0 028	0 11	9 5E 7	1 3E 5
	Total	0 029	0 14	1 0E 6	2 1E 5
Hypothetical Future Resident					
	Dermal	0 26	2 6	1 5E 5	3 3E 4
	Ingestion	15	30	3 6E 4	9 8E 4
	Total	15	33	3 8E 4	1 3E 3

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Excavation Worker Building 5 Hotspot 5A
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgro p f Lead Adult Lead C mmittee

V si d te 05/19/03

Exposure Variable	PbB Equation[1] 1*	2**	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi = Hom	Using Equation 1 GSDi = Het	Using Equation 2 GSDi = H m	Using Equation 2 GSDi = H t
PbS	X	X	S il lead trati	g/g ppm	905 0	905 0	905 0	905 0
$R_{etal/maternal}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	Geom tri tandard d PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR	X		S il gesti rate (in l ding l de ed ind dus)	g/d y	0 100	0 100		--
IR_{S+D}		X	T tal gesti rate f tdoo l and indoo d t	g/d y			0 100	0 100
W_S		X	W ghti g facto fra f IR_{S+D} gested as td l				1 0	1 0
K_{SD}		X	Mas fracti f l dust	--			0 7	0 7
$AF_{S\ D}$	X	X	Ab rpti fracti (sam f so l and dus)		0 12	0 12	0 12	0 12
$EF_{S\ D}$	X	X	Exp re freq y (am f l and dus)	d ys/y	30	30	30	30
$AT_{S,D}$	X	X	A rag g tim (am f l and dust)	d ys/y	365	365	365	365
PbB_{adul}	PbB f ad lt w rk geom tri mean			g/dL	1 9	1 9	1 9	1 9
$PbB_{f\ tal,\ 0.95}$	95th p rce til PbB among f tuses f dult w k rs			g/dL	6 1	6 1	6 1	6 1
PbB	Targ t PbB l el f co cer (e.g 10 g/dL)			g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} \geq PbB_t)$	Pr b b lity that f tal PbB PbB assumi g l gn rmal distrib ti			%	1 1%	1 1%	1 1%	1 1%

[1] Eq ti l does t pp rti pos re betwee l and dust gesti (ex l des W K)
When IR IR_{S+} and W 1 0 th eq ti y ld th sam PbB_{fetal}

Equati 1 bas d Eq 1 2 i USEPA (1996)

PbB_{ul} =	(PbS BKSF IR AF EF /AT) PbB
$PbB_{fetal,\ 5}$ =	PbB_{adu} (GSD_i^{64} R)

Eq ti 2 lt rn t pp ach based Eq 1 2, d A 19 i USEPA (1996)

PbB_{ul} =	PbS BKSF*([(IR D) AF EF W]+[K (IR$_{S+}$) (1 W) AF EF])/365 PbB
$PbB_{f\ ta,\ 5}$ =	PbB_{adult} (GSD_i^{64} R)

S urce U.S EPA (1996) R mmend ti ns f th Technical R i w W kg p f Le d
f l terim Approach t Assessi g Risks Associ ted with Ad lt Exposures to Lead i S il

Printed 03/15/2004 4 04 PM

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Excavation Worker Building 5 Hotspot 5A
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA T ch ical R i w W kg oup f L ad Adult Lead Committ

Versi d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSD1 = Hom	Using Equation 1 GSD1 = H t	Using Equation 2 GSD1 = H m	Using Equation 2 GSD1 = Het
PbS	X	X	S il lead ce trati	g/g ppm	905 0	905 0	905 0	905 0
$R_{fetal/maternal}$	X	X	F tal/m te al PbB rati	--	0 9	0 9	0 9	0 9
BKSF	X	X	B kin u Sl pe Fact	g/dL per g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d u PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baselin PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gestu rate (l d g l d d d dust)	g/d y	0 330	0 330		
IR_{S+D}		X	T tal ingestu rate f td l and d d t	g/d y			0 330	0 330
W_S		X	W ghtu g fact fracti f IR p gested as tdoo so l				1 0	1 0
K_{SD}		X	Mass fra tu f so l d t				0 7	0 7
$AF_{S,D}$	X	X	Absorpti f tu (sam f l and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp ure freq y (am f l and dus)	d ys/y	60	60	60	60
$AT_{S,D}$	X	X	A rag g m (am f l and dust)	d ys/y	365	365	365	365
PbB_{adul}			PbB f ad lt w rk geom tri me	g/dL	3 9	3 9	3 9	3 9
$PbB_{tal,0.95}$			95th p rce til PbB am ng f tuses f dult w rker	g/dL	12 6	12 6	12.6	12 6
PbB			T rg t PbB l el f cern (e.g 10 ug/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{tal} > PbB_t)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti	%	8 9%	8 9%	8 9%	8 9%

Eq u l does t pporti p ure b twee l and dust g (l des W K)
When IR IR$_{S+}$ and W 1 0 th eq u s y ld th am PbB_{fetal}

Equati 1 based Eq 1 2 i USEPA (1996)

PbB_{dul} =	(PbS BKSF IR_{S+} $AF_{S,D}$ EF /AT) + PbB
$PbB_{tal,\ s}$ =	$PbB_{ad\ lt}$ $(GSD_i^{64}$ R)

Eq atio 2 alt rn t pp oach based Eq 1 2 and A 19 i USEPA (1996)

PbB_{dul} =	PbS BKSF ([(IR_{S+D}) AF EF W]+[K_{SD} (IR) (1 W) AF EF])/365 PbB
$PbB_{fetal,\ .95}$ =	PbB_{adult} $(GSD_i^{64}$ R)

S urce U.S EPA (1996) R comm d ti ns f th Techni al R vi w W kg p f Le d
f App ch t Assessi g Risks Associ ted with Ad lt Exposu es to Lead i S il

Attachment A-19 21

Site Worker Building 5 Hotspot 5A
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R lew W kgroup f Lead Ad lt Lead C mmittee

V rsi n date 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSD1 Hom	Using Equation 1 GSD1 Het	Using Equation 2 GSD1 Hom	Using Equation 2 GSD1 Het
PbS	X	X	S il l ad trati	g/g ppm	1790 0	1790 0	1790 0	1790 0
$R_{fetal/maternal}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d vi ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l ding il d ved ind d)	g/d y	0 050	0 050		
$IR_{S\ D}$		X	T tal gesti rate f tdoo l and ind d t	g/d y			0 050	0 050
W_S		X	W ghtng facto fractio f IR_S gested tdoo l				1 0	1 0
K_{SD}		X	Mass f ac f so l dus				0 7	0 7
$AF_{S,D}$	X	X	Ab rpti fra ti (sam f l and d)		0 12	0 12	0 12	0 12
$EF_{S\ D}$	X	X	Expos re freq y (am f l and dust)	d ys/y	219	219	219	219
AT	X	X	A eraging m (am f so l and dus)	d ys/y	365	365	365	365
PbB_{adult}			PbB f ad lt w rk geom tri me	g/dL	4 1	4 1	4 1	4 1
$PbB_{f\ tal,0.95}$			95th p rce til PbB am g f tuses f dult w rk rs	g/dL	13.3	13.3	13.3	13.3
PbB			T g t PbB le el f concern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > PbB_t)$			Prob b lity th t f tal PbB PbB assumi g l gn rmal distrib ti	%	10 1%	10 1%	10 1%	10 1%

Eq ti l does t apporti exp re betwee l and dust gesti (l des W K_S)
Wh IR IR and W 1 0 th eq ti y ld th am PbB_{fetal}

Equati 1 based o Eq 1 2 i USEPA (1996)

PbB ul =	(PbS BKSF IR_{S+} AF EF /AT D) + PbB
PbB tal, 0 5 =	PbB_{adult} $(GSD_i^{64}$ R)

Equati 2 alt rnate ppro ch b sed Eq 1 2 and A 19 in USEPA (1996)

PbB dul =	PbS BKSF*([(IR) AF EF W]+[K_D (IR_{S+}) (1 W) AF EF_D])/365+PbB
PbB tal, 5 =	PbB_{adult} $(GSD_i^{643}$ R)

S urce U.S EPA (1996) Recommend ti ns f th Technical R vi w W kg p f Le d
f an I terim App ach to Assessi g Risks Associ ted with Adult Exposures to Lead i S il

Attachment A-19 22

Site Worker Building 5 Hotspot 5A
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kg p f Le d Adult Lead C mmittee

V ion d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSD1 = Hom	Using Equation 1 GSD1 = Het	Using Equation 2 GSD1 = Hom	Using Equation 2 GSD1 = Het
PbS	X	X	S il i d trati	g/g ppm	1790 0	1790 0	1790 0	1790 0
$R_{tal/maternal}$	X	X	F tal/m te al PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B k ti Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Ge m tandard d PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ges rate (l d g l d d indoo d)	g/d y	0 100	0 100		
$IR_{S\ D}$		X	T tal gest rate f td l and d dus	g/d y			0 100	0 100
W_S		X	W ghti g fac fracti f $IR_{S\ p}$ gested as td l				1 0	1 0
K_{SD}		X	Mas frac f so l dust				0 7	0 7
$AF_{S\ D}$	X	X	Absorpti fra ti (sam f l and d t)		0 12	0 12	0 12	0 12
$EF_{S\ D}$	X	X	Expos re freq cy (am f l and d)	d ys/y	250	250	250	250
$AT_{S,D}$	X	X	A erag g tim (am f l d d t)	d ys/y	365	365	365	365
$\widehat{PbB}_{adul}$			PbB f d lt w k geom tri me	g/dL	7 4	7 4	7 4	7 4
$\widehat{PbB}_{f\ tal,\ 0.95}$			95th p centil PbB am ng f tuses f dult w rk	g/dL	24 0	24 0	24 0	24 0
PbB			T g t PbB l el f co cern (e.g. 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(\widehat{PbB}_{f\ tal} > PbB_0)$			Pr b bility th t f tal PbB PbB assumi g l g rmal distrib ti	%	30.2%	30 2%	30.2%	30 2%

Eq ti l doe t pp rti p re betwee so l and dust gesti (ex l des W K)
Wh IR IR_{S+} and W 1 0 th q ns y ld th am $PbB_{f\ al}$

Equati 1 based o Eq 1 2 1 USEPA (1996)

$PbB_{\ ul}$ =	(PbS BKSF IR_{S+} AF EF /AT) + PbB
$PbB_{fetal,\ 0\ 95}$ =	PbB_{adu} $(GSD_1^{.645}$ R)

Eq atio 2 alt rn t pp h based Eq 1 2 d A 19 1 USEPA (1996)

PbB_{adul} =	PbS BKSF ([(IR) AF EF W]+[K (IR_{S+}) (1 W) AF EF])/365+PbB
$PbB_{fetal,\ 5}$ =	PbB_{adult} $(GSD_1^{.645}$ R)

Attachment A-19-23

Trespasser Building 5 Hotspot 5A
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re iew Workgroup fo Lead Adult Lead C mmittee

Versi date 05/19/03

Exposure Variable	PbB Equation[1] 1	PbB Equation[1] 2	Description of Exposure Varimble	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi = Hom	Using Equation 1 GSDi = Hei	Using Equation 2 GSDi = H m	Using Equation 2 GSDi = Hei
PbS	X	X	S il lead ce trati	g/g ppm	1790 0	1790 0	1790 0	1790 0
$R_{f\ al/maternal}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Si pe Fac	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri standard d u PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ges rate (l d g l d d doo d t)	g/d y	0 050	0 050		
IR_{S+D}		X	T tal gestu rate f doo l and d dust	g/d y			0 050	0 050
W_S		X	W ghti g fact fra ti f IR_{S+D} ingested as td so l			--	1 0	1 0
K_{SD}		X	Mass f acti f so l dust				0 7	0 7
$AF_{S,D}$	X	X	Absorp fra ti (sam f so l and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp ure freq en y (am f l and dust)	d ys/y	6	6	6	6
$AT_{S,D}$	X	X	A raging tim (am f l and dust)	d ys/y	365	365	365	365
PbB_{adul}			PbB f adult w rk geom tri me	g/dL	1 6	1 6	1 6	1 6
$PbB_{fetal,\ .95}$			95th p rce til PbB am ng f tuses f adult work rs	g/dL	5.2	5 2	5.2	5 2
$\bar{PbB}$			Targ t PbB l l f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{tal} > PbB_t)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Equati l does t apporti po re b twee soil and dust g (l d W K)
Whe IR IR_{S+} and W l 0 th eq ti ns y eld th am $PbB_{f\ al}$

Equati 1 bas d Eq 1 2 l USEPA (1996)

$PbB_{\ ul}$ =	(PbS BKSF IR_{S+} AF EF /AT) PbB
$PbB_{tal,\ 5}$ =	PbB_{adult} $(GSD_i^{.64}$ R)

Equatio 2 altern t ppro ch based o Eq 1 2 d A 19 l USEPA (1996)

PbB_{dul} =	PbS BKSF*([(IR_{S+D}) AF_S EF_S W_S]+[K_D (IR_{S+D}) (1 W) AF_D EF_D])/365+PbB
$PbB_{fetal,}$ =	$PbB_{adu\ l}$ $(GSD_i^{.645}$ R)

S ur U.S EPA (1996) R comm nd ti ns f th Technical R vi w W kg p f L d
f I terim App oach t Assessi g Risks Associ ted with Ad lt Exposures to Lead i S il

Attachment A-19 24

Trespasser Building 5 Hotspot 5A
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA T h ical R ew W kgro p fo Lead Adult L d C mmittee

V rsio d t 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSD1 Hom	Using Equation 1 GSD1 Het	Using Equation 2 GSD1 Hom	Using Equation 2 GSD1 Het
PbS	X	X	S il l ad ce tr tu	g/g ppm	1790 0	1790 0	1790 0	1790 0
$R_{al/ma\ ernal}$	X	X	F tal/m ternal PbB ratu		0 9	0 9	0 9	0 9
BKSF	X	X	B ku tu Sl p F t	g/dL p g/d y	0 4	0 4	0 4	0 4
GSD_I	X	X	Ge m tr tandard d tu PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l d g l d ed i d d t)	g/d y	0 100	0 100		
$IR_{S\ D}$		X	T tal gestu rate f tdoo l and d dust	g/d y			0 100	0 100
W_S		X	W ghu g fac fracti f IR gested as td l				1 0	1 0
K_{SD}		X	Mas fra tu f so l dus				0 7	0 7
$AF_{S\ D}$	X	X	Ab rptu fractu (s m f l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp ure freq y (am f l and dus)	d ys/y	12	12	12	12
$AT_{S,D}$	X	X	A g g t m (am f l and d t)	d ys/y	365	365	365	365
PbB_{adul}			**PbB f adult w rk geom tri mean**	**g/dL**	**1.8**	**1 8**	**1 8**	**1 8**
$PbB_{fetal\ 0.95}$			**95th percentile PbB among f tuses f adult w rk rs**	**g/dL**	**5 9**	**5 9**	**5 9**	**5 9**
PbB	?		**Targ t PbB l i f co rn (e.g 10 g/dL)**	**g/dL**	**10 0**	**10 0**	**10 0**	**10 0**
$P(PbB_{fetal} > PbB_t)$			**Pr b bility th t f tal PbB PbB ass ml g l gn rmal distrib tl**	**%**	**1 0%**	**1 0%**	**1 0%**	**1 0%**

Equatu l doe t app rtu p ure betwee l and dust g tu (l des W K)
Wh IR IR_{S+} and W l 0 th q tu ns y ld th am PbB_{fetal}

Equati l bas d Eq 1 2 i USEPA (1996)

PbB_{dul} =	**(PbS BKSF IR $_D$ AF EF_S/AT) + PbB**
$PbB_{eta\ ,\ s}$ =	**PbB_{adul} (GSD_I^{64} R)**

Equ ti 2 lt t ppro h b sed Eq 1 2 and A 19 i USEPA (1996)

PbB_{dul} =	**PbS BKSF*([(IR_{S+D}) AF EF W]+[K (IR_D) (1 W) AF EF])/365+PbB**
$PbB_{f\ tal,\ s}$ =	**PbB_{adult} (GSD_I^{645} R)**

S ce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f L ad
f App ach t Assessi g Ri ks Associ ted with Ad lt Expos res to Lead i S il

Attachment A-19-25

Hotspot 5A
Residential Exposure to Lead
Calculated Blood Lead and Lead Uptakes from IEUBK Model Software
St Louis Army Ammunition Plant
St Louis Missouri

Year	Air (ug/dL)	Diet (ug/dL)	Alternate (ug/dL)	Water (ug/dL)	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
5 1	0 021	1 954	0	0 283	27 03	29 288	**15 1**
1 2	0 034	1 94	0	0 671	40 793	43 439	**17 4**
2 3	0 062	2 275	0	0 729	42 597	45 664	**16 5**
3 4	0 067	2 278	0	0 774	44 363	47 481	**16**
4 5	0 067	2 405	0	0 88	36 022	39 374	**13 6**
5 6	0 093	2 632	0	0 963	33 627	37 315	**11 7**
6 7	0 093	2 964	0	0 999	32 395	36 452	**10 4**

Attachment A 20 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 5B Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
Benzo(a)pyrene	mg/kg	0 3	0 3	1/1	0 30	0 30	0 13	NTV	7 3E+00	0 74

Hotspot 5B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg day) [1]	Background
Benzo(a)anthracene	mg/kg	0 035	1 6	3/3	1 6	0 67	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 024	1 3	3/3	1 3	0 54	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 028	1 7	3/3	1 7	0 70	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 004	0 2	3/3	0 20	0 087	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	0 013	0 8	3/3	0 80	0 33	0 13	NTV	7 3E-01	0 41

* Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-20 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 6	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 8
Benzo(a)pyrene	1 3	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 2E 7
Benzo(b)fluoranthene	1 7	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 6E 8
Dibenz(a h)anthracene	0 20	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 9E 8
Indeno(1 2 3 cd)pyrene	0 80	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	7 6E 9
												Total	0 0E+0	1 8E 7

Attachment A-20-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT_c	$RfD_{o\ l}$	$SF_{o\ l}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 6	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 8
Benzo(a)pyrene	1 3	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 1E 7
Benzo(b)fluoranthene	1 7	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 4E 8
Dibenz(a h)anthracene	0 20	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 6E 8
Indeno(1 2 3 cd)pyrene	0 80	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	6 5E 9
										Total	0 0E+0	1 5E 7

Attachment A-20 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 67	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	4 3E 10
Benzo(a)pyrene	0 54	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 4E 9
Benzo(b)fluoranthene	0 70	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	4 5E 10
Dibenz(a h)anthracene	0 087	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	5 6E 10
Indeno(1 2 3 cd)pyrene	0 33	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 1E 10
												Total	0 0E+0	5 1E 9

Attachment A-20-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 67	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	8 2E 10
Benzo(a)pyrene	0 54	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	6 6E 9
Benzo(b)fluoranthene	0 70	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	8 6E 10
Dibenz(a h)anthracene	0 087	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 1E 9
Indeno(1 2 3 cd)pyrene	0 33	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 1E 10
										Total	0 0E+0	9 8E 9

Attachment A-20-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	6 6E 7
												Total	0 0E+0	6 6E 7

Attachment A-20-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10 ^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	7 7E 7
										Total	0 0E+0	7 7E 7

Attachment A-20-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 2E 8
												Total	0 0E+0	1 2E 8

Attachment A-20-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF\ )/(BW\ AT\ )$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 7E 8
										Total	0 0E+0	7 7E 8

Attachment A-20-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	5 7E 8
												Total	0 0E+0	5 7E 8

Attachment A-20-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 4E 8
										Total	0 0E+0	4 4E 8

Attachment A-20-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	6 9E 10
												Total	0 0E+0	6 9E 10

Attachment A-20-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{r}\ )/(BW\ AT\ )$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	3 3E 9
										Total	0 0E+0	3 3E 9

Attachment A-20 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{ad\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{ad\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{ch\ ld}\ ED_{hild}/BW_{child})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
$SF_{o\ l}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{hild}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD_{l}	SF_{l}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 2E 6
															Total	0 0E+0	2 2E 6

Attachment A-20-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_{c})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 4E 6
													Total	0 0E+0	3 4E 6

Attachment A-20 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB $SA_{ch\ ld}$ EF ED_{hild})/(BW_{child} AT RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED $_{d\ lt}$ = Exposure Duration for an Adult (years)
$BW_{ch\ ld}$ = Body Weight for a Child (kg)
BW $_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD $_{ral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF_{oral} ((SA_{child} $ED_{ch\ ld}$/$BW_{ch\ ld}$)+(SA $_{d\ lt}$ ED $_{d\ lt}$/BW $_{dult}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA $_{d\ lt}$	EF	ED_{child}	ED $_{d\ lt}$	BW $_{hild}$	BW $_{d\ lt}$	AT	AT	$RfD_{o\ l}$	SF $_{l}$	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 0E 7
															Total	0 0E+0	1 0E 7

Attachment A 20-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 30	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 3E 6
													Total	0 0E+0	1 3E 6

Attachment A-20-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	5 1E 9	1 8E 7
Ingestion	0	0	9 8E 9	1 5E 7
Total	0	0	1 5E 8	3 3E 7
Future Industrial/Commercial Worker				
Dermal	0	0	1 2E 8	6 6E 7
Ingestion	0	0	7 7E 8	7 7E 7
Total	0	0	8 8E 8	1 4E 6
Current Trespasser/Site Visitor				
Dermal	0	0	6 9E 10	5 7E 8
Ingestion	0	0	3 3E 9	4 4E 8
Total	0	0	4 0E 9	1 0E 7
Hypothetical Future Resident				
Dermal	0	0	1 0E 7	2 2E 6
Ingestion	0	0	1 3E 6	3 4E 6
Total	0	0	1 4E 6	5 6E 6

Attachment A 21 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 6 Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day) [1]	Background
4 4' DDT	mg/kg	0 0062	4	6/7	0 91	0 38	0 03	5 0E-04	3 4E 01	
Arsenic	mg/kg	4	5 7	7/7	4 9	4 5	0 03	NE	NE	13 22
Beryllium	mg/kg	0 76	1 6	7/7	1 2	0 97	0	2 0E 03	NTV	1 01
Mercury	mg/kg	0 015	1 5	6/7	0 94	0 52	0	3 0E 04	NTV	0 15

Hotspot 6 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day) [1]	Background
4 4' DDT	mg/kg	0 0014	21	12/14	1 8	0 75	0 03	5 0E 04	3 4E-01	
Arsenic	mg/kg	3 1	5 7	14/14	4 8	4 4	0 03	NE	NE	13 22
Beryllium	mg/kg	0 76	1 6	14/14	1 2	1 0	0	5 0E 03	NTV	1 01
Chromium	mg/kg	18	31	14/14	26	24	0	2 0E-02	NTV	25 46
Mercury	mg/kg	0 011	1 5	12/15	0 63	0 32	0	3 0E-03	NTV	0 15

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-21-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	1 8	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	5 0E 04	3 4E 01	3 3E 3	1 8E 9
Beryllium	1 2	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	26	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Mercury	0 63	1E 6	0 9	0	3 300	60	1	70	84	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	3 3E 3	1 8E 9

Attachment A-21-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	1 8	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	1 2E 2	6 8E 9
Beryllium	1 2	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	8 1E 4	NA
Chromium	26	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	4 4E 3	NA
Mercury	0 63	1E 6	330	60	1	70	84	25 550	3 0E 03	NTV	7 1E 4	NA
										Total	1 8E 2	6 8E 9

Attachment A-21-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 75	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E 04	3 4E 01	1 8E 4	5 1E 11
Beryllium	1 0	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	24	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Mercury	0 32	1E 6	0 2	0	2 000	30	1	70	42	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	1 8E 4	5 1E 11

Attachment A-21-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 75	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	1 5E 3	4 3E 10
Beryllium	1 0	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	2 0E 4	NA
Chromium	24	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 2E 3	NA
Mercury	0 32	1E 6	100	30	1	70	42	25 550	3 0E 03	NTV	1 1E 4	NA
										Total	3 1E 3	4 3E 10

Attachment A-21-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
4 4 DDT	0 91	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E 04	0 34	3 5E 4	2 1E 8
Beryllium	1 2	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 94	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 04	NTV	0 0E+0	NA
												Total	3 5E 4	2 1E 8

Attachment A-21-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 91	1E 6	100	250	25	70	9 125	25 550	5 0E 04	0 34	1 8E 3	1 1E 7
Beryllium	1 2	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	5 9E 4	NA
Mercury	0 94	1E 6	100	250	25	70	9 125	25 550	3 0E 04	NTV	3 1E 3	NA
										Total	5 4E 3	1 1E 7

Attachment A-21-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 38	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	5 0E 04	0 34	1 3E 5	1 6E 10
Beryllium	0 97	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 52	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 04	NTV	0 0E+0	NA
												Total	1 3E 5	1 6E 10

Attachment A-21-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 38	1E 6	50	250	5	70	1 825	25 550	5 0E 04	0 34	3 7E 4	4 5E 9
Beryllium	0 97	1E 6	50	250	5	70	1 825	25 550	2 0E 03	NTV	2 4E 4	NA
Mercury	0 52	1E 6	50	250	5	70	1 825	25 550	3 0E 04	NTV	8 5E 4	NA
										Total	1 5E 3	4 5E 9

Attachment A-21 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 91	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E 04	0 34	2 5E 5	1 8E 9
Beryllium	1 2	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 94	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 04	NTV	0 0E+0	NA
												Total	2 5E 5	1 8E 9

Attachment A-21-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 91	1E 6	100	12	30	70	10 950	25 550	5 0E 04	0 34	8 5E 5	6 2E 9
Beryllium	1 2	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	2 8E 5	NA
Mercury	0 94	1E 6	100	12	30	70	10 950	25 550	3 0E 04	NTV	1 5E 4	NA
										Total	2 6E 4	6 2E 9

Attachment A-21-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	$RfD_{o\ al}$	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 38	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	0 34	4 3E 7	9 4E 12
Beryllium	0 97	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 52	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 04	NTV	0 0E+0	NA
												Total	4 3E 7	9 4E 12

Attachment A-21-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 38	1E 6	50	6	9	70	3 285	25 550	5 0E 04	0 34	8 9E 6	2 0E 10
Beryllium	0 97	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	5 7E 6	NA
Mercury	0 52	1E 6	50	6	9	70	3 285	25 550	3 0E 04	NTV	2 0E 5	NA
										Total	3 5E 5	2 0E 10

Attachment A-21 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{hld}\ AT_{nc}\ RfD_{l})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hld} = Body Weight for a Child (kg)
$BW_{ad\ lt}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{al}\ ((SA_{child}\ ED_{hild}/BW_{hild})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	ED_{dult}	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	RfD_{l}	SF_{ral}	Hazard Index	Cancer Risk
4 4 DDT	0 91	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	5 0E 04	0 34	0 00200315	7 2E 8
Beryllium	1 2	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	0	NA
Mercury	0 94	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 04	NTV	0	NA
															Total	2 0E 3	7 2E 8

Attachment A-21 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = ((CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child}) + (IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_{c}))$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
4 4 DDT	0 91	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E 04	0 34	2 3E 2	4 8E 7
Beryllium	1 2	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	7 7E 3	NA
Mercury	0 94	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 04	NTV	4 0E 2	NA
													Total	7 1E 2	4 8E 7

Attachment A 21 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED $_{hild}$)/(BW_{child} AT RfD_{oral})
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA $_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED $_{hild}$ = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW $_{hild}$ = Body Weight for a Child (kg)
BW $_{d\ lt}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD $_{al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF_{oral} ((SA_{child} ED $_{hild}$/BW $_{hild}$)+(SA $_{d\ lt}$ ED $_{d\ lt}$/BW $_{d\ lt}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{child}	ED $_{d\ lt}$	BW $_{hild}$	BW $_{d\ lt}$	AT	AT	RfD $_{ral}$	SF $_{l}$	Hazard Index	Cancer Risk
4 4 DDT	0 38	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	5 0E 04	0 34	8 4E 5	1 4E 9
Beryllium	0 97	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	0 0E+0	NA
Mercury	0 52	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 04	NTV	0 0E+0	NA
															Total	8 4E 5	1 4E 9

Attachment A 21 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{ad\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
$IR_{d\ lt}$ = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{ral}\ ((IR_{hld}\ ED_{ch\ ld}/BW_{ch\ ld})+(IR_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	$IR_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ i}$	$SF_{\ i}$	Hazard Index	Cancer Risk
4 4 DDT	0 38	1E 6	100	50	350	6	3	15	70	2 190	25 550	5 0E 04	0 34	4 9E 3	7 5E 8
Beryllium	0 97	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	3 1E 3	NA
Mercury	0 52	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 04	NTV	1 1E 2	NA
													Total	1 9E 2	7 5E 8

Attachment A-21-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 00018	0 0033	5 1E 11	1 8E 9
	Ingestion	0 0031	0 018	4 3E 10	6 8E 9
	Total	0 0033	0 021	4 8E 10	8 6E 9
Future Industrial/Commercial Worker					
	Dermal	0 000013	0 00035	1 6E 10	2 1E 8
	Ingestion	0 0015	0 0054	4 5E 9	1 1E 7
	Total	0 0015	0 0058	4 7E 9	1 3E 7
Current Trespasser/Site Visitor					
	Dermal	0 00000043	0 000025	9 4E 12	1 8E 9
	Ingestion	0 000035	0 00026	2 0E 10	6 2E 9
	Total	0 000035	0 00029	2 0E 10	8 1E 9
Hypothetical Future Resident					
	Dermal	0 000084	0 0020	1 4E 9	7 2E 8
	Ingestion	0 019	0 071	7 5E 8	4 8E 7
	Total	0 019	0 073	7 6E 8	5 6E 7

Attachment A 22 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 7A Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day) [1]	Background
PCB 1254	mg/kg	0 016	0 34	6/8	0 14	0 08	0 14	2 0E 05	2/1*	
Arsenic*	mg/kg	5 2	7 3	7/7	6 5	5 9	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 5	0 66	7/7	0 62	0 59	0	NE	NE	1 01
Chromium	mg/kg	24	42	7/7	38	32	0	3 0E-03	NTV	25 46
Benzo(a)anthracene	mg/kg	0 48	3 8	7/7	3 4	1 3	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 56	2 8	7/7	2 2	1 1	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 7	4	7/7	3 1	1 5	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene*	mg/kg	0 075	0 25	7/7	0 19	0 12	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	0 29	1 7	7/7	1 4	0 66	0 13	NTV	7 3E 01	0 41

Hotspot 7A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
PCB 1254	mg/kg	0 016	0 34	6/22	0 13	0 095	0 14	5 0E-05	2/1*	
Arsenic*	mg/kg	1 1	7 3	21/21	4 8	4 2	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 5	0 89	21/21	0 7	0 66	0	NE	NE	1 01
Chromium	mg/kg	22	42	21/21	32	30	0	2 0E 02	NTV	25 46
Benzo(a)anthracene	mg/kg	0 002	3 8	19/21	1 6	0 76	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 003	2 8	19/21	1 1	0 51	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 005	4	19/21	1 4	0 71	0 13	NTV	7 3E-01	0 63
Dibenz(a h)anthracene*	mg/kg	0 004	0 25	12/21	0 087	0 061	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 001	1 7	18/21	0 91	0 46	0 13	NTV	7 3E 01	0 41

*Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

IRIS recommends using a slope factor of 2 0 for RME and 1 0 for CTE

Attachment A-22 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT $_c$ RfD $_{al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD $_{ral}$	SF $_{l}$	Hazard Index	Cancer Risk
PCB 1254	0 13	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	1 1E 2	3 6E 9
Chromium	32	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 6	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 8
Benzo(a)pyrene	1 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 0E 7
Benzo(b)fluoranthene	1 4	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 8
Dibenz(a h)anthracene	0 087	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	8 2E 9
Indeno(1 2 3 cd)pyrene	0 91	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	8 6E 9
												Total	1 1E 2	1 5E 7

Attachment A-22 3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{al})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 $x10^{-6}$ kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{ral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 13	1E 6	330	60	1	70	84	25 550	5 0E 05	2 0E+00	8 8E 3	2 9E 9
Chromium	32	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 4E 3	NA
Benzo(a)anthracene	1 6	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 8
Benzo(a)pyrene	1 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	8 9E 8
Benzo(b)fluoranthene	1 4	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 1E 8
Dibenz(a h)anthracene	0 087	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	7 0E 9
Indeno(1 2 3 cd)pyrene	0 91	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	7 4E 9
										Total	1 4E 2	1 3E 7

Attachment A-22 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
PCB 1254	0 095	1E 6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E 05	1 0E+00	1 1E 3	8 9E 11
Chromium	30	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 76	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	4 8E 10
Benzo(a)pyrene	0 51	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 2E 9
Benzo(b)fluoranthene	0 71	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	4 5E 10
Dibenz(a h)anthracene	0 061	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 9E 10
Indeno(1 2 3 cd)pyrene	0 46	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 9E 10
												Total	1 1E 3	5 0E 9

Attachment A-22-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED $SF_{o\ al}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Average Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
PCB 1254	0 095	1E 6	100	30	1	70	42	25 550	5 0E 05	1 0E+00	1 9E 3	1 6E 10
Chromium	30	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 5E 3	NA
Benzo(a)anthracene	0 76	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	9 3E 10
Benzo(a)pyrene	0 51	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	6 2E 9
Benzo(b)fluoranthene	0 71	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	8 7E 10
Dibenz(a h)anthracene	0 061	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	7 5E 10
Indeno(1 2 3 cd)pyrene	0 46	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 6E 10
										Total	3 5E 3	9 5E 9

Attachment A-22 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{ral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{ral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
PCB 1254	0 14	1E 6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E 05	2 0E+00	6 3E 3	9 0E 8
Chromium	38	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	3 4	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 4E 7
Benzo(a)pyrene	2 2	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 8E 6
Benzo(b)fluoranthene	3 1	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	6 8E 7
Dibenz(a h)anthracene	0 19	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 2E 7
Indeno(1 2 3 cd)pyrene	1 4	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 1E 7
												Total	6 3E 3	7 1E 6

Attachment A-22-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10 ^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
PCB 1254	0 14	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	6 8E 3	9 8E 8
Chromium	38	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 2E 2	NA
Benzo(a)anthracene	3 4	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	8 7E 7
Benzo(a)pyrene	2 2	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	5 6E 6
Benzo(b)fluoranthene	3 1	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 9E 7
Dibenz(a h)anthracene	0 19	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 8E 7
Indeno(1 2 3 cd)pyrene	1 4	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 6E 7
										Total	1 9E 2	8 2E 6

Attachment A-22 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{ral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT_c	RfD	SF	Hazard Index	Cancer Risk
PCB 1254	0 080	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E 05	1 0E+00	3 3E 4	4 7E 10
Chromium	32	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 3	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	5 2E 9
Benzo(a)pyrene	1 1	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 4E 8
Benzo(b)fluoranthene	1 5	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 0E 9
Dibenz(a h)anthracene	0 12	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 9
Indeno(1 2 3 cd)pyrene	0 66	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 6E 9
												Total	3 3E 4	6 3E 8

Attachment A-22-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED $SF_{o al}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 080	1E 6	50	250	5	70	1 825	25 550	2 0E 05	1 0E+00	2 0E 3	2 8E 9
Chromium	32	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 2E 3	NA
Benzo(a)anthracene	1 3	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 3E 8
Benzo(a)pyrene	1 1	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 8E 7
Benzo(b)fluoranthene	1 5	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 8E 8
Dibenz(a h)anthracene	0 12	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 1E 8
Indeno(1 2 3 cd)pyrene	0 66	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 7E 8
										Total	7 2E 3	4 0E 7

Attachment A-22 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF ral	Hazard Index	Cancer Risk
PCB 1254	0 14	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2 0E+00	4 6E 4	7 8E 9
Chromium	38	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	3 4	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	6 4E 8
Benzo(a)pyrene	2 2	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 2E 7
Benzo(b)fluoranthene	3 1	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	5 9E 8
Dibenz(a h)anthracene	0 19	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 6E 8
Indeno(1 2 3 cd)pyrene	1 4	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 6E 8
												Total	4 6E 4	6 1E 7

Attachment A-22-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Average Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 14	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2 0E+00	3 3E 4	5 6E 9
Chromium	38	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	5 9E 4	NA
Benzo(a)anthracene	3 4	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	5 0E 8
Benzo(a)pyrene	2 2	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 2E 7
Benzo(b)fluoranthene	3 1	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 6E 8
Dibenz(a h)anthracene	0 19	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 8E 8
Indeno(1 2 3 cd)pyrene	1 4	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 1E 8
										Total	9 2E 4	4 7E 7

Attachment A-22 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD	SF	Hazard Index	Cancer Risk
PCB 1254	0 080	1E 6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1 1E 5	2 7E 11
Chromium	32	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 3	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 0E 10
Benzo(a)pyrene	1 1	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 5E 9
Benzo(b)fluoranthene	1 5	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 4E 10
Dibenz(a h)anthracene	0 12	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 8E 10
Indeno(1 2 3 cd)pyrene	0 66	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 5E 10
												Total	1 1E 5	3 6E 9

Attachment A-22-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD $_l$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = A e aging Time for Carcinogens (25 550 days)
SF $_{al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT $_c$	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0 080	1E 6	50	6	9	70	3 285	25 550	2 0E 05	1 0E+00	4 7E 5	1 2E 10
Chromium	32	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 3E 4	NA
Benzo(a)anthracene	1 3	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 4E 9
Benzo(a)pyrene	1 1	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 2E 8
Benzo(b)fluoranthene	1 5	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 7E 9
Dibenz(a h)anthracene	0 12	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 3E 9
Indeno(1 2 3 cd)pyrene	0 66	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	7 3E 10
										Total	1 7E 4	1 7E 8

Attachment A 22 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
—COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{c\ d}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{rel})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{ad\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ l}$ = Exposure Duration for an Adult (years)
BW_{dd} = Body Weight for a Child (kg)
$BW_{d\ l}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{rel}\ ((SA_{c\ ild}\ ED_{hild}/BW_{hild})+(SA\ \ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{l} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	RfD_{l}	SF_{rel}	Hazard Index	Cancer Risk
PCB 1254	0 14	1E-6	0 3	0 14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E-05	2 0E+00	0 03595392	3 1E 7
Chromium	38	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E-03	NTV	0	NA
Benzo(a)anthracene	3 4	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 5E-6
Benzo(a)pyrene	2 2	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 5
Benzo(b)fluoranthene	3 1	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	2 3E 6
Dibenz(a h)anthracene	0 19	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 6
Indeno(1 2 3-cd)pyrene	1 4	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 0E 6
															Total	3 6E 2	2 4E 5

Attachment A 22 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{ad\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
$IR_{ch\ ld}$ = Soil Ingestion Rate for a Child (mg/day)
$IR_{d\ lt}$ = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{ch\ ld}\ ED_{hild}/BW_{h\ ld})+(IR_{dult}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
$SF_{or\ l}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	IR_{dult}	EF	ED_{hild}	$ED_{d\ l}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
PCB 1254	0 14	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	8 9E 2	4 4E 7
Chromium	38	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E-03	NTV	1 6E 1	NA
Benzo(a)anthracene	3 4	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 9E 6
Benzo(a)pyrene	2 2	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 5E 5
Benzo(b)fluoranthene	3 1	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 5E 6
Dibenz(a h)anthracene	0 19	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 2E 6
Indeno(1 2 3-cd)pyrene	1 4	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	1 6E 6
													Total	2 5E 1	3 7E 5

Attachment A 22 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{c\ ild}\ EF\ ED_{hild})/(BW_{hild}\ AT\ \ RfD_{ra})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ l}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ t}$ = Exposure Duration for an Adult (years)
BW_{ild} = Body Weight for a Child (kg)
BW_{d} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
$R_fD_{\ l}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{child}\ ED_{hild}/BW_{ild})+(SA_{ad\ l}\ ED_{d\ lt}/BW_{d\ lt})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{no}	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
PCB 1254	0 080	1E 6	0 04	0 14	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E-05	1 0E+00	2 1E 3	4 1E 9
Chromium	32	1E-6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E-03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 3	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	4 5E 8
Benzo(a)pyrene	1 1	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 8E 7
Benzo(b)fluoranthene	1 5	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	5 2E 8
Dibenz(a h)anthracene	0 12	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	4 1E 8
Indeno(1 2 3-cd)pyrene	0 66	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	2 3E 8
															Total	2 1E 3	5 4E 7

Attachment A 22 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{ad\ l}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{ad\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{hild} = Soil Ingestion Rate for a Child (mg/day)
IR_{dult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{ch\ ld}\ ED_{ch\ ld}/BW_{hild})+(IR_{d\ lt}\ ED_{dult}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{hild}	ED_{dult}	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	RfD_{ral}	SF_{l}	Hazard Index	Cancer Risk
PCB 1254	0 080	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E+00	2 6E 2	4 6E 8
Chromium	32	1E-6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	6 8E 2	NA
Benzo(a)anthracene	1 3	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	5 5E 7
Benzo(a)pyrene	1 1	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	4 6E 6
Benzo(b)fluoranthene	1 5	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	6 3E 7
Dibenz(a h)anthracene	0 12	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	5 1E 7
Indeno(1 2 3 cd)pyrene	0 66	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	2 8E 7
													Total	9 4E 2	6 6E-6

Attachment A-22-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 0011	0 011	5 0E 9	1 5E 7
	Ingestion	0 0035	0 014	9 5E 9	1 3E 7
	Total	0 0046	0 025	1 4E 8	2 8E 7
Future Industrial/Commercial Worker					
	Dermal	0 00033	0 0063	6 3E 8	7 1E 6
	Ingestion	0 0072	0 019	4 0E 7	8 2E 6
	Total	0 0075	0 026	4 7E 7	1 5E 5
Current Trespasser/Site Visitor					
	Dermal	0 000011	0 00046	3 6E 9	6 1E 7
	Ingestion	0 00017	0 0009	1 7E 8	4 7E 7
	Total	0 00018	0 0014	2 1E 8	1 1E 6
Hypothetical Future Resident					
	Dermal	0 0021	0 036	5 4E 7	2 4E 5
	Ingestion	0 094	0 25	6 6E 6	3 7E 5
	Total	0 10	0 29	7 2E 6	6 1E 5

Attachment A 23 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 7B Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	3.2	3.2	1/1	3.2	3.2	0.03	NE	NE	13.22
Beryllium	mg/kg	0.38	0.38	1/1	0.38	0.38	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.072	0.072	1/1	0.072	0.072	0.13	NTV	7.3	0.74

Hotspot 7B Combined Surface and Subsurface Soil (0 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	3.2	5.6	3/3	5.6	4.3	0.03	NE	NE	13.22
Beryllium	mg/kg	0 38	1 3	3/3	1 3	0 74	0	5 0E-03	NTV	1 01
Benzo(a)pyrene	mg/kg	0.033	0.072	2/3	0.072	0 045	0.13	NTV	7.3	0.74

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-23-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 072	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	6 8E 9
												Total	0 0E+0	6 8E 9

Attachment A-23-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	8 8E 4	NA
Benzo(a)pyrene	0 072	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	5 8E 9
										Total	8 8E 4	5 8E 9

Attachment A-23-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 74	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 045	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 9E 10
												Total	0 0E+0	2 9E 10

Attachment A-23-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 74	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	1 5E 4	NA
Benzo(a)pyrene	0 045	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	5 6E 10
										Total	1 5E 4	5 6E 10

Attachment A-23-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} $RfD_{o\ al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 6E 7
												Total	0 0E+0	1 6E 7

Attachment A-23-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_o)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 8E 7
										Total	0 0E+0	1 8E 7

Attachment A-23-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 9E 9
												Total	0 0E+0	2 9E 9

Attachment A-23-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 8E 8
										Total	0 0E+0	1 8E 8

Attachment A-23-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 4E 8
												Total	0 0E+0	1 4E 8

Attachment A-23-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 1E 8
										Total	0 0E+0	1 1E 8

Attachment A-23-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 7E 10
												Total	0 0E+0	1 7E 10

Attachment A-23-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_o)/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	7 9E 10
										Total	0 0E+0	7 9E 10

Attachment A-23 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{child})/(BW $_{hild}$ AT_{nc} RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA $_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{ad\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW $_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF $_{ral}$ ((SA_{child} ED_{child}/BW_{child})+(SA $_{d\ lt}$ ED $_{d\ lt}$/BW $_{d\ lt}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA $_{hild}$	SA $_{d\ lt}$	EF	ED $_{hild}$	ED $_{d\ lt}$	BW $_{hild}$	BW $_{d\ lt}$	AT	AT	RfD $_{l}$	SF $_{l}$	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	5 3E 7
															Total	0 0E+0	5 3E 7

Attachment A-23-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{c} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_{c})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_{c} = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_{c}	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 2E 7
													Total	0 0E+0	8 2E 7

Attachment A 23 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA_{child} EF ED_{child})/(BW_{hild} AT RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA $_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
$ED_{ch\ ld}$ = Exposure Duration for a Child (years)
$ED_{ad\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW $_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD $_{al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB EF SF $_{ral}$ ((SA_{child} ED_{child}/$BW_{h\ ld}$)+(SA $_{d\ lt}$ ED $_{d\ lt}$/BW $_{d\ lt}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA $_{hild}$	SA $_{d\ lt}$	EF	ED_{child}	ED $_{d\ lt}$	BW $_{hild}$	BW $_{d\ lt}$	AT $_c$	AT	RfD_{oral}	SF $_{l}$	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	2 5E 8
															Total	0 0E+0	2 5E 8

Attachment A 23 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 072	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 0E 7
													Total	0 0E+0	3 0E 7

Attachment A-23-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	2 9E 10	6 8E 9
	Ingestion	0 00015	0 00088	5 6E 10	5 8E 9
	Total	0 00015	0 00088	8 4E 10	1 3E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	2 9E 9	1 6E 7
	Ingestion	0	0	1 8E 8	1 8E 7
	Total	0	0	2 1E 8	3 4E 7
Current Trespasser/Site Visitor					
	Dermal	0	0	1 7E 10	1 4E 8
	Ingestion	0	0	7 9E 10	1 1E 8
	Total	0	0	9 6E 10	2 4E 8
Hypothetical Future Resident					
	Dermal	0	0	2 5E 8	5 3E 7
	Ingestion	0	0	3 0E 7	8 2E 7
	Total	0	0	3 3E 7	1 4E 6

Attachment A 24 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 7C Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg day) [1]	Background
Arsenic	mg/kg	6'8	6'8	1/1	6'8	6 8	0'03	NE	NE	13'22
Beryllium[2]	mg/kg	0'39	0 39	1/1	0 39	0 39	0	NE	NE	1 01
Chromium	mg/kg	31	31	1/1	31	31	0	3 0E 03	NTV	25 46
Lead	mg/kg	900	900	1/1	900	900	0	NE	NE	363
Benzo(a)pyrene	mg/kg	0'34	0'34	1/1	0 34	0 34	0'13	NTV	7'3	0'74

Hotspot 7C Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	4'6	6'8	3/3	6'8	5'77	0 03	NE	NE	13'22
Beryllium	mg/kg	0 39	1 1	3/3	1 1	0 76	0	5 0E 03	NTV	1 01
Chromium	mg/kg	31	38	3/3	38	35	0	2 0E 02	NTV	25 46
Lead	mg/kg	8 1	900	3/3	900	307	0	NE	NE	363
Benzo(a)pyrene	mg/kg	0'0 11	0'34	2/3	0'34	0'13	0 13	NTV	7'3	0'74

[2] Present at background level

Lead has no RfD or SF and is evaluated separately

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-24-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	$RfD_{o\ al}$	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	38	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 2E 8
												Total	0 0E+0	3 2E 8

Attachment A-24-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	7 4E 4	NA
Chromium	38	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	6 4E 3	NA
Benzo(a)pyrene	0 34	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 7E 8
										Total	7 1E 3	2 7E 8

Attachment A-24 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{o\ al})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 76	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	35	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)pyrene	0 13	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	8 1E 10
												Total	0 0E+0	8 1E 10

Attachment A-24-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF\ \ )/(BW\ AT\ )$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 76	1E 6	100	30	1	70	42	25550	5 0E 03	NTV	1 5E 4	NA
Chromium	35	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 8E 3	NA
Benzo(a)pyrene	0 13	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 6E 9
										Total	1 9E 3	1 6E 9

Attachment A-24-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	7 4E 7
												Total	0 0E+0	7 4E 7

Attachment A-24-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 0E 2	NA
Benzo(a)pyrene	0 34	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	8 7E 7
										Total	1 0E 2	8 7E 7

Attachment A-24-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil-
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 4E 8
												Total	0 0E+0	1 4E 8

Attachment A-24-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 1E 3	NA
Benzo(a)pyrene	0 34	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	8 7E 8
										Total	5 1E 3	8 7E 8

Attachment A-24-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	6 4E 8
												Total	0 0E+0	6 4E 8

Attachment A-24-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4 9E 4	NA
Benzo(a)pyrene	0 34	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	5 0E 8
										Total	4 9E 4	5 0E 8

Attachment A-24-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	7 8E 10
												Total	0 0E+0	7 8E 10

Attachment A-24-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ra})/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 2E 4	NA
Benzo(a)pyrene	0 34	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	3 7E 9
										Total	1 2E 4	3 7E 9

Attachment A-24 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{ad\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{ch\ ld}\ ED_{child}/BW_{child})+(SA_{ad\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{hild}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
Benzo(a)pyrene	0 34	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 5E 6
															Total	0 0E+0	2 5E 6

Attachment A-24-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 3E 1	NA
Benzo(a)pyrene	0 34	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 9E 6
													Total	1 3E 1	3 9E 6

Attachment A-24 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
$SA_{ch\ ld}$ = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{ad\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{ad\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{hild}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 2E 7
															Total	0 0E+0	1 2E 7

Attachment A-24 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	6 6E 2	NA
Benzo(a)pyrene	0 34	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 6
													Total	6 6E 2	1 4E 6

Attachment A-24-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	8 1E 10	3 2E 8
	Ingestion	0 0019	0 0071	1 6E 9	2 7E 8
	Total	0 0019	0 0071	2 4E 9	6 0E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	1 4E 8	7 4E 7
	Ingestion	0 0051	0 010	8 7E 8	8 7E 7
	Total	0 0051	0 010	1 0E 7	1 6E 6
Current Trespasser/Site Visitor					
	Dermal	0	0	7 8E 10	6 4E 8
	Ingestion	0 00012	0 00049	3 7E 9	5 0E 8
	Total	0 00012	0 00049	4 5E 9	1 1E 7
Hypothetical Future Resident					
	Dermal	0	0	1 2E 7	2 5E 6
	Ingestion	0 066	0 13	1 4E 6	3 9E 6
	Total	0 066	0 13	1 5E 6	6 4E 6

Attachment A 24 19

Excavation Worker Building 7 Hotspot 7C
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgro p fo Le d Adult Lead C mmittee

Versi d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSDi Hom	Using Equation 1 GSDi Het	Using Equation 2 GSDi Hom	Using Equation 2 GSDi H
PbS	X	X	Soil lead tr ti	g/g o ppm	306 7	306 7	306 7	306 7
$R_{etal/matern}$	X	X	F tal/maternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Slop Facto	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	Geom tri tandard d PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baseli PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l ding il de ed d dust)	g/d y	0 100	0 100		
$IR_{S\ D}$		X	T tal ingesti rate f td l and d dust	g/d y			0 100	0 100
W_S		X	W ghti g fact frac f IR_{S+D} gested as td l				1 0	1 0
K_{SD}		X	Mas fracti f soil in d t				0 7	0 7
$AF_{S\ D}$	X	X	Absorpti f acti (same f l and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq cy (am f l and dust)	d ys/y	30	30	30	30
$AT_{S,D}$	X	X	A raging tim (am f il and dust)	d ys/y	365	365	365	365
PbB_{fetal}			PbB f adult work geom tri mean	g/dL	1 7	1 7	1 7	1 7
$PbB_{etal,\ .95}$			95th percentil PbB am ng f tuses f dult work rs	g/dL	5 4	5 4	5 4	5.4
PbB_t			T g t PbB l el f ncern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{fetal} > PbB_t)$			Prob billty th t fetal PbB PbB ass ml g l gn rmal distrib ti	%	0 7%	0 7%	0 7%	0 7%

Eq tio l does t apporti expo ure betwee oil and d st gesti (ex l d W K)
Whe IR IR_{S+} and W 1 0 th eq ti y ld th am $PbB_{f\ al}$

Equatio 1 based Eq 1 2 1 USEPA (1996)

PbB_{ul} =	(PbS BKSF*IR AF EF /AT $_D$) + PbB
$PbB_{tal,\ s}$ =	PbB_{ul} ($GSD_i^{.64}$ R)

Equati 2 alt rn t pproach b ed Eq 1 2 d A 19 1 USEPA (1996)

PbB_{dul} =	PbS BKSF ([(IR_{S+}) AF EF W]+[K_D (IR_D) (1 W_S) AF_D EF])/365+PbB
$PbB_{tal,\ s}$ =	PbB_{adult} ($GSD_i^{.645}$ R)

S urce U.S EPA (1996) R comm d ti ns f th Technical R i w W kg p f Le d
f I terim Approach to Assessi g Risks Associ ted with Ad lt Exposures to Lead i S il

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Excavation Worker Building 7 Hotspot 7C
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA T hnical Re l w W kg p fo L ad Ad lt Lead C mmittee

Version date 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSD1 = Hom	Using Equation 1 GSD1 = Het	Using Equation 2 GSD1 = Hom	Using Equation 2 GSD1 = Het
PbS	X	X	S il l d trati	g/g ppm	306 7	306 7	306 7	306 7
R tal/m ternal	X	X	F tal/m te al PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki ti Sl p F t	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	Ge m tri tandard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas l PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l d g il d ed doo dust)	g/d y	0 330	0 330		
IR_{S+D}		X	T tal gesti rate f id l and doo d t	g/d y			0 330	0 330
W_S		X	W ghti g f t fracti f IR_{S+} gested as id l				1 0	1 0
K_{SD}		X	Mas f ti f il d t				0 7	0 7
$AF_{S D}$	X	X	Ab rpti f ti (m f so l and d t)		0 12	0 12	0 12	0 12
$EF_{S, D}$	X	X	Exp re freq y (am f l and d)	d ys/y	60	60	60	60
$AT_{S, D}$	X	X	A rag g tim (am f l and dust)	d ys/y	365	365	365	365
PbB_{adul}			PbB f ad lt w k geom tri mean	g/dL	2.3	2.3	2.3	2.3
$PbB_{tal, 0.95}$			*95th perce til PbB am ng f tuses f dult work rs*	g/dL	7 6	7 6	7 6	7 6
PbB			Targ t PbB l l f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_t)$			Pr b billty th t f tal PbB PbB assumi g l g rmal distrib ti	%	2.2%	2 2%	2 2%	2 2%

Eq ti l does t app rti po re betwe o l and d st gesti (ex l d W K)
Whe IR IR_{S+} and W 1 0 th eq ti s y ld the am PbB_t

Equati 1, based o Eq 1 2 1 USEPA (1996)

PbB_{dul} =	(PbS BKSF IR $_D$ AF EF_S/AT_D) + PbB
$PbB_{fetal, 5}$ =	$PbB_{ad l}$ $(GSD_i^{645}$ R)

Equati 2 lt rn t pp ch based Eq 1 2 and A 19 1 USEPA (1996)

PbB_{adul} =	PbS BKSF*([(IR_{S+D}) AF EF W]+[K (IR_{S+}) (1 W) AF EF_D])/365+PbB
$PbB_{f tal, 5}$ =	$PbB_{ad lt}$ $(GSD_i^{64}$ R)

S ce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f Le d
f App ach t Assessi g Risks Associ t d with Ad lt Exposures to Le d i S il

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Attachment A-24-21

Site Worker Building 7 Hotspot 7C
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U.S EPA Technical R l w W kgro p f Lead Ad lt Lead C mmitt

Versio date 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSDi Hom	Using Equation 1 GSDi Het	Using Equation 2 GSDi B m	Using Equation 2 GSDi Het
PbS	X	X	S il l d tra	g/g ppm	900 0	900 0	900 0	900 0
$R_{f\ al/matern}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki uc Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d vi ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas li PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l d g l den ed doo d t)	g/d y	0 050	0 050		
IR_{S+D}		X	T tal gesti rate f td l and ind d t	g/d y			0 050	0 050
W_S		X	W ghti g f to fra f IR gested as tdoo so l	--			1 0	1 0
K_{SD}		X	Mass frac of l d t				0 7	0 7
$AF_{S\ D}$	X	X	Absorpti fra ti (am f l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq en y (am f l and dus)	d ys/y	219	219	219	219
$AT_{S,D}$	X	X	A eraging tim (am f l and d t)	d ys/yr	365	365	365	365
PbB^{i}_{adul}	PbB f d lt w k geom tri mean			g/dL	2.8	2 8	2 8	2 8
$PbB^{i}_{f\ tal,0.95}$	95th perce til PbB am ng f tuses f dult w k rs			g/dL	9.2	9.2	9.2	9 2
PbB	Targ t PbB l el f co cern (e.g. 10 g/dL)			g/dL	10 0	10 0	10 0	10 0
$P(PbB^{i}_{etal} > PbB_t)$	Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti			%	3 9%	3 9%	3 9%	3 9%

Eq ti l does t pporti po ure be wee l and dust gesti (l des W K)
Whe IR IR_{S+} and W l 0 th eq ti ns y eld th am PbB_{fetal}

Equati 1 based Eq 1 2 l USEPA (1996)

PbB ul =	(PbS BKSF IR_{S+} AF EF_S/AT) + PbB
PbB etal, s =	PbB_{adult} (GSD 64 R)

Equatio 2 alt rn t pproach b sed Eq 1 2, and A 19 l USEPA (1996)

PbB ul =	PbS BKSF*((((IR_{S+D}) AF EF_S W]+[K_{SD} (IR_{S+}) (1 W) AF EF])/365 PbB
PbB fetal, =	$PbB_{ad lt}$ (GSD 64 R)

S ce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f Le d
f I terim App ch t Assessi g Risks Associ ted with Ad lt Exposures to Lead i S il

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Site Worker Building 7 Hotspot 7C
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re i w Workgro p f Lead Adult Lead C mmittee

V rsi n date 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSDi = Hom	Using Equation 1 GSDi = Het	Using Equation 2 GSDi = Hom	Using Equation 2 GSDi = H t
PbS	X	X	S il lead trati	g/g ppm	900 0	900 0	900 0	900 0
$R_{fetal/matern}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B kineti Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	Geom tri andard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas l PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l d g l d d d dus)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal ges rate f d l and d d	g/d y			0 100	0 100
W_S		X	W ghting facto fracti f IR_{S+D} gested as td l				1 0	1 0
K_{SD}		X	Mass fracti f il i dust				0 7	0 7
$AF_{S,D}$	X	X	Absorpti fracti (sam f l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq y (am f l and dus)	d ys/y	250	250	250	250
$AT_{S,D}$	X	X	A raging tim (am f l and dust)	d ys/yr	365	365	365	365
PbB_{adul}			PbB f ad lt w rk geometri mean	g/dL	4.5	4.5	4 5	4 5
$PbB_{f tal, 0 95}$			95th p ce til PbB am ng f tuses f dult work rs	g/dL	14 6	14 6	14 6	14 6
PbB			Targ t PbB l el f concern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_t)$			Probability that f tal PbB PbB assumi g l gno mal distrib ti	%	12.2%	12.2%	12.2%	12 2%

Eq ti l doe ot app rti pos re betwee il and d t gesti (l d W K_{SD})
When IR IR_{S+} and W l 0 th eq ns y ld th am PbB_f

Equati 1 based Eq 1 2 i USEPA (1996)

PbB_{dult} =	(PbS BKSF IR $_D$ AF $_D$ EF /AT $_D$) + PbB
$PbB_{fetal, 95}$ =	PbB_{adult} (GSD_i^{64} R)

Eq ti 2 alt t pproach b sed o Eq 1 2 and A 19 i USEPA (1996)

PbB_{dul} =	PbS BKSF*([(IR_S) AF_S EF W]+[K_{SD} (IR_{S+D}) (1 W) AF_D EF])/365+PbB
$PbB_{fetal, 5}$ =	PbB_{adult} ($GSD_i^{.645}$ R)

S ce, U S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f L ad
f an App ach to Assessi g Risks Associ ted with Ad lt Expos es to Lead i S il

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Attachment A-24-23

Trespasser Building 7 Hotspot 7C
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgroup f Le d Adult Lead C mmittee

Version dat 05/19/03

Exposure Variable	PbB Equation[1] 1	2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario Using Equation 1 GSD1 Hom	GSD1 Het	Using Equation 2 GSD1 H m	GSD1 H
PbS	X	X	S il lead ce trati	g/g ppm	900 0	900 0	900 0	900 0
$R_{fetal/maternal}$	X	X	F tal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B kin tic Sl pe F t	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri tandard d b PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baseli PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (in l ding il den d d dus)	g/d y	0 050	0 050		
$IR_{S\ D}$		X	T tal gesti rate f tdoo l and ind d t	g/d y			0 050	0 050
W_S		X	W ghtng facto frac f IR_{S+} gested as doo l				1 0	1 0
K_{SD}		X	Mass frac f so l dust	--		--	0 7	0 7
$AF_{S\ D}$	X	X	Absorp fra ti (sam f so l and d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq ency (am f il and d t)	d ys/y	6	6	6	6
$AT_{S,D}$	X	X	A erag g m (am f l and dus)	d ys/y	365	365	365	365
$\widetilde{PbB}_{adul}$	PbB f ad lt w rk geom tri mean			g/dL	1 6	1 6	1 6	1 6
$\widetilde{PbB}_{fetal\ 0.95}$	95th p rcentil PbB among f tuses f dult w rk rs			ug/dL	5 1	5 1	5 1	5 1
PbB	Targ t PbB l el f co cern (e.g., 10 g/dL)			g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > PbB_t)$	Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib ti			%	0 6%	0 6%	0 6%	0 6%

[1] Eq ti l doe t pporti p re betwee l and d t gesti (l des W K)
Wh IR IR and W 1 0 th eq ti yi ld th am PbB_{fetal}

Equati 1 based o Eq 1 2 1 USEPA (1996)

PbB_{adul} =	(PbS BKSF IR_{S+D} AF EF /AT_D) PbB
$PbB_{fetal,\ 95}$ =	PbB_{adult} (GSD_1^{645} R)

Eq ti 2 lt rn t ppro ch based Eq 1, 2 d A 19 l USEPA (1996)

PbB_{adul} =	PbS BKSF ([(IR) AF_S EF_S W_S]+[K_D (IR_{S+D}) (1 W) AF EF_D])/365+PbB
$PbB_{f\ tal,\ 0.95}$ =	PbB_{adult} (GSD_1^{645} R)

S urce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f Le d
f an I terim App ach to Assessi g Risks Associ ted with Ad lt Exposures to Lead i S il

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Trespasser Building 7 Hotspot 7C
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R vi w W kgro p fo Lead Ad lt Lead C mmittee

V rsi d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario Using Equation 1		Using Equation 2	
					GSD = Hom	GSD = Het	GSD = H m	GSD = Het
PbS	X	X	S il i d centrati	g/g ppm	900 0	900 0	900 0	900 0
$R_{tal/maternal}$	X	X	F tal/maternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Sl pe F t	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri andard d ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baseli PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ingesti rate (l d g il de ed doo d)	g/d y	0 100	0 100		
$IR_{S D}$		X	T tal gesti rate f d l and doo d t	g/d y			0 100	0 100
W_S		X	W ght g fact f ti f IR gested as id l				1 0	1 0
K_{SD}		X	Mas f ti f l d				0 7	0 7
$AF_{S D}$	X	X	Absorpti f ti (am f l d d t)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq y (am f l and d t)	d ys/y	12	12	12	12
$AT_{S,D}$	X	X	A rag g tim (am f l and d t)	d ys/y	365	365	365	365
PbB_{adul}	PbB f d lt w k geom tri me			g/dL	1 7	1 7	1 7	1 7
$PbB_{f tal 0.95}$	95th p rce til PbB among f tuses f dult work rs			g/dL	5 4	5 4	5 4	5 4
PbB	Targ t PbB l el f concern (e.g., 10 g/dL)			g/dL	10 0	10 0	10 0	10 0
$P(PbB_{fetal} > PbB_t)$	Pr b bility th t fetal PbB PbB assumi g l gn rmal distrib ti			%	0 87	0 87	0 87	0 87

Eq ti 1 does t pporti po re betwee l and dust gesti (l des W K)
Wh IR IR_{S+} and W 1 0 the eq ti ns y ld th am $PbB_{f al}$

Equatio 1 based o Eq 1 2 i USEPA (1996)

$$PbB_{dul} = (PbS\ BKSF\ IR\ AF_D\ EF_S/AT_D) + PbB$$

$$PbB_{etal,\ 5} = PbB_{adul}\ (GSD_i^{.64}\ R)$$

Equati 2 lt rn t ppro ch b sed Eq 1 2, and A 19 i USEPA (1996)

$$PbB_{dul} = PbS\ BKSF*([(IR_{S+D})\ AF\ EF\ W]+[K\ (IR_{S+D})\ (1\ W)\ AF\ EF_D])/365+PbB$$

$$PbB_{fetal,\ 5} = PbB_{adul}\ (GSD_i^{.645}\ R)$$

S urce U.S EPA (1996) R comm d ti ns f th Technical R vi w W kg p f Le d
f an In App ach to Assessi g Risks Associ ted with Adult Expos res to Lead i S il

Attachment A-24-25

Hotspot 7C
Residential Exposure to Lead
Calculated Blood Lead and Lead Uptakes from IEUBK Model Software
St Louis Army Ammunition Plant
St Louis Missouri

Year	Air (ug/dL)	Diet (ug/dL)	Alternate (ug/dL)	Water (ug/dL)	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
5 1	0 021	2 236	0	0 323	15 608	18 188	**9 6**
1 2	0 034	2 262	0	0 783	24	27 079	**11**
2 3	0 062	2 615	0	0 838	24 705	28 22	**10 3**
3 4	0 067	2 585	0	0 878	25 397	28 926	**9 9**
4 5	0 067	2 636	0	0 965	19 918	23 585	**8 3**
5 6	0 093	2 841	0	1 04	18 32	22 295	**7**
6 7	0 093	3 173	0	1 07	17 5	21 835	**6 3**

Attachment A 25-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot 8A Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{ral} (mg/kg day)	SF_{oral} (mg/kg-day)	Background
Arsenic	mg/kg	6 5	7.9	2/2	7.9	7.2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 3	0.76	2/2	0.76	0 53	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.008	0.21	2/2	0.21	0.11	0 13	NTV	7 3	0 74

Hotspot 8A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{ral} (mg/kg-day)	SF_{ral} (mg/kg day) [1]	Background
Arsenic	mg/kg	6 3	8 4	6/6	8	7 3	0 03	NE	NE	13 22
Beryllium	mg/kg	0 3	0.79	6/6	0.73	0.56	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 009	2	4/6	1 58	0 68	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 008	0 99	4/6	0 61	0 25	0 13	NTV	7 3	0 74
Dibenz(a,h)anthracene [2]	mg/kg	0 036	0 14	3/6	0 098	0 06	0 13	NTV	7 3	0 3

[2] Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-25-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 6	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 8
Benzo(a)pyrene	0 61	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	5 8E 8
Dibenz(a h)anthracene	0 098	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	9 3E 9
												Total	0 0E+0	8 2E 8

Attachment A-25-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF\ )/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	$RfD_{o\ al}$	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 6	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 8
Benzo(a)pyrene	0 61	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	4 9E 8
Dibenz(a h)anthracene	0 098	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	7 9E 9
										Total	0 0E+0	7 0E 8

Attachment A-25-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 68	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	4 3E 10
Benzo(a)pyrene	0 25	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 6E 9
Dibenz(a h)anthracene	0 06	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 8E 10
												Total	0 0E+0	2 4E 9

Attachment A-25-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 68	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	8 3E 10
Benzo(a)pyrene	0 25	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 1E 9
Dibenz(a h)anthracene	0 06	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	7 3E 10
										Total	0 0E+0	4 6E 9

Attachment A-25 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED $SF_{o\ al}$)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 21	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 6E 7
												Total	0 0E+0	4 6E 7

Attachment A-25-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 21	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	5 4E 7
										Total	0 0E+0	5 4E 7

Attachment A-25-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 11	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 3E 9
												Total	0 0E+0	4 3E 9

Attachment A-25-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 11	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 8E 8
										Total	0 0E+0	2 8E 8

Attachment A-25-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 21	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 0E 8
												Total	0 0E+0	4 0E 8

Attachment A-25-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 21	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 1E 8
										Total	0 0E+0	3 1E 8

Attachment A-25-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 11	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 5E 10
												Total	0 0E+0	2 5E 10

Attachment A-25-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_o)/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 11	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 2E 9
										Total	0 0E+0	1 2E 9

Attachment A-25 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{ch\ ld}\ AT_{nc}\ RfD_{\ ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
$SA_{ch\ ld}$ = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{\ d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{\ d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{ad\ lt}$ = Body Weight for an Adult (kg)
$AT_{\ c}$ = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{\ ral}\ ((SA_{child}\ ED_{child}/BW_{ch\ ld})+(SA_{ad\ lt}\ ED_{\ d\ lt}/BW_{\ d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{\ d\ lt}$	EF	$ED_{\ hild}$	$ED_{\ d\ lt}$	$BW_{\ hild}$	$BW_{\ d\ lt}$	AT	AT	RfD	SF	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 21	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 6
															Total	0 0E+0	1 6E 6

Attachment A-25-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 21	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 4E 6
													Total	0 0E+0	2 4E 6

Attachment A-25 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_c	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 11	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	3 8E 8
															Total	0 0E+0	3 8E 8

Attachment A 25-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 11	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	4 6E 7
													Total	0 0E+0	4 6E 7

Attachment A-25-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	2 4E 9	8 2E 8
	Ingestion	0	0	4 6E 9	7 0E 8
	Total	0	0	7 0E 9	1 5E 7
Future Industrial/Commercial Worker					
	Dermal	0	0	4 3E 9	4 6E 7
	Ingestion	0	0	2 8E 8	5 4E 7
	Total	0	0	3 2E 8	1 0E 6
Current Trespasser/Site Visitor					
	Dermal	0	0	2 5E 10	4 0E 8
	Ingestion	0	0	1 2E 9	3 1E 8
	Total	0	0	1 5E 9	7 1E 8
Hypothetical Future Resident					
	Dermal	0	0	3 8E 8	1 6E 6
	Ingestion	0	0	4 6E 7	2 4E 6
	Total	0	0	5 0E 7	4 0E 6

Attachment A 26 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 8B Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg day) [1]	Background
Arsenic*	mg/kg	6.4	6.4	1/1	6.4	6.4	0.03	NE	NE	13.22
Beryllium*	mg/kg	0.53	0.53	1/1	0.53	0.53	0	NE	NE	1.01
Benzo(a)pyrene*	mg/kg	0.18	0.18	1/1	0.18	0.18	0.13	NTV	7.3	0.74

Hotspot 8B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg day) [1]	Background
Arsenic*	mg/kg	5.3	9.2	3/3	9.2	6.97	0.03	NE	NE	13.22
Beryllium*	mg/kg	0.53	0.78	3/3	0.78	0.62	0	NE	NE	1.01
Benzo(a)pyrene*	mg/kg	0.18	0.33	2/3	0.33	0.18	0.13	NTV	7.3	0.74

* Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-26-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 33	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 1E 8
												Total	0 0E+0	3 1E 8

Attachment A-26-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 33	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 7E 8
										Total	0 0E+0	2 7E 8

Attachment A-26-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 1E 9
												Total	0 0E+0	1 1E 9

Attachment A-26-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	2 2E 9
										Total	0 0E+0	2 2E 9

Attachment A-26-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 9E 7
												Total	0 0E+0	3 9E 7

Attachment A-26-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF)/(BW AT)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 6E 7
										Total	0 0E+0	4 6E 7

Attachment A-26-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 2E 9
												Total	0 0E+0	7 2E 9

Attachment A-26-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} $RfD_{o\ al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10 ^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 6E 8
										Total	0 0E+0	4 6E 8

Attachment A-26-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 4E 8
												Total	0 0E+0	3 4E 8

Attachment A-26-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_o)/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 6E 8
										Total	0 0E+0	2 6E 8

Attachment A-26-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 1E 10
												Total	0 0E+0	4 1E 10

Attachment A-26-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 0E 9
										Total	0 0E+0	2 0E 9

Attachment A-26 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
RfD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 3E 6
															Total	0 0E+0	1 3E 6

Attachment A-26-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_c\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_c	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 1E 6
													Total	0 0E+0	2 1E 6

Attachment A-26 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{hild}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
$BW_{ad\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{ch\ ld}\ ED_{child}/BW_{child})+(SA_{d\ lt}\ ED_{ad\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{hild}	$SA_{d\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	$RfD_{\ l}$	$SF_{\ l}$	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	6 2E 8
															Total	0 0E+0	6 2E 8

Attachment A-26 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	7 6E 7
													Total	0 0E+0	7 6E 7

Attachment A-26-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	1 1E 9	3 1E 8
	Ingestion	0	0	2 2E 9	2 7E 8
	Total	0	0	3 4E 9	5 8E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	7 2E 9	3 9E 7
	Ingestion	0	0	4 6E 8	4 6E 7
	Total	0	0	5 3E 8	8 5E 7
Current Trespasser/Site Visitor					
	Dermal	0	0	4 1E 10	3 4E 8
	Ingestion	0	0	2 0E 9	2 6E 8
	Total	0	0	2 4E 9	6 0E 8
Hypothetical Future Resident					
	Dermal	0	0	6 2E 8	1 3E 6
	Ingestion	0	0	7 6E 7	2 1E 6
	Total	0	0	8 2E 7	3 4E 6

Attachment A 27 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot NE Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD $_{ral}$ (mg/kg day)	SF $_{ral}$ (mg/kg day)	Background
Arsenic	mg/kg	2 6	2 60	1/1	2 60	2 60	0 03	NE	NE	13 22
Beryllium	mg/kg	0 23	0 23	1/1	0 23	0 23	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	2 2	2 20	1/1	2 20	2 20	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	1 8	1 8	1/1	1 8	1 8	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	2 5	2 5	1/1	2 5	2 5	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 19	0 19	1/1	0 19	0 19	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	1 1	1 1	1/1	1 1	1 1	0 13	NTV	7 3E 01	0 41

Hotspot NE Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD $_{al}$ (mg/kg day)	SF_{oral} (mg/kg day) [1]	Background
Arsenic	mg/kg	2 1	3 3	3/3	3 3	2 67	0 03	NE	NE	13 22
Beryllium	mg/kg	0 18	0 56	3/3	0 56	0 32	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 019	2 2	2/3	2 2	0 79	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 0080	1 8	2/3	1 8	0 61	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 016	2 5	2/3	2 5	0 85	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 19	0 19	1/3	0 19	0 09	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 0040	1 1	2/3	1 1	0 42	0 13	NTV	7 3E-01	0 41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-27 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c $RfD_{o\ al}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	$RfD_{o\ l}$	SF_{ral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 1E 8
Benzo(a)pyrene	1 8	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 7E 7
Benzo(b)fluoranthene	2 5	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 4E 8
Dibenz(a h)anthracene	0 19	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 8E 8
Indeno(1 2 3 cd)pyrene	1 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 0E 8
												Total	0 0E+0	2 4E 7

Attachment A-27-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_o = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_o)/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

	CS	CF	IR	EF	ED	BW	AT_c	AT	RfD_{oral}	SF_o	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 8E 8
Benzo(a)pyrene	1 8	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 5E 7
Benzo(b)fluoranthene	2 5	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 0E 8
Dibenz(a h)anthracene	0 19	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 5E 8
Indeno(1 2 3 cd)pyrene	1 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	8 9E 9
										Total	0 0E+0	2 1E 7

Attachment A-27 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT	RfD_{oral}	SF_{al}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 79	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	5 1E 10
Benzo(a)pyrene	0 61	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 9E 9
Benzo(b)fluoranthene	0 85	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	5 4E 10
Dibenz(a h)anthracene	0 089	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	5 6E 10
Indeno(1 2 3 cd)pyrene	0 42	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 7E 10
												Total	0 0E+0	5 8E 9

Attachment A-27-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 79	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	9 7E 10
Benzo(a)pyrene	0 61	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	7 5E 9
Benzo(b)fluoranthene	0 85	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 0E 9
Dibenz(a h)anthracene	0 089	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 1E 9
Indeno(1 2 3 cd)pyrene	0 42	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 2E 10
										Total	0 0E+0	1 1E 8

Attachment A-27-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{al})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	4 8E 7
Benzo(a)pyrene	1 8	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 9E 6
Benzo(b)fluoranthene	2 5	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	5 5E 7
Dibenz(a h)anthracene	0 19	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 2E 7
Indeno(1 2 3 cd)pyrene	1 1	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 4E 7
												Total	0 0E+0	5 6E 6

Attachment A-27-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{o\ al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Ave ag ng Time fo Ca c nogens (25 550 da, s)
$SF_{o\ al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	$RfD_{o\ al}$	$SF_{o\ al}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	5 6E 7
Benzo(a)pyrene	1 8	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 6E 6
Benzo(b)fluoranthene	2 5	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	6 4E 7
Dibenz(a h)anthracene	0 19	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 8E 7
Indeno(1 2 3 cd)pyrene	1 1	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 8E 7
										Total	0 0E+0	6 6E 6

Attachment A-27-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	8 8E 9
Benzo(a)pyrene	1 8	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 2E 8
Benzo(b)fluoranthene	2 5	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	9 9E 9
Dibenz(a h)anthracene	0 19	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 6E 9
Indeno(1 2 3 cd)pyrene	1 1	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 4E 9
												Total	0 0E+0	1 0E 7

Attachment A-27-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	5 6E 8
Benzo(a)pyrene	1 8	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 6E 7
Benzo(b)fluoranthene	2 5	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 4E 8
Dibenz(a h)anthracene	0 19	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 8
Indeno(1 2 3 cd)pyrene	1 1	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 8E 8
										Total	0 0E+0	6 6E 7

Attachment A-27-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 2E 8
Benzo(a)pyrene	1 8	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 4E 7
Benzo(b)fluoranthene	2 5	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 7E 8
Dibenz(a h)anthracene	0 19	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 6E 8
Indeno(1 2 3 cd)pyrene	1 1	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 1E 8
												Total	0 0E+0	4 9E 7

Attachment A-27-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 2E 8
Benzo(a)pyrene	1 8	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 6E 7
Benzo(b)fluoranthene	2 5	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 7E 8
Dibenz(a h)anthracene	0 19	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 8E 8
Indeno(1 2 3 cd)pyrene	1 1	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 6E 8
										Total	0 0E+0	3 8E 7

Attachment A-27-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_c	AT_c	RfD_o	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 0E 10
Benzo(a)pyrene	1 8	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 1E 9
Benzo(b)fluoranthene	2 5	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 7E 10
Dibenz(a h)anthracene	0 19	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 4E 10
Indeno(1 2 3 cd)pyrene	1 1	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 5E 10
												Total	0 0E+0	5 9E 9

Attachment A-27-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 4E 9
Benzo(a)pyrene	1 8	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 0E 8
Benzo(b)fluoranthene	2 5	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 8E 9
Dibenz(a h)anthracene	0 19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 1E 9
Indeno(1 2 3 cd)pyrene	1 1	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 2E 9
										Total	0 0E+0	2 8E 8

Attachment A 27 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hld})/(BW_{hld}\ AT_{nc}\ RfD_{i})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
ED_{dult} = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
BW_{dult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{hild}/BW_{hild})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{hild}	ED_{adult}	BW_{hild}	BW_{adult}	AT_{nc}	AT	RfD_{i}	SF_{i}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	1 6E-6
Benzo(a)pyrene	1 8	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 3E 5
Benzo(b)fluoranthene	2 5	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 8E 6
Dibenz(a h)anthracene	0 19	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 6
Indeno(1 2 3-cd)pyrene	1 1	1E-6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	8 1E 7
															Total	0 0E+0	1 9E 5

Attachment A-27-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR_{child} EF ED_{hild})/(BW_{hild} AT RfD $_{al}$)
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
ED_{dult} = Exposure Duration for an Adult (years)
BW_{hild} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1 x10^{-6} kg/mg)
$IR_{ch\,ld}$ = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF EF SF_{oral} ((IR_{child} ED_{hild}/BW_{hild})+($IR_{d\,lt}$ $ED_{ad\,lt}$/$BW_{d\,lt}$)))/(AT)
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF $_{al}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	$IR_{d\,lt}$	EF	ED_{hild}	$ED_{d\,lt}$	BW_{hild}	$BW_{d\,lt}$	AT_{nc}	AT	RfD $_{l}$	SF $_{l}$	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 5E 6
Benzo(a)pyrene	1 8	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 1E 5
Benzo(b)fluoranthene	2 5	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 9E 6
Dibenz(a h)anthracene	0 19	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 2E 6
Indeno(1 2 3 cd)pyrene	1 1	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 3E 6
													Total	0 0E+0	2 9E 5

Attachment A 27 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{hild})/(BW_{hild}\ AT_{nc}\ RfD_{al})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
$SA_{ch\ ld}$ = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{hild} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{child}\ ED_{hild}/BW_{child})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	$SA_{ad\ lt}$	EF	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT_{nc}	AT	$RfD_{\ l}$	SF_{ral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	7 6E 8
Benzo(a)pyrene	1 8	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	6 2E 7
Benzo(b)fluoranthene	2 5	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	8 6E 8
Dibenz(a h)anthracene	0 19	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	6 5E 8
Indeno(1 2 3-cd)pyrene	1 1	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E-01	NA	3 8E 8
															Total	0 0E+0	8 8E 7

Attachment A 27 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 2	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	9 3E 7
Benzo(a)pyrene	1 8	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	7 6E 6
Benzo(b)fluoranthene	2 5	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 6
Dibenz(a h)anthracene	0 19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	8 0E 7
Indeno(1 2 3 cd)pyrene	1 1	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	4 6E 7
													Total	0 0E+0	1 1E 5

Attachment A-27-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	5 8E 9	2 4E 7
	Ingestion	0	0	1 1E 8	2 1E 7
	Total	0	0	1 7E 8	4 5E 7
Future Industrial/Commercial Worker					
	Dermal	0	0	1 0E 7	5 6E 6
	Ingestion	0	0	6 6E 7	6 6E 6
	Total	0	0	7 6E 7	1 2E 5
Current Trespasser/Site Visitor					
	Dermal	0	0	5 9E 9	4 9E 7
	Ingestion	0	0	2 8E 8	3 8E 7
	Total	0	0	3 4E 8	8 6E 7
Hypothetical Future Resident					
	Dermal	0	0	8 8E 7	1 9E 5
	Ingestion	0	0	1 1E 5	2 9E 5
	Total	0	0	1 2E 5	4 8E 5

Attachment A 28 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot RDA Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD oral (mg/kg-day)	SF oral (mg/kg-day) [1]	Background
Arsenic*	mg/kg	4	4	1/1	4	4	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 61	0 61	1/1	0 61	0 61	0	NE	NE	1 01

Hotspot RDA Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD oral (mg/kg day)	SF_{oral} (mg/kg day) [1]	Background
Arsenic*	mg/kg	4	9 4	3/3	9 4	6 67	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 61	0 7	3/3	0 70	0 64	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 091	1 2	3/3	1 2	0 47	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 1	1 1	3/3	1 1	0 44	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 13	1 5	3/3	1 5	0 61	0 13	NTV	7 3E 01	0 63
Dibenz(a,h)anthracene*	mg/kg	0 014	0 16	3/3	0 16	0 06	0 13	NTV	7 3E+00	0 3

*Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-28 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 2	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 1E 8
Benzo(a)pyrene	1 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 0E 7
Benzo(b)fluoranthene	1 5	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 4E 8
Dibenz(a h)anthracene	0 16	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 5E 8
												Total	0 0E+0	1 4E 7

Attachment A-28-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 47	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 8E 10
Benzo(a)pyrene	0 44	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	5 4E 9
Benzo(b)fluoranthene	0 61	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	7 4E 10
Dibenz(a h)anthracene	0 064	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	7 8E 10
										Total	0 0E+0	7 5E 9

Attachment A-28-4
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 2	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	9 7E 9
Benzo(a)pyrene	1 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	8 9E 8
Benzo(b)fluoranthene	1 5	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 2E 8
Dibenz(a h)anthracene	0 16	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 3E 8
										Total	0 0E+0	1 2E 7

Attachment A-28-5
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0 47	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	3 0E 10
Benzo(a)pyrene	0 44	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 8E 9
Benzo(b)fluoranthene	0 61	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	3 9E 10
Dibenz(a h)anthracene	0 064	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	4 1E 10
												Total	0 0E+0	3 9E 9

Attachment A-28-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	3 9E 9	1 4E 7
Ingestion	0	0	7 5E 9	1 2E 7
Total	0	0	1 1E 8	2 7E 7

Attachment A 29 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot RDB Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Antimony		34	34	1/1	34	34	0	4 0E 04	NTV	
Arsenic*	mg/kg	8 6	8 6	1/1	8 6	8 6	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 63	0 63	1/1	0 63	0 63	0	NE	NE	1 01
Benzo(a)pyrene*	mg/kg	0 22	0 22	1/1	0 22	0 22	0 13	NTV	7 3E+00	0 74

Hotspot RDB Combined Surface and Subsurface Soil (0 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
Antimony	mg/kg	3 8	34	3/3	34	14 03	0	4 0E 04	NTV	
Arsenic*	mg/kg	3 6	8 6	3/3	8 6	6 10	0 03	NE	NE	13 22
Beryllium*	mg/kg	0 54	0 63	3/3	0 63	0 58	0	NE	NE	1 01
Benzo(a)pyrene*	mg/kg	0 22	0 22	1/3	0 22	0 09	0 13	NTV	7 3E+00	0 74

* Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-29-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 9	0	3 300	60	1	70	84	25 550	4 0E 04	NTV	0 0E+0	NA
Benzo(a)pyrene	0 22	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	2 1E 8
												Total	0 0E+0	2 1E 8

Attachment A-29-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	330	60	1	70	84	25 550	4 0E 04	NTV	2 9E 1	NA
Benzo(a)pyrene	0 22	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 8E 8
										Total	2 9E 1	1 8E 8

Attachment A-29-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	14	1E 6	0 2	0	2 000	30	1	70	42	25 550	4 0E 04	NTV	0 0E+0	NA
Benzo(a)pyrene	0 094	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	6 0E 10
												Total	0 0E+0	6 0E 10

Attachment A-29-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	14	1E 6	100	30	1	70	42	25 550	4 0E 04	NTV	3 6E 2	NA
Benzo(a)pyrene	0 094	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 2E 9
										Total	3 6E 2	1 2E 9

Attachment A-29-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 04	NTV	0 0E+0	NA
Benzo(a)pyrene	0 22	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 8E 7
												Total	0 0E+0	4 8E 7

Attachment A-29-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	100	250	25	70	9 125	25 550	4 0E 04	NTV	8 3E 2	NA
Benzo(a)pyrene	0 22	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	5 6E 7
										Total	8 3E 2	5 6E 7

Attachment A-29-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	4 0E 04	NTV	0 0E+0	NA
Benzo(a)pyrene	0 22	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	8 8E 9
												Total	0 0E+0	8 8E 9

Attachment A-29-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	50	250	5	70	1 825	25 550	4 0E 04	NTV	4 2E 2	NA
Benzo(a)pyrene	0 22	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	5 6E 8
										Total	4 2E 2	5 6E 8

Attachment A-29-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E 04	NTV	0 0E+0	NA
Benzo(a)pyrene	0 22	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 2E 8
												Total	0 0E+0	4 2E 8

Attachment A-29-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	100	12	30	70	10 950	25 550	4 0E 04	NTV	4 0E 3	NA
Benzo(a)pyrene	0 22	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 2E 8
										Total	4 0E 3	3 2E 8

Attachment A-29-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	4 0E 04	NTV	0 0E+0	NA
Benzo(a)pyrene	0 22	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5 0E 10
												Total	0 0E+0	5 0E 10

Attachment A-29-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $_c$ RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10 ^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	50	6	9	70	3 285	25 550	4 0E 04	NTV	1 0E 3	NA
Benzo(a)pyrene	0 22	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 4E 9
										Total	1 0E 3	2 4E 9

Attachment A-29 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)[1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4 0E 04	NTV	0	NA
Benzo(a)pyrene	0 22	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 6
															Total	0 0E+0	1 6E 6

Attachment A-29 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{hld}\ EF\ ED_{hld})/(BW_{chld}\ AT_{nc}\ RfD_{al})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{chld} = Exposure Duration for a Child (years)
ED_{adlt} = Exposure Duration for an Adult (years)
BW_{chld} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{hild} = Soil Ingestion Rate for a Child (mg/day)
IR_{dlt} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{chld}\ ED_{chld}/BW_{chld})+(IR_{adlt}\ ED_{adlt}/BW_{dlt})))/(AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adlt}	EF	ED_{child}	ED_{dlt}	BW_{child}	BW_{adlt}	AT_c	AT_c	RfD_{ral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	200	100	350	6	24	15	70	2 190	25 550	4 0E 04	NTV	1 1E+0	NA
Benzo(a)pyrene	0 22	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 5E 6
													Total	1 1E+0	2 5E 6

Attachment A-29 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT_{c})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)[1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4 0E 04	NTV	0 0E+0	NA
Benzo(a)pyrene	0 22	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	7 6E 8
															Total	0 0E+0	7 6E 8

Attachment A-29-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{child}\ EF\ ED_{child})/(BW_{child}\ AT\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	100	50	350	6	3	15	70	2 190	25 550	4 0E 04	NTV	5 4E 1	NA
Benzo(a)pyrene	0 22	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	9 3E 7
													Total	5 4E 1	9 3E 7

Attachment A-29-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	6 0E 10	2 1E 8
	Ingestion	0 036	0 29	1 2E 9	1 8E 8
	Total	0 036	0 29	1 7E 9	3 9E 8
Future Industrial/Commercial Worker					
	Dermal	0	0	8 8E 9	4 8E 7
	Ingestion	0 042	0 083	5 6E 8	5 6E 7
	Total	0 042	0 083	6 5E 8	1 0E 6
Current Trespasser/Site Visitor					
	Dermal	0	0	5 0E 10	4 2E 8
	Ingestion	0 0010	0 0040	2 4E 9	3 2E 8
	Total	0 0010	0 0040	2 9E 9	7 4E 8
Hypothetical Future Resident					
	Dermal	0	0	7 6E 8	1 6E 6
	Ingestion	0 54	1 1	9 3E 7	2 5E 6
	Total	0 54	1 1	1 0E 6	4 1E 6

Attachment A 30 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot RDC Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	0 67	4 7	2/2	4 7	2 7	0 03	NE	NE	13 22
Beryllium	mg/kg	0 76	6 7	2/2	6 7	3 7	0	2 0E 03	NTV	1 01
Chromium	mg/kg	31	37	2/2	37	34	0	3 0E 03	NTV	25 46

Hotspot RDC Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg day) [1]	Background
Arsenic	mg/kg	0 67	6 6	6/6	5 9	4 3	0 03	NE	NE	13 22
Beryllium	mg/kg	0 76	6 7	6/6	3 6	2 1	0	5 0E 03	NTV	1 01
Chromium	mg/kg	24	37	6/6	34	30	0	2 0E 02	NTV	25 46

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-30-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	3 6	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	34	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	3 6	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	2 4E 3	NA
Chromium	34	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 7E 3	NA
										Total	8 1E 3	0 0E+0

Attachment A-30-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	2 1	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	30	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	2 1	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	4 2E 4	NA
Chromium	30	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 5E 3	NA
										Total	2 0E 3	0 0E+0

Attachment A-30-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	6 7	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	37	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	6 7	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	3 3E 3	NA
Chromium	37	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 2E 2	NA
										Total	1 5E 2	0 0E+0

Attachment A-30-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	34	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	$SF_{o\ al}$	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	50	250	5	70	1 825	25 550	2 0E 03	NTV	9 1E 4	NA
Chromium	34	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 5E 3	NA
										Total	6 5E 3	0 0E+0

Attachment A-30-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	6 7	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	37	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	6 7	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	1 6E 4	NA
Chromium	37	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	5 8E 4	NA
										Total	7 4E 4	0 0E+0

Attachment A-30-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	34	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{o\ al})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{o\ al}$ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	2 2E 5	NA
Chromium	34	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 3E 4	NA
										Total	1 5E 4	0 0E+0

Attachment A-30 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{oral}\ ((SA_{child}\ ED_{child}/BW_{child})+(SA_{adult}\ ED_{adult}/BW_{adult})))/(AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	6 7	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	0	NA
Chromium	37	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
															Total	0 0E+0	0 0E+0

Attachment A-30 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{hild}\ EF\ ED_{child})/(BW_{hild}\ AT_c\ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{hild} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{child}\ ED_{child}/BW_{child})+(IR_{adult}\ ED_{adult}/BW_{adult})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = *Oral Cancer Slope Factor (mg/kg/day)* [1]

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{hild}	BW_{adult}	AT	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	6 7	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	4 3E 2	NA
Chromium	37	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 6E 1	NA
													Total	2 0E 1	0 0E+0

Attachment A-30 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA_{child}\ EF\ ED_{child})/(BW_{child}\ AT_{nc}\ RfD_{ral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
$SA_{d\ lt}$ = Surface Area of Exposed Skin for an Adult (cm^2/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
$ED_{d\ lt}$ = Exposure Duration for an Adult (years)
$BW_{ch\ ld}$ = Body Weight for a Child (kg)
$BW_{d\ lt}$ = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ EF\ SF_{ral}\ ((SA_{ch\ ld}\ ED_{child}/BW_{child})+(SA_{d\ lt}\ ED_{d\ lt}/BW_{d\ lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA_{hild}	$SA_{d\ lt}$	$EF_{}$	ED_{hild}	$ED_{d\ lt}$	BW_{hild}	$BW_{d\ lt}$	AT	AT	RfD_{ral}	$SF_{}$	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	34	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
															Total	0 0E+0	0 0E+0

Attachment A 30 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR_{hild}\ EF\ ED_{ch\,ld})/(BW_{ch\,ld}\ AT_{nc}\ RfD_{o\,al})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
$ED_{ch\,ld}$ = Exposure Duration for a Child (years)
ED_{dult} = Exposure Duration for an Adult (years)
$BW_{ch\,ld}$ = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
$IR_{ch'ld}$ = Soil Ingestion Rate for a Child (mg/day)
IR_{dult} = Soil Ingestion Rate for an Adult (mg/day)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ EF\ SF_{oral}\ ((IR_{hild}\ ED_{ch\,ld}/BW_{h\,ld})+(IR_{d\,lt}\ ED_{dult}/BW_{d\,lt})))/(AT\ )$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR_{hild}	$IR_{ad\,lt}$	EF	ED_{child}	$ED_{ad\,lt}$	BW_{hild}	$BW_{d\,lt}$	AT_c	AT	$RfD_{\ i}$	$SF_{\ ral}$	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	1 2E 2	NA
Chromium	34	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	7 2E 2	NA
													Total	8 4E 2	0 0E+0

Attachment A-30-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 0020	0 0081	0 0E+0	0 0E+0
	Total	0 0020	0 0081	0 0E+0	0 0E+0
Future Industrial/Commercial Worker					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 0065	0 015	0 0E+0	0 0E+0
	Total	0 0065	0 015	0 0E+0	0 0E+0
Current Trespasser/Site Visitor					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 00015	0 00074	0 0E+0	0 0E+0
	Total	0 00015	0 00074	0 0E+0	0 0E+0
Hypothetical Future Resident					
	Dermal	0	0	0 0E+0	0 0E+0
	Ingestion	0 084	0 20	0 0E+0	0 0E+0
	Total	0 084	0 20	0 0E+0	0 0E+0

Attachment A-31 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot RR Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	4 6	4 6	1/1	4 6	4 6	0 03	NE	NE	13 22
Beryllium	mg/kg	0 6	0 6	1/1	0 6	0 6	0	NE	NE	1 01

Hotspot RR Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg day)	SF_{oral} (mg/kg day) [1]	Background
Arsenic	mg/kg	4 6	8 4	3/3	8 4	5 9	0 03	NE	NE	13 22
Beryllium	mg/kg	0 6	1 3	3/3	1 3	0 87	0	5 0E 03	NTV	1 01
Chromium	mg/kg	23	48	3/3	48	33	0	2 0E 02	NTV	25 46

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-31-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	48	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-31-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	8 8E 4	NA
Chromium	48	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	8 1E 3	NA
										Total	9 0E 3	0 0E+0

Attachment A-31-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Beryllium	0 87	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	33 00	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-31-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT $_c$ RfD$_{oral}$)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^6 kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT$_{nc}$ = Averaging Time for Non Carcinogens (days)
R$_f$D$_{oral}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF $_{ral}$)/(BW AT)

Where CR = Cancer Risk (unitless)
AT$_c$ = Averaging Time for Carcinogens (25 550 days)
SF$_{oral}$ = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT$_{nc}$	AT$_c$	RfD$_{oral}$	SF$_{oral}$	Hazard Index	Cancer Risk
Beryllium	0 87	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	1 8E 4	NA
Chromium	33 00	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 7E 3	NA
										Total	1 9E 3	0 0E+0

Attachment A-31-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	0	0
	Ingestion	0 0019	0 0090	0	0
	Total	0 0019	0 0090	0	0

Attachment A 32 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot SEA Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD $_{ral}$ (mg/kg-day)	SF_{oral} (mg/kg-day)	Background
Arsenic	mg/kg	4.1	4.3	2/2	4.3	4.2	0.03	NE	NE	13.22
Beryllium	mg/kg	0.66	0.73	2/2	0.73	0.70	0	NE	NE	1.01
Benzo(a)anthracene	mg/kg	2 6	2 6	1/2	2 6	1 38	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	2 1	2 1	1/2	2 1	1 07	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	2 5	2 5	1/2	2 5	1 33	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 36	0 36	1/2	0 36	0 20	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	1 4	1 4	1/2	1 4	0 78	0 13	NTV	7 3E-01	0 41

Present at background level
NE Not evaluated quantitatively
NTV No toxicity value

Attachment A-32-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 6	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 5E 8
Benzo(a)pyrene	2 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	2 0E 7
Benzo(b)fluoranthene	2 5	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 4E 8
Dibenz(a h)anthracene	0 36	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 4E 8
Indeno(1 2 3-cd)pyrene	1 4	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 8
												Total	0 0E+0	2 9E 7

Attachment A-32-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_c\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

	CS	CF	IR	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2 6	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 1E 8
Benzo(a)pyrene	2 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 7E 7
Benzo(b)fluoranthene	2 5	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 0E 8
Dibenz(a h)anthracene	0 36	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 9E 8
Indeno(1 2 3 cd)pyrene	1 4	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 1E 8
										Total	0 0E+0	2 5E 7

Attachment A-32 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 38	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 8E 10
Benzo(a)pyrene	1 07	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	6 8E 9
Benzo(b)fluoranthene	1 33	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 5E 10
Dibenz(a h)anthracene	0 20	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 2E 9
Indeno(1 2 3 cd)pyrene	0 78	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	5 0E 10
												Total	0 0E+0	1 0E 8

Attachment A-32-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
R_fD_{al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 38	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 7E 9
Benzo(a)pyrene	1 07	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 3E 8
Benzo(b)fluoranthene	1 33	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 6E 9
Dibenz(a h)anthracene	0 20	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	2 4E 9
Indeno(1 2 3 cd)pyrene	0 78	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	9 6E 10
										Total	0 0E+0	2 0E 8

Attachment A-32-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	1 0E 8	2 9E 7
Ingestion	0	0	2 0E 8	2 5E 7
Total	0	0	3 0E 8	5 5E 7

Attachment A 33 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot SEB Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF_{oral} (mg/kg-day) [1]	Background
Arsenic	mg/kg	6.9	7.3	2/2	7.3	7.1	0.03	NE	NE	13.22
Beryllium	mg/kg	0.58	0.66	2/2	0.66	0.62	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.18	0.18	1/2	0.18	0.18	0.13	NTV	7.3E+00	0.74

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-33-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 7E 8
												Total	0 0E+0	1 7E 8

Attachment A-33-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 5E 8
										Total	0 0E+0	1 5E 8

Attachment A-33-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 1E 9
												Total	0 0E+0	1 1E 9

Attachment A-33-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS\ CF\ IR\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ IR\ EF\ ED\ SF_{oral})/(BW\ AT_c)$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 18	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	2 2E 9
										Total	0 0E+0	2 2E 9

Attachment A-33-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0	0	1 1E 9	1 7E 8
	Ingestion	0	0	2 2E 9	1 5E 8
	Total	0	0	3 4E 9	3 2E 8

Attachment A 34 1
Summary of COPCs Exposure Point Concentrations and Toxicity Values
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Site-Wide Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD ral (mg/kg-day)	SF ral (mg/kg-day)	Background
Dioxin TEQ	mg/kg	4 90E 07	2 00E 04	31/31	5 50E 05	3 40E 05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0049	14	23/189	3 1	1 3	0 14	2 0E 05	2/1	
PCB 1254	mg/kg	0 0065	0 35	17/193	0 35	0 35	0 14	2.0E 05	2/1	
4 4 DDE	mg/kg	0 0006	65	29/41	4 3	1 6	0 03	5 0E-04	3 4E-01	
4 4 DDT	mg/kg	0 0012	1100	30/41	72	27	0 03	5 0E 04	3 4E-01	
Antimony	mg/kg	1 9	34	72/175	8 3	7 8	0	4 0E-04	NTV	
Arsenic	mg/kg	0 67	14	173/173	6 0	5 7	0 03	3 0E-04	1 5E+00	13 22
Beryllium	mg/kg	0 088	6 7	172/172	0 73	0 67	0	2 0E-03	NTV	1 01
Chromium	mg/kg	2	151	172/172	24	23	0	3 0E-03	NTV	25 46
Copper	mg/kg	1 6	126	171/172	39	27	0	4 0E 02	NTV	59 1
Lead	mg/kg	2 1	1790	164/172	68	48	0	NTV	NTV	363
Mercury	mg/kg	0 008	1 5	160/172	0 079	0 06	0	3 0E-04	NTV	0 15
Benzo(a)anthracene	mg/kg	0 002	25	124/156	0 36	0 26	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 002	19	122/156	0 48	0 28	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 003	16	122/156	0 35	0 26	0 13	NTV	7 3E 01	0 63
Benzo(k)fluoranthene	mg/kg	0 002	19	122/154	0 21	0 16	0 13	NTV	7 3E-02	0 46
Dibenz(a h)anthracene	mg/kg	0 002	7 1	69/154	0 16	0 081	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	0 001	11	117/156	0 25	0 19	0 13	NTV	7 3E 01	0 41

Site-Wide Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD_{oral} (mg/kg-day)	SF ral (mg/kg-day) [1]	Background
Dioxin TEQ	mg/kg	4 9E 07	3 0E-04	70/70	3 6E 05	2 3E 05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0049	14	45/549	1 1	0 51	0 14	5 0E-05	2/1	
PCB-1254	mg/kg	0 0065	0 35	18/553	0 35	0 35	0 14	5 0E 05	2/1	
4 4 DDE	mg/kg	0 0006	65	28/67	2 6	1 0	0 03	5 0E-04	3 4E 01	
4 4 DDT	mg/kg	0 0006	1100	54/88	34	13	0 03	5 0E 04	3 4E-01	
Antimony	mg/kg	1 8	34	239/502	7 5	7 3	0	4 0E 04	NTV	
Arsenic	mg/kg	0 67	14	500/500	5 5	5 4	0 03	3 0E 04	1 5E+00	13 22
Beryllium	mg/kg	0 0087	6 7	499/499	0 71	0 67	0	5 0E 03	NTV	1 01
Chromium	mg/kg	2	151	499/499	23	22	0	2 0E 02	NTV	25 46
Copper	mg/kg	1 6	1260	498/499	22	18	0	4 0E-02	NTV	59 1
Lead	mg/kg	2 1	1790	450/499	32	25	0	NTV	NTV	363
Mercury	mg/kg	0 008	1 5	446/500	0 049	0 041	0	3 0E-03	NTV	0 15
Benzo(a)anthracene	mg/kg	0 002	25	251/458	0 32	0 22	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 002	19	241/458	0 21	0 14	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 001	16	249/458	0 27	0 21	0 13	NTV	7 3E 01	0 63
Benzo(k)fluoranthene	mg/kg	0 002	19	252/451	0 23	0 16	0 13	NTV	7 3E 02	0 46
Dibenz(a h)anthracene	mg/kg	0 001	7 1	115/453	0 078	0 052	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	0 001	11	228/455	0 20	0 15	0 13	NTV	7 3E 01	0 41

The RfD for PCB-1254 was used to evaluate PCB 1248
Lead has no RfD or SF and is evaluated separately
IRIS recommends using a slope factor of 2 0 for RME and 1 0 for CTE
NTV No toxicity value

Attachment A 34 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{rfd})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{rfd} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{rfd})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{rfd} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT	RfD_{rfd}	SF_{rfd}	Hazard Index	Cancer Risk
Dioxin TEQ	3 60E-05	1E-6	0 9	0 03	3 300	60	1	70	84	25 550	NTV	1 5E+05	NA	1 6E 8
PCB 1248	1 1	1E-6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	9 3E 2	3 1E 8
PCB 1254	0 35	1E-6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	3 0E 2	9 8E 9
4 4 DDE	2 6	1E-6	0 9	0 03	3 300	60	1	70	84	25 550	5 0E-04	3 4E-01	4 7E 3	2 6E 9
4 4 DDT	34	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	5 0E-04	3 4E 01	6 2E 2	3 5E-8
Antimony	7 5	1E-6	0 9	0	3 300	60	1	70	84	25 550	4 0E 04	NTV	0 0E+0	NA
Arsenic	5 5	1E-6	0 9	0 03	3 300	60	1	70	84	25 550	3 0E-04	1 5E+00	1 7E 2	2 5E 8
Beryllium	0 71	1E-6	0 9	0	3 300	60	1	70	84	25 550	5 0E-03	NTV	0 0E+0	NA
Chromium	23	1E-6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Copper	22	1E-6	0 9	0	3 300	60	1	70	84	25 550	4 0E-02	NTV	0 0E+0	NA
Lead	32	1E-6	0 9	0	3 300	60	1	70	84	25 550	NTV	NTV	NA	NA
Mercury	0 049	1E-6	0 9	0	3 300	60	1	70	84	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	0 32	1E-6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E-01	NA	3 0E 9
Benzo(a)pyrene	0 21	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	2 0E 8
Benzo(b)fluoranthene	0 27	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 6E 9
Benzo(k)fluoranthene	0 23	1E-6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E-02	NA	2 2E 10
Dibenz(a h)anthracene	0 078	1E-6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	7 4E 9
Indeno(1 2 3-cd)pyrene	0 2	1E-6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E-01	NA	1 9E 9
												Total	2 1E 1	1 5E 7

Attachment A 34 3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

	CS	CF	IR	EF	ED	BW	AT_{nc}	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	3 60E 05	1E 6	330	60	1	70	84	25 550	NTV	1 5E+05	NA	6 0E 8
PCB 1248	1 1	1E 6	330	60	1	70	84	25 550	5 0E 05	2 0E+00	7 4E 2	2 4E 8
PCB 1254	0 35	1E 6	330	60	1	70	84	25 550	5 0E 05	2 0E+00	2 4E 2	7 7E 9
4 4 DDE	2 6	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	1 8E 2	9 8E 9
4 4 DDT	34	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	2 3E 1	1 3E 7
Antimony	7 5	1E 6	330	60	1	70	84	25 550	4 0E 04	NTV	6 3E 2	NA
Arsenic	5 5	1E 6	330	60	1	70	84	25 550	3 0E 04	1 5E+00	6 2E 2	9 1E 8
Beryllium	0 71	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	4 8E 4	NA
Chromium	23	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	3 9E 3	NA
Copper	22	1E 6	330	60	1	70	84	25 550	4 0E 02	NTV	1 9E 3	NA
Lead	32	1E 6	330	60	1	70	84	25 550	NTV	NTV	NA	NA
Mercury	0 049	1E 6	330	60	1	70	84	25 550	3 0E 03	NTV	5 5E 5	NA
Benzo(a)anthracene	0 32	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 6E 9
Benzo(a)pyrene	0 21	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 7E 8
Benzo(b)fluoranthene	0 27	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 2E 9
Benzo(k)fluoranthene	0 23	1E 6	330	60	1	70	84	25 550	NTV	7 3E 02	NA	1 9E 10
Dibenz(a h)anthracene	0 078	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	6 3E 9
Indeno(1 2 3 cd)pyrene	0 2	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 6E 9
										Total	4 8E 1	3 5E 7

Attachment A 34 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT	RfD_{al}	SF_{al}	Hazard Index	Cancer Risk
Dioxin TEQ	2 30E-05	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	NTV	1 5E+05	NA	6 9E 10
PCB 1248	0 51	1E-6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E-05	1 0E+00	5 8E 3	4 8E 10
PCB 1254	0 35	1E-6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E-05	1 0E+00	4 0E 3	3 3E 10
4 4 DDE	1	1E-6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E-04	3 4E-01	2 4E 4	6 8E 11
4 4 DDT	13	1E-6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E-04	3 4E-01	3 2E 3	8 9E 10
Antimony	7 3	1E-6	0 2	0	2 000	30	1	70	42	25 550	4 0E-04	NTV	0 0E+0	NA
Arsenic	5 4	1E-6	0 2	0 03	2 000	30	1	70	42	25 550	3 0E-04	1 5E+00	2 2E 3	1 6E 9
Beryllium	0 67	1E-6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	22	1E-6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Copper	18	1E-6	0 2	0	2 000	30	1	70	42	25 550	4 0E-02	NTV	0 0E+0	NA
Lead	25	1E-6	0 2	0	2 000	30	1	70	42	25 550	NTV	NTV	NA	NA
Mercury	0 041	1E-6	0 2	0	2 000	30	1	70	42	25 550	3 0E-03	NTV	0 0E+0	NA
Benzo(a)anthracene	0 22	1E-6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 4E 10
Benzo(a)pyrene	0 14	1E-6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	8 9E 10
Benzo(b)fluoranthene	0 21	1E-6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E-01	NA	1 3E 10
Benzo(k)fluoranthene	0 16	1E-6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E-02	NA	1 0E 11
Dibenz(a h)anthracene	0 052	1E-6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 3E 10
Indeno(1 2 3 cd)pyrene	0 15	1E-6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E-01	NA	9 6E 11
												Total	1 5E 2	5 7E 9

Attachment A 34 5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Dioxin TEQ	2 30E-05	1E 6	100	30	1	70	42	25 550	NTV	1 5E+05	NA	5 8E 9
PCB 1248	0 51	1E 6	100	30	1	70	42	25 550	5 0E 05	0E+00	0E 2	8 6E 10
PCB 1254	0 35	1E 6	100	30	1	70	42	25 550	5 0E 05	1 0E+00	7 1E 3	5 9E 10
4 4 DDE	1	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	2 0E 3	5 7E 10
4 4 DDT	13	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	2 7E 2	7 4E 9
Antimony	7 3	1E 6	100	30	1	70	42	25 550	4 0E 04	NTV	1 9E 2	NA
Arsenic	5 4	1E 6	100	30	1	70	42	25 550	3 0E 04	1 5E+00	1 8E 2	1 4E 8
Beryllium	0 67	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	1 4E 4	NA
Chromium	22	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 1E 3	NA
Copper	18	1E 6	100	30	1	70	42	25 550	4 0E 02	NTV	4 6E 4	NA
Lead	25	1E 6	100	30	1	70	42	25 550	NTV	NTV	NA	NA
Mercury	0 041	1E 6	100	30	1	70	42	25 550	3 0E 03	NTV	1 4E 5	NA
Benzo(a)anthracene	0 22	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 7E 10
Benzo(a)pyrene	0 14	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 7E 9
Benzo(b)fluoranthene	0 21	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 6E 10
Benzo(k)fluoranthene	0 16	1E 6	100	30	1	70	42	25 550	NTV	7 3E 02	NA	2 0E 11
Dibenz(a h)anthracene	0 052	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	6 4E 10
Indeno(1 2 3 cd)pyrene	0 15	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 8E 10
										Total	8 5E 2	3 2E 8

Attachment A 34 6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS\ CF\ AD\ AB\ SA\ EF\ ED)/(BW\ AT_{nc}\ RfD_{oral})$

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS\ CF\ AD\ AB\ SA\ EF\ ED\ SF_{oral})/(BW\ AT)$

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	5 50E-05	1E-6	0 20	0 03	3 300	250	25	70	9 125	25 550	NTV	1 5E+05	NA	5 7E 7
PCB 1248	3 1	1E 6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E-05	2 0E+00	1 4E 1	2 0E-6
PCB 1254	0 35	1E-6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E-05	2 0E+00	1 6E 2	2 3E 7
4 4 DDE	4 3	1E-6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E 04	3 4E-01	1 7E 3	1 0E 7
4 4 DDT	72	1E-6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E 04	3 4E 01	2 8E 2	1 7E 6
Antimony	8 3	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 04	NTV	0 0E+0	NA
Arsenic	6 0	1E-6	0 20	0 03	3 300	250	25	70	9 125	25 550	3 0E 04	1 5E+00	3 9E 3	6 2E 7
Beryllium	0 73	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E-03	NTV	0 0E+0	NA
Chromium	24	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E-03	NTV	0 0E+0	NA
Copper	39	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E-02	NTV	0 0E+0	NA
Lead	68	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	NTV	NTV	NA	NA
Mercury	0 079	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E-04	NTV	0 0E+0	NA
Benzo(a)anthracene	0 36	1E-6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 9E 8
Benzo(a)pyrene	0 48	1E-6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 1E 6
Benzo(b)fluoranthene	0 35	1E-6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 7E 8
Benzo(k)fluoranthene	0 21	1E-6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E-02	NA	4 6E 9
Dibenz(a h)anthracene	0 16	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 5E 7
Indeno(1 2 3-cd)pyrene	0 25	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E-01	NA	5 5E 8
												Total	1 9E 1	6 8E-6

Attachment A 34 7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{rai})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{rai} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{rai})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{rai} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT	RfD_{rai}	SF_{rai}	Hazard Index	Cancer Risk
Dioxin TEQ	5 50E 05	1E-6	100	250	25	70	9 125	25 550	NTV	1 5E+05	NA	2 9E 6
PCB 1248	3 1	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 5E 1	2 2E 6
PCB 1254	0 35	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 7E 2	2 4E 7
4 4 DDE	4 3	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	8 4E 3	5 1E 7
4 4 DDT	72	1E-6	100	250	25	70	9 125	25 550	5 0E-04	3 4E 01	1 4E 1	8 6E 6
Antimony	8 3	1E 6	100	250	25	70	9 125	25 550	4 0E 04	NTV	2 0E 2	NA
Arsenic	6 0	1E 6	100	250	25	70	9 125	25 550	3 0E 04	1 5E+00	2 0E 2	3 1E 6
Beryllium	0 73	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	3 6E 4	NA
Chromium	24	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	7 8E 3	NA
Copper	39	1E 6	100	250	25	70	9 125	25 550	4 0E 02	NTV	9 5E 4	NA
Lead	68	1E 6	100	250	25	70	9 125	25 550	NTV	NTV	NA	NA
Mercury	0 079	1E 6	100	250	25	70	9 125	25 550	3 0E 04	NTV	2 6E 4	NA
Benzo(a)anthracene	0 36	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	9 2E 8
Benzo(a)pyrene	0 48	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 2E 6
Benzo(b)fluoranthene	0 35	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	8 9E 8
Benzo(k)fluoranthene	0 21	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 02	NA	5 4E 9
Dibenz(a h)anthracene	0 16	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 1E 7
Indeno(1 2 3 cd)pyrene	0 25	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	6 4E 8
										Total	3 7E 1	1 9E 5

Attachment A 34 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF*AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x 10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ora})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT	RfD_{al}	SF_{ral}	Hazard Index	Cancer Risk
Dioxin TEQ	3 40E-05	1E-6	0 03	0 03	2 000	250	5	70	1 825	25 550	NTV	1 5E+05	NA	6 4E 9
PCB 1248	1 3	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E-05	1 0E+00	5 3E 3	7 6E 9
PCB 1254	0 35	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E-05	1 0E+00	1 4E 3	2 1E 9
4 4 DDE	1 6	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	5 0E-04	3 4E-01	2 6E 4	3 2E 9
4 4 DDT	27	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	5 0E-04	3 4E-01	4 4E 3	5 4E 8
Antimony	7 8	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	4 0E-04	NTV	1 6E 3	NA
Arsenic	5 7	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	3 0E 04	1 5E+00	1 6E 3	5 0E-8
Beryllium	0 67	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E-03	NTV	2 8E 5	NA
Chromium	23	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	3 0E-03	NTV	6 3E 4	NA
Copper	27	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	4 0E 02	NTV	5 5E 5	NA
Lead	48	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	NTV	NA	NA
Mercury	0 06	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	3 0E 04	NTV	1 6E 5	NA
Benzo(a)anthracene	0 26	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 1E 9
Benzo(a)pyrene	0 28	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 2E 8
Benzo(b)fluoranthene	0 26	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 1E 9
Benzo(k)fluoranthene	0 16	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E-02	NA	6 9E 11
Dibenz(a h)anthracene	0 081	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 5E 9
Indeno(1 2 3-cd)pyrene	0 19	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E-01	NA	8 1E 10
												Total	1 5E 2	1 4E 7

Attachment A 34-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10 ^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
$R_fD_{\ l}$ = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Dioxin TEQ	3 40E-05	1E-6	50	250	5	70	1 825	25 550	NTV	1 5E+05	NA	1 8E 7
PCB 1248	1 3	1E-6	50	250	5	70	1 825	25 550	2 0E 05	1 0E+00	3 2E 2	4 5E 8
PCB 1254	0 35	1E 6	50	250	5	70	1 825	25 550	2 0E-05	1 0E+00	8 6E 3	1 2E 8
4 4 DDE	1 6	1E-6	50	250	5	70	1 825	25 550	5 0E 04	3 4E-01	1 6E 3	1 9E 8
4 4 DDT	27	1E-6	50	250	5	70	1 825	25 550	5 0E-04	3 4E 01	2 6E 2	3 2E 7
Antimony	7 8	1E-6	50	250	5	70	1 825	25 550	4 0E-04	NTV	9 5E 3	NA
Arsenic	5 7	1E-6	50	250	5	70	1 825	25 550	3 0E 04	1 5E+00	9 3E 3	3 0E 7
Beryllium	0 67	1E-6	50	250	5	70	1 825	25 550	2 0E 03	NTV	1 6E 4	NA
Chromium	23	1E-6	50	250	5	70	1 825	25 550	3 0E 03	NTV	3 8E 3	NA
Copper	27	1E-6	50	250	5	70	1 825	25 550	4 0E 02	NTV	3 3E 4	NA
Lead	48	1E-6	50	250	5	70	1 825	25 550	NTV	NTV	NA	NA
Mercury	0 06	1E-6	50	250	5	70	1 825	25 550	3 0E 04	NTV	9 8E 5	NA
Benzo(a)anthracene	0 26	1E-6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 6E 9
Benzo(a)pyrene	0 28	1E-6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 1E 8
Benzo(b)fluoranthene	0 26	1E-6	50	250	5	70	1 825	25 550	NTV	7 3E-01	NA	6 6E 9
Benzo(k)fluoranthene	0 16	1E-6	50	250	5	70	1 825	25 550	NTV	7 3E-02	NA	4 1E 10
Dibenz(a h)anthracene	0 081	1E-6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 1E 8
Indeno(1 2 3-cd)pyrene	0 19	1E-6	50	250	5	70	1 825	25 550	NTV	7 3E-01	NA	4 8E 9
										Total	9 2E 2	9 9E 7

Attachment A 34 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ra})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT	RfD_{al}	SF_{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	5 50E 05	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	NTV	1 5E+05	NA	4 9E 8
PCB 1248	3 1	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2 0E+00	1 0E 2	1 7E 7
PCB 1254	0 35	1E-6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E-05	2 0E+00	1 1E 3	2 0E 8
4 4 DDE	4 3	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E-04	3 4E-01	1 2E-4	8 7E 9
4 4 DDT	72	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E-04	3 4E 01	2 0E 3	1 5E 7
Antimony	8 3	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E-04	NTV	0 0E+0	NA
Arsenic	6 0	1E-6	0 3	0 03	3 300	12	30	70	10 950	25 550	3 0E-04	1 5E+00	2 8E-4	5 4E 8
Beryllium	0 73	1E-6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E-03	NTV	0 0E+0	NA
Chromium	24	1E-6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E-03	NTV	0 0E+0	NA
Copper	39	1E-6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E 02	NTV	0 0E+0	NA
Lead	68	1E-6	0 3	0	3 300	12	30	70	10 950	25 550	NTV	NTV	NA	NA
Mercury	0 079	1E-6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 04	NTV	0 0E+0	NA
Benzo(a)anthracene	0 36	1E-6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E-01	NA	6 8E 9
Benzo(a)pyrene	0 48	1E-6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	9 1E 8
Benzo(b)fluoranthene	0 35	1E-6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E-01	NA	6 6E 9
Benzo(k)fluoranthene	0 21	1E-6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E-02	NA	4 0E 10
Dibenz(a h)anthracene	0 16	1E-6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 0E 8
Indeno(1 2 3-cd)pyrene	0 25	1E-6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E-01	NA	4 7E 9
												Total	1 4E 2	5 9E 7

Attachment A 34 11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{rai})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
R_fD_{rai} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{rai})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{rai} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT	RfD_{rai}	SF_{rai}	Hazard Index	Cancer Risk
Dioxin TEQ	5 50E-05	1E 6	100	12	30	70	10 950	25 550	NTV	1 5E+05	NA	1 7E 7
PCB 1248	3 1	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2 0E+00	7 3E 3	1 2E 7
PCB 1254	0 35	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2 0E+00	8 2E 4	1 4E 8
4 4 DDE	4 3	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	4 0E 4	2 9E 8
4 4 DDT	72	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	6 8E 3	4 9E 7
Antimony	8 3	1E 6	100	12	30	70	10 950	25 550	4 0E 04	NTV	9 7E 4	NA
Arsenic	6 0	1E 6	100	12	30	70	10 950	25 550	3 0E 04	1 5E+00	9 4E 4	1 8E 7
Beryllium	0 73	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	1 7E 5	NA
Chromium	24	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	3 8E 4	NA
Copper	39	1E 6	100	12	30	70	10 950	25 550	4 0E 02	NTV	4 6E 5	NA
Lead	68	1E 6	100	12	30	70	10 950	25 550	NTV	NTV	NA	NA
Mercury	0 079	1E 6	100	12	30	70	10 950	25 550	3 0E 04	NTV	1 2E 5	NA
Benzo(a)anthracene	0 36	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	5 3E 9
Benzo(a)pyrene	0 48	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	7 1E 8
Benzo(b)fluoranthene	0 35	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	5 1E 9
Benzo(k)fluoranthene	0 21	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 02	NA	3 1E 10
Dibenz(a h)anthracene	0 16	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 4E 8
Indeno(1 2 3 cd)pyrene	0 25	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 7E 9
										Total	1 8E 2	1 1E 6

Attachment A 34 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm^2)
AB = Absorbed Fraction (unitless)
SA = Surface Area of Exposed Skin (cm^2/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ra} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT – Averaging Time for Carcinogens (days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT_{nc}	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Dioxin TEQ	3 40E-05	1E-6	0 04	0 03	2 000	6	9	70	3 285	25 550	NTV	1 5E+05	NA	3 7E 10
PCB 1248	1 3	1E-6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1 7E 4	4 4E 10
PCB 1254	0 35	1E 6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	4 6E 5	1 2E 10
4 4 DDE	1 6	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	3 4E 01	1 8E 6	3 9E 11
4 4 DDT	27	1E-6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E-04	3 4E 01	3 0E 5	6 7E 10
Antimony	7 8	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	4 0E-04	NTV	0 0E+0	NA
Arsenic	5 7	1E-6	0 04	0 03	2 000	6	9	70	3 285	25 550	3 0E-04	1 5E+00	1 1E 5	6 2E 10
Beryllium	0 67	1E-6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E-03	NTV	0 0E+0	NA
Chromium	23	1E-6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E-03	NTV	0 0E+0	NA
Copper	27	1E-6	0 04	0	2 000	6	9	70	3 285	25 550	4 0E 02	NTV	0 0E+0	NA
Lead	48	1E-6	0 04	0	2 000	6	9	70	3 285	25 550	NTV	NTV	NA	NA
Mercury	0 06	1E-6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 04	NTV	0 0E+0	NA
Benzo(a)anthracene	0 26	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E-01	NA	6 0E 11
Benzo(a)pyrene	0 28	1E-6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	6 4E 10
Benzo(b)fluoranthene	0 26	1E-6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E-01	NA	6 0E 11
Benzo(k)fluoranthene	0 16	1E-6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E-02	NA	3 7E 12
Dibenz(a h)anthracene	0 081	1E-6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 9E 10
Indeno(1 2 3-cd)pyrene	0 19	1E-6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E-01	NA	4 4E 11
												Total	2 6E 4	3 2E 9

Attachment A 34 13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{ral})

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1 x10^{-6} kg/mg)
IR = Soil Ingestion Rate for an Adult (mg/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration for an Adult (years)
BW = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
R_fD_{ral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ral})/(BW AT)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT	RfD_{ral}	SF_{ral}	Hazard Index	Cancer Risk
Dioxin TEQ	3 40E 05	1E 6	50	6	9	70	3 285	25 550	NTV	1 5E+05	NA	7 7E 9
PCB 1248	1 3	1E-6	50	6	9	70	3 285	25 550	2 0E 05	1 0E+00	6E 4	2 0E 9
PCB 1254	0 35	1E 6	50	6	9	70	3 285	25 550	2 0E 05	1 0E+00	2 1E 4	5 3E 10
4 4 DDE	1 6	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	3 8E 5	8 2E 10
4 4 DDT	27	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	6 3E 4	1 4E 8
Antimony	7 8	1E 6	50	6	9	70	3 285	25 550	4 0E 04	NTV	2 3E 4	NA
Arsenic	5 7	1E 6	50	6	9	70	3 285	25 550	3 0E 04	1 5E+00	2 2E 4	1 3E 8
Beryllium	0 67	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	3 9E 6	NA
Chromium	23	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	9 0E 5	NA
Copper	27	1E 6	50	6	9	70	3 285	25 550	4 0E 02	NTV	7 9E 6	NA
Lead	48	1E 6	50	6	9	70	3 285	25 550	NTV	NTV	NA	NA
Mercury	0 06	1E 6	50	6	9	70	3 285	25 550	3 0E 04	NTV	2 3E 6	NA
Benzo(a)anthracene	0 26	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 9E 10
Benzo(a)pyrene	0 28	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	3 1E 9
Benzo(b)fluoranthene	0 26	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 9E 10
Benzo(k)fluoranthene	0 16	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 02	NA	1 8E 11
Dibenz(a h)anthracene	0 081	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	8 9E 10
Indeno(1 2 3 cd)pyrene	0 19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 1E 10
										Total	2 2E 3	4 3E 8

Attachment A 34 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI (CS CF AD AB SA_{child} EF ED_{child})/(BW_{child} AT_{nc} RfD_{oral})
(haza d estimate assumes child only exposure)

Where HI Hazard Index (unitless)
CS Concentration of Chemical in Soil (mg/kg)
CF Conversion Factor (1 x 10 kg/mg)
AD Adherence Factor for Soil (mg/cm)
AB – Absorbed Fraction (unitless)
SA_{child} Surface Area of Exposed Skin for a Child (cm /day)
SA_{adult} Surface Area of Exposed Skin for an Adult (cm /day)
EF Exposure Frequency (days/year)
ED_{child} – Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} Body Weight for a Child (kg)
BW_{adult} Body Weight for an Adult (kg)
AT_{nc} Averaging Time for Non-Carcinogens (days)
R_fD_{oral} Oral Reference Dose (mg/kg/day)

Equation 2 CR (CS CF AD AB EF*SF_{oral} ((SA_{child} ED_{child}/BW_{child}) (SA_{adult} ED_{adult}/BW_{adult})))/(AT)
(cancer risk assumes child adult exposure)

Where CR Cancer Risk (unitless)
AT = Averag ng Time for Carcinogens (days)
SF_{oral} Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{chi}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{nc}	AT	RfD_{or}	SF_{or}	Hazard Index	Cancer Risk
Dioxin TEQ	5 50E 05	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	1 5E 05	NA	1 9E 6
PCB 1248	3 1	1E 6	0 3	0 14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E 00	0 7961225	6 8E 6
PCB-1254	0 35	1E 6	0 3	0 14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E 00	0 0898848	7 6E 7
4 4 DDE	4 3	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	0 0094654	3 4E 7
4 4 DDT	72	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	5 0E-04	3 4E 01	0 1584907	5 7E 6
Antimony	8 3	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4 0E-04	NTV	0	NA
Arsenic	6 0	1E-6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 04	1 5E 00	0 0220126	2 1E 6
Beryllium	0 73	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	0	NA
Chromium	24	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
Coppe	39	1E-6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4 0E 02	NTV	0	NA
Lead	68	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	NTV	NA	NA
Mercury	0 079	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 04	NTV	0	NA
Benzo(a)anthracene	0 36	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 7E 7
Benzo(a)pyrene	0 48	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 00	NA	3 6E 6
Benzo(b)fluoranthene	0 35	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 6E 7
Benzo(k)fluoranthene	0 21	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 02	NA	1 6E 8
Dibenz(a h)anthracene	0 18	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 00	NA	1 2E 6
Indeno(1,2 3-cd)pyrene	0 25	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 8E 7
															Total	1 1E+0	2 3E 5

Attachment A 34 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI – (CS CF IR_{child} EF ED_{child})/(BW_{child} AT_{nc} RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI – Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} – Exposure Duration for a Child (years)
ED_{adult} Exposure Duration for a Adult (years)
BW_{child} Body Weight for a Child (kg)
BW_{adult} Body Weight fo an Adult (kg)
AT_{nc} – Averaging Time for Non Carcinogens (days)
CF = Con ersion Factor (1 x10^{-6} kg/mg)
IR_{child} So l Ingestion Rate for a Ch ld (mg/day)
IR_{adult} Soil Ingestion Rate fo an Adult (mg/day)
R D $_{ral}$ – Oral Reference Dose (mg/kg/day)

Equation 2 CR (CS CF EF*SF $_{ral}$ ((IR_{child} ED_{child}/BW_{child}) (IR $_{ult}$ ED_{adult}/BW_{adult})))/(AT_c)
(cancer risk assumes child + adult exposure)

Where *CR = Cancer Risk (unitless)*
AT = Averaging Time for Carcinogens (25 550 days)
SF $_{ral}$ = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR $_{h\,ld}$	IR $_d$	EF	ED $_{ld}$	ED $_d$	BW $_{ld}$	BW $_d$	AT	AT	RfD $_{ra}$	SF $_{ral}$	Hazard Index	Cancer Risk
Dioxin TEQ	5 50E 05	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	1 5E+05	NA	1 3E 5
PCB 1248	3 1	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	2 0E 0	9 7E 6
PCB 1254	0 35	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	2 2E 1	1 1E 6
4 4 DDE	4 3	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	1 1E 1	2 3E 6
4 4 DDT	72	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	1 8E 0	3 8E 5
Antimony	8 3	1E 6	200	100	350	6	24	15	70	2 190	25 550	4 0E 04	NTV	2 7E 1	NA
Arsen c	6 0	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 04	1 5E+00	2 6E 1	1 4E 5
Beryllium	0 73	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	4 7E 3	NA
Ch omium	24	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 0E 1	NA
Coppe	39	1E 6	200	100	350	6	24	15	70	2 190	25 550	4 0E 02	NTV	1 2E 2	NA
Lead	68	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	NTV	NA	NA
Mercury	0 079	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 04	NTV	3 4E 3	NA
Benzo(a)anthracene	0 36	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	4 1E 7
Benzo(a)pyrene	0 48	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	5 5E 6
Benzo(b)fluoranthene	0 35	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	4 0E 7
Benzo(k)fluoranthene	0 21	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-02	NA	2 4E 8
Dibenz(a h)anthracene	0 16	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 8E 6
Indeno(1 2 3-cd)pyrene	0 25	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	2 9E 7
													Total	4 8E+0	8 7E 5

Attachment A 34 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI (CS CF*AD AB SA_{child} EF*ED_{child})/(BW_{child} AT_{no} RfD_{oral})
(hazard estimate assumes child only exposure)

Where HI Hazard Index (unitless)
CS Concentration of Chemical in Soil (mg/kg)
CF Conversion Factor (1 x 10 kg/mg)
AD – Adherence Factor for Soil (mg/cm)
AB Absorbed Fraction (unitless)
SA_{child} Surface Area of Exposed Skin for a Child (cm /day)
SA_{adult} Surface Area of Exposed Skin for an Adult (cm /day)
EF Exposure Frequency (days/year)
ED_{child} Exposure Duration for a Ch ld (years)
ED_{adult} Exposure Duration for an Adult (years)
BW_{child} Body We ght for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{no} = Averaging Time for Non-Carcinogens (days)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR (CS CF*AD AB EF SF_{oral} ((SA_{child} ED_{child}/BW_{child}) (SA_{adult} ED_{adult}/BW_{adult})))/(AT)
(cancer risk assumes child + adult exposure)

Where CR – Cancer Risk (unitless)
AT Averaging Time for Carcinogens (days)
SF_{oral} – Oral Cancer Slope Facto (mg/kg/day)

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_{no}	AT	RfD_{oral}	SF_{or}	Hazard Index	Cancer Risk
D oxin TEQ	3 40E 05	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	1 5E 05	NA	5 5E 8
PCB 1248	1 3	1E 6	0 04	0 14	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E 00	3 4E 2	6 6E 8
PCB 1254	0 35	1E 6	0 04	0 14	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E 00	9 0E 3	1 8E 8
4 4 DDE	1 6	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	3 5E 4	5 9E 9
4 4 DDT	27	1E-6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	6 0E 3	1 0E 7
Antimony	7 8	1E-6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4 0E 04	NTV	0 0E 0	NA
Arsenic	5 7	1E 6	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 04	1 5E 00	2 1E 3	9 3E 8
Beryllium	0 67	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	0 0E 0	NA
Chromium	23	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E-03	NTV	0 0E 0	NA
Copper	27	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4 0E 02	NTV	0 0E 0	NA
Lead	48	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	NTV	NA	NA
Mercury	0 06	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 04	NTV	0 0E 0	NA
Benzo(a)anthracene	0 26	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 9E 9
Benzo(a)pyrene	0 28	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 00	NA	9 6E 8
Benzo(b)fluoranthene	0 26	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 9E 9
Benzo(k)fluoranthene	0 16	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 02	NA	5 5E 10
Dibenz(a h)anthracene	0 081	1E-6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 00	NA	2 8E 8
Indeno(1 2 3 cd)pyrene	0 19	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	6 5E 9
															Total	5 1E 2	4 9E 7

Attachment A 34 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI – (CS CF IR_{child} EF ED_{child})/(BW_{child} AT_{nc} RfD $_{ral}$)
(hazard estimate assumes child only exposure)

Where HI Hazard Index (un tless)
CS = Concentration of Chemical in Soil (mg/kg)
EF – Exposure Frequency (days/year)
ED_{child} Exposure Duration for a Child (years)
ED_{adult} Exposure Duration for an Adult (years)
BW_{child} Body Weight for a Child (kg)
BW_{adult} Body We ght for an Adult (kg)
AT_{nc} Averaging Time for Non Carcinogens (days)
CF Conversion Factor (1 x10 kg/mg)
IR_{child} Soil Ingestion Rate for a Child (mg/day)
IR_{adult} So l Ingestion Rate for an Adult (mg/day)
R D $_{ral}$ Oral Refe ence Dose (mg/kg/day)

Equation 2 CR – (CS CF EF*SF $_{ral}$ ((IR_{child} ED_{child}/BW_{child})+(IR_{adult} ED $_{ult}$/BW_{adult})))/(AT_c)
(cancer risk assumes ch ld adult exposure)

Where CR Cancer Risk (unitless)
AT Averaging Time for Carcinogens (25 550 days)
SF_{oral} Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	$IR_{ch\ ld}$	IR	EF	ED $_{hild}$	ED $_{d\ lt}$	$BW_{ch\ ld}$	BW	AT_{nc}	AT	RfD	SF_{ora}	Hazard Index	Cancer Risk
Dioxin TEQ	3 40E 05	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	1 5E+05	NA	2 9E 6
PCB 1248	1 3	1E-6	100	50	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E 00	4 2E 1	7 5E 7
PCB 1254	0 35	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 05	1 0E+00	1 1E 1	2 0E 7
4 4 DDE	1 6	1E 6	100	50	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	2 0E 2	3 1E 7
4 4 DDT	27	1E 6	100	50	350	6	3	15	70	2 190	25 550	5 0E 04	3 4E 01	3 5E 1	5 3E 6
Antimony	7 8	1E-6	100	50	350	6	3	15	70	2 190	25 550	4 0E 04	NTV	1 2E 1	NA
Arsenic	5 7	1E-6	100	50	350	6	3	15	70	2 190	25 550	3 0E 04	1 5E+00	1 2E 1	4 9E 6
Beryll um	0 67	1E-6	100	50	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	2 1E 3	NA
Chromium	23	1E-6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	4 9E 2	NA
Copper	27	1E 6	100	50	350	6	3	15	70	2 190	25 550	4 0E 02	NTV	4 3E 3	NA
Lead	48	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	NTV	NA	NA
Mercury	0 06	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 04	NTV	1 3E 3	NA
Benzo(a)anth acene	0 26	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 7
Benzo(a)py ene	0 28	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 2E 6
Benzo(b)fluoranthene	0 26	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 1E 7
Benzo(k)fluoranthene	0 16	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 02	NA	6 7E 9
Dibenz(a h)anthracene	0 081	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 00	NA	3 4E 7
Indeno(1 2 3-cd)pyrene	0 19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 0E 8
													Total	1 2E 0	1 6E 5

Attachment A-34-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Site-Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

		Hazard Index		Cancer Risk	
		CTE	RME	CTE	RME
Future Excavation/Construction Worker					
	Dermal	0 015	0 21	5 7E 9	1 5E 7
	Ingestion	0 085	0 48	3 2E 8	3 5E 7
	Total	0 10	0 68	3 8E 8	5 0E 7
Future Industrial/Commercial Worker					
	Dermal	0 015	0 19	1 4E 7	6 8E 6
	Ingestion	0 09	0 37	9 9E 7	1 9E 5
	Total	0 11	0 56	1 1E 6	2 6E 5
Current Trespasser/Site Visitor					
	Dermal	0 00026	0 014	3 2E 9	5 9E 7
	Ingestion	0 0022	0 018	4 3E 8	1 1E 6
	Total	0 0025	0 031	4 6E 8	1 7E 6
Hypothetical Future Resident					
	Dermal	0 051	1 1	4 9E 7	2 3E 5
	Ingestion	1 2	4 8	1 6E 5	8 7E 5
	Total	1 2	5 9	1 7E 5	1 1E 4

Attachment A 34-19

Excavation Worker Site-wide
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R view W kgro p f Lead Adult Lead C mmittee

V rsi d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSD1 Hom	Using Equation 1 GSD1 H t	Using Equation 2 GSD1 H m	Using Equation 2 GSD1 Hat
PbS	X	X	S il lead ce tr	g/g ppm	24 6	24 6	24 6	24 6
$R_{etal/maternal}$	X	X	F tal/m ternal PbB ratu	–	0 9	0 9	0 9	0 9
BKSF	X	X	B kine Sl pe Fact	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d PbB	--	2 18	2 18	2 18	2 18
PbB_0	X	X	Baselin PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il inges rate (l d g l d d ind dus)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal gestu rate f d l and d d	g/d y			0 100	0 100
W_S		X	W ghung fact fractu f IR_S ingested as idoo so l				1 0	1 0
K_{SD}		X	Mass fractu f so l dust	--			0 7	0 7
$AF_{S,D}$	X	X	Abs rptu fractu (same f il and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp sure freq ency (am f l and dus)	d ys/y	30	30	30	30
$AT_{S,D}$	X	X	A erag g tim (am f il and dust)	d ys/yr	365	365	365	365
PbB_{adul}			PbB f adult w rk geom tri mean	g/dL	1.5	1 5	1 5	1.5
$PbB_{f tal 0.95}$			95th percentil PbB among f tuses f dult workers	g/dL	5 0	5 0	5 0	5 0
PbB			T g t PbB l el f co cern (e.g 10 ug/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_0)$			Pr b bility th t f tal PbB PbB assumi g l gn rmal distrib tl	%	0 6%	0 6%	0 6%	0 6%

Eq tu l does t pportu expos re betwee l and d t gestu (l des W K)
Wh IR IR_{S+} and W 1 0 th eq tu y eld th am PbB_{total}

Equati 1 based o Eq 1 2 i USEPA (1996)

PbB_{ul} =	(PbS BKSF IR_{S+D} AF EF /AT) + PbB
$PbB_{tal, 5}$ =	PbB_{adult} $(GSD_1^{64}$ R)

Eq tl 2 lt rn t ppro ch b sed o Eq 1 2 d A 19 i USEPA (1996)

PbB_{adul} =	PbS BKSF ([(IR_{S+D}) AF EF W]+[K (IR_{S+D}) (1 W) AF EF_D])/365 PbB
$PbB_{fetal, 5}$ =	PbB_{adult} $(GSD_1^{645}$ R)

S urce U.S EPA (1996) Recomm d ti ns f th Technical R i w W kgr p f Le d
f an I terim App oach to Assessi g Risks Associ ted with Ad lt Exposures to Lead i S it

Attachment A-34 20

Excavation Worker Site-wide
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re i w W rkgro p fo Le d Adult Lead C mmittee

V rsio d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSDi = Hom	Using Equation 1 GSDi = Het	Using Equation 2 GSDi = Hom	Using Equation 2 GSDi = Het
PbS	X	X	S il lead ce trati	g/g ppm	24 6	24 6	24 6	24 6
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B okineti Sl pe Facto	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	Geom tri tandard d vi ti PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Bas lin PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (in l d g l de ed dpo dus)	g/d y	0 330	0 330		
IR_{S+D}		X	T tal gesti rate f td l and d dust	g/day			0 330	0 330
W_S		X	W ghtung facto f acti f IR_{S+} gested as tdoo so l				1 0	1 0
K_{SD}		X	Mas f acti f l d t				0 7	0 7
$AF_{S,D}$	X	X	Abs rpti f ti (am f l and d)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp re freq y (am f l and d t)	d ys/y	60	60	60	60
$AT_{S,D}$	X	X	A ragi g tim (am f so l and d t)	d ys/yr	365	365	365	365
PbB_{adult}			PbB f ad lt w rk geom tri mean	g/dL	**1 6**	**1 6**	**1 6**	**1 6**
$PbB_{fetal,0.95}$			95th p rce til PbB am ng f tuses of adult work rs	ug/dL	**5.2**	**5.2**	**5.2**	**5.2**
PbB_t			T g t PbB l el f concern (e.g 10 ug/dL)	ug/dL	**10 0**	**10 0**	**10 0**	**10 0**
$P(PbB_{fetal} > PbB_t)$			Pr b bility th t f tal PbB PbB assumi g l gnormal distrib ti	%	**0 6%**	**0 6%**	**0 6%**	**0 6%**

Eq ti l does t pp rti pos re betwee l and d t g ti (ex l des W K)
Whe IR IR d W l 0 th eq ti y ld th am $PbB_{f\ 0.9}$

Equati 1 based Eq 1 2 l USEPA (1996)

$$PbB_{adul} = (PbS\ BKSF\ IR_{S+}\ AF\ EF\ /AT\ ) + PbB$$

$$PbB_{tal,} = PbB_{adult}\ (GSD_i^{.64}\ R)$$

Equati 2 lternat appro ch based Eq 1 2, and A 19 l USEPA (1996)

$$PbB_{adul} = PbS\ BKSF*([(IR_{S+}\ )\ AF\ EF\ W\ ]+[K\ (IR_{S+D})\ (1\ W\ )\ AF\ EF_D])/365+PbB$$

$$PbB_{fetal,\ 95} = PbB_{adul}\ (GSD_i^{.645}\ R)$$

S urce U.S EPA (1996) Recomm dati ns f th Technical R i w W kgr p f Le d f an m App oach t Assessi g Risks Associ ted with Ad lt Exposures to Lead l S il

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Attachment A-34-21

Site Worker Site Wide
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical Re i w Wo kgroup for Lead Ad lt Lead C mmittee

V rsi d t 05/19/03

Exposure Variable	PbB Equation[1] 1	2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario Using Equation 1 GSD1 = Hom	GSD1 = H 1	Using Equation 2 GSD1 = H m	GSD1 = Het
PbS	X	X	Soil lead ce tra	g/g ppm	48 1	48 1	48 1	48 1
$R_{tal/maternal}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B kı ti Sl pe Facto	g/dL p g/d y	0 4	0 4	0 4	0 4
GSD	X	X	G m tri tandard d vi PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il ges rate (l d g l d ed indoo dust)	g/d y	0 050	0 050		
IR_S		X	T tal gestı rate f tdoo l and d d	g/d y			0 050	0 050
W_S		X	W ghting fact fractı f IR_{S+D} ingested as id l				1 0	1 0
K_{SD}		X	Mas frac f soil in dust	--	--		0 7	0 7
$AF_{S,D}$	X	X	Absorp fractı (sam f soil and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Exp ure freque y (am f il and dust)	d ys/yr	219	219	219	219
$AT_{S,D}$	X	X	A raging m (am f il and dus)	days/yr	365	365	365	365
PbB_{dul}			PbB f ad lt w k geom tri me	g/dL	1 6	1 6	1 6	1 6
$PbB_{total, 0.95}$			95th perce til PbB am ng f tuses f adult workers	g/dL	5.2	5 2	5 2	5 2
PbB			Targ t PbB l el f co cern (e.g 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f\ tal} > PbB_t)$			Pr b bility th t f tal PbB PbB assuming l gnormal distrib ti	%	0 6%	0 6%	0 6%	0 6%

[1] Eq ti l does t app rtı exp re betwee l and dust ingestı (ex l d s W K)
Wh IR IR_{S+} and W 1 0 th eq ti ns y ld th am PbB_{total}

Equati 1 bas d Eq 1 2 i USEPA (1996)

PbB_{dul} =	(PbS BKSF IR $_D$ AF EF$_S$/AT) PbB
$PbB_{tn,\ s}$ =	$PbB_{ad\ lt}$ $(GSD_1^{64}$ R)

Equati 2, lt rn t ppro h bas d Eq 1 2 and A 19 i USEPA (1996)

PbB_{ul} =	PbS BKSF*(((IR $_D$) AF EF W] [K (IR$_{S+D}$) (1 W) AF EF])/365+PbB
$PbB_{tal,\ .95}$ =	PbB_{adult} $(GSD_1^{645}$ R)

S ce U.S EPA (1996) R comme d ti ns f th Technical R vi w W kgr p f Lead
f an Interim App ch t Assessi g Risks Associ ted with Ad lt Exposu es to Lead i S il

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Site Worker Site-Wide
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U S EPA Technical R i w W kgro p f Le d Adult Lead Committee

Ve si d te 05/19/03

Exposure Variable	PbB Equation 1	PbB Equation 2	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario Using Equation 1 GSD1 = Hom	Using Equation 1 GSD1 = Het	Using Equation 2 GSD1 = Hom	Using Equation 2 GSD1 = Het
PbS	X	X	S il lead centrati	g/g ppm	48 1	48 1	48 1	48 1
$R_{f\ tal/maternal}$	X	X	F tal/m ternal PbB ra		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Sl pe Facto	g/dL p g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geometri tandard d u PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baselin PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gestu rate (l d g l d ed doo dust)	g/day	0 100	0 100		
$IR_{S\ D}$		X	T tal gestu rate f tdoo l and d dust	g/d y			0 100	0 100
W_S		X	W ghtu g facto frac f $IR_{S,}$ gested as id l				1 0	1 0
K_{SD}		X	Mass f actu f so l dust				0 7	0 7
$AF_{S\ D}$	X	X	Ab rpu fracti (sam f l and dust)		0 12	0 12	0 12	0 12
$EF_{S,}$	X	X	Exp re freq y (am f l and dust)	d ys/y	250	250	250	250
$AT_{S,D}$	X	X	A raging tim (sam f so l and dust)	d ys/y	365	365	365	365
PbB_{adult}			PbB f ad lt w rk geometri mean	g/dL	1 7	1 7	1 7	1 7
$PbB_{fetal,\ 0.95}$			95th percentil PbB am ng f tuses f ad lt w rkers	g/dL	5.5	5.5	5 5	5.5
PbB			T g t PbB le el f co cern (g, 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{fetal} > PbB_t)$			Prob bility th t fetal PbB PbB assuming logn rmal distrib tio	%	0 8%	0 8%	0.8%	0 8%

[1] Eq ti l does ot app rti posure betwee l and dust ingestio (ex l des W K)
When IR IR$_{S,}$ and W 1 0 th eq tions y eld th am $PbB_{f\ 0.9}$

Equation 1 based on Eq 1 2 in USEPA (1996)

PbB_{adul} =	(PbS BKSF IR_{S+D} AF EF_S/AT $_D$) + PbB
$PbB_{etal,\ 5}$ =	PbB_{adu} ($GSD_1^{.64}$ R)

Equati 2 lt rnate pp ach based Eq 1 2, and A 19 1 USEPA (1996)

PbB_{adult} =	PbS BKSF*([(IR_{S+D}) AF EF_S W]+[K (IR_{S+D}) (1 W) AF_D EF])/365 PbB
$PbB_{fetal,\ 5}$ =	PbB_{adult} ($GSD_1^{.645}$ R)

S urce U.S EPA (1996) R mm d ti ns f th Technical R vi w W kg p f Le d
f an n App ch to Assessi g Risks Associ ted with Ad lt Exposure to Le d l S il

Attachment A 34 23

Site wide Trespasser
Central Tendency Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U.S EPA Technical Re i w W kgro p f L ad Adult Le d C mmitt

V rsi d te 05/19/03

Exposure Variable	PbB Equation[1] 1	PbB Equation[1] 2	Description of Exposure Variable	Units	Values for Non Residential Exposure Scenario: Using Equation 1 GSD$_i$ = Hom	Using Equation 1 GSD$_i$ = Het	Using Equation 2 GSD$_i$ = Hom	Using Equation 2 GSD$_i$ = Het
PbS	X	X	S il lead centr tu	g/g ppm	48 1	48 1	48 1	48 1
$R_{f tal/maternal}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki tu Sl pe F to	g/dL pe g/d y	0 4	0 4	0 4	0 4
GSD_i	X	X	G m tri tandard d tu PbB		2 18	2 18	2 18	2 18
PbB	X	X	Basel PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il inges rate (in l di g l den ed indoo dust)	g/d y	0 050	0 050		
IR_{S+D}		X	T tal ges rate f td l and indoo dus	g/d y			0 050	0 050
W_S		X	W ghti g f t frac f IR_{S+D} gested as d l				1 0	1 0
K_{SD}		X	Mas fracti f so l d st				0 7	0 7
$AF_{S D}$	X	X	Absorpti fracti (sam f so l and dus)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo re freq en y (am f l and dus)	d ys/y	6	6	6	6
$AT_{S,D}$	X	X	A raging um (am f l and dus)	d ys/y	365	365	365	365
PbB_{adult}	PbB f ad lt w rk geometri mean			g/dL	1.5	1 5	1.5	1 5
$PbB_{f tal 0.95}$	95th p rce tl PbB am ng f tuses f dult w rk rs			g/dL	5 0	5 0	5 0	5 0
PbB	T g t PbB l el f co cern (e.g. 10 g/dL)			g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_t)$	P b bility th t f tal PbB PbB assumi g l gn rmal distrib ti			%	0 6%	0 6%	0 6%	0 6%

[1] Eq l doe t pporti po re betwee l and dusi gesti (l des W K)
Wh IR IR and W l 0 th eq ti y ld th am PbB_{fetal}

Equati 1 bas d Eq 1 2 l USEPA (1996)

PbB ul =	(PbS BKSF IR AF EF /AT) + PbB
$PbB_{fetal,95}$ =	PbB_{adult} ($GSD_i^{.64}$ R)

Equ ti 2, alt rn t ppro h b d Eq 1 2, and A 19 in USEPA (1996)

PbB ul =	PbS BKSF*([(IR) AF EF W]+[K_D (IR_{S+}) (1 W) AF_D EF])/365+PbB
$PbB_{fetal,95}$ =	PbB_{adult} ($GSD_i^{.64}$ R)

S urce U.S EPA (1996) R commend ti ns f th Technical R vi w W rkg p f Lead
f an I terim App ch to Assessi g Risks Associ ted with Ad lt Exposures to Le d I S il

Attachment A-34 24

Site-wide Trespasser
Reasonable Maximum Exposure
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Calculations of Blood Lead Concentrations (PbBs)

U.S EPA Technical Re i w Workgro p f Lead Adult Lead Committe

V rsi d te 05/19/03

Exposure Variable	PbB Equation 1*	PbB Equation 2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1 GSD1 = Hom	Using Equation 1 GSD1 = Het	Using Equation 2 GSD1 = Hom	Using Equation 2 GSD1 = Het
PbS	X	X	S il lead trati	g/g ppm	48 1	48 1	48 1	48 1
$R_{etal/mat rnal}$	X	X	Fetal/m ternal PbB rati		0 9	0 9	0 9	0 9
BKSF	X	X	B ki u Sl pe Fact	g/dL per g/d y	0 4	0 4	0 4	0 4
GSD	X	X	Geom tri tandard d vi PbB		2 18	2 18	2 18	2 18
PbB_0	X	X	Baselin PbB	g/dL	1 53	1 53	1 53	1 53
IR_S	X		S il gesti rate (l d g l derived i doo d t)	g/d y	0 100	0 100		
IR_{S+D}		X	T tal gesti rate f tdoo l and d dust	g/d y			0 100	0 100
W_S		X	W gh g f to frac f IR_{S+D} gested as td l				1 0	1 0
K_{SD}		X	Mass fracti f il dust				0 7	0 7
$AF_{S,D}$	X	X	Ab rpti frac (same f l and dust)		0 12	0 12	0 12	0 12
$EF_{S,D}$	X	X	Expo re freq cy (am f l and dust)	d ys/yr	12	12	12	12
$AT_{S,D}$	X	X	A rag g tim (am f l and dust)	d ys/y	365	365	365	365
PbB_{dul}			PbB f adult w rk geom tri mean	g/dL	1.5	1 5	1 5	1.5
$PbB_{f tal 0 5}$			95th p rce til PbB am ng f tuses f dult w kers	g/dL	5 0	5 0	5 0	5 0
PbB_{c}			T rg t PbB l l f conce (e.g., 10 g/dL)	g/dL	10 0	10 0	10 0	10 0
$P(PbB_{f tal} > PbB_t)$			Prob bility th t f tal PbB PbB ass mi g l gn rmal distrib ti	%	0 6%	0 6%	0 6%	0 6%

Eq ti l does t pporti pos re betwee s l and d t g ti (l des W K_S)
When IR IR and W 1 0 th eq ati ns y ld th m PbB_{fetal}

Equati 1 based Eq 1 2 in USEPA (1996)

PbB_{dul} =	(PbS BKSF IR_{S+} AF $_D$ EF_S/AT) + PbB
$PbB_{fetal, 5}$ =	PbB_{adult} $(GSD_1^{.645}$ R)

Eq ati 2 alt rn t ppro ch b sed Eq 1 2 nd A 19 1 USEPA (1996)

PbB_{dul} =	PbS BKSF*([(IR $_D$) AF EF W]+[K (IR_S $_D$) (1 W_S) AF_D EF])/365+PbB
$PbB_{f tal, 0 95}$ =	$PbB_{adu l}$ $(GSD_1^{.645}$ R)

S urce U.S EPA (1996) Recomm nd ti ns f th Technical R view W kgr p f Lead
f n m App ach t Assessing Risks Associ ted with Ad lt Exposures to Lead i S il

Pri ted 03/15/2004 4 06 PM

Attachment A-34-25

Site Wide
Residential Exposure to Lead
Calculated Blood Lead and Lead Uptakes from IEUBK Model Software
St Louis Army Ammunition Plant
St Louis Missouri

Year	Air (ug/dL)	Diet (ug/dL)	Alternate (ug/dL)	Water (ug/dL)	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
5 1	0 021	2 638	0	0 382	1 111	4 152	**2 3**
1 2	0 034	2 755	0	0 953	1 763	5 506	**2 3**
2 3	0 062	3 107	0	0 996	1 771	5 935	**2 2**
3 4	0 067	3 007	0	1 022	1 783	5 878	**2 1**
4 5	0 067	2 919	0	1 069	1 331	5 385	**1 8**
5 6	0 093	3 088	0	1 13	1 201	5 512	**1 7**
6 7	0 093	3 413	0	1 151	1 135	5 792	**1 6**

Atta hment A 35-1
Johns n Ettl g R lt for Site Wld Soil (w/ B m nt)
St Louis Army Ammunition Plant
St Lo is Mi u l
D t Entry Sh t T ichloroethan

SL ADV
Version 3 0 02/03

Res t to
D fa lts

CALCULATE RISK-BASED SO L CONCENTRATION (enter "X" i "YES" bo)

YES [ ]

OR

CALCULATE NCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (ter "X" i ES" bo and initial soil onc below)

YES [X]

ENTER Chemical CAS N (numbers only no dashes)	ENTER Initi l soil onc C_s (µg/kg)	Chem al
71666	1 10E+01	1,1,1 Trichlo than

MORE ↓

ENTER Averag oil mper tur T (°C)	ENTER Depth below gr de bott m f nclosed spa floor L_f (m)	ENTER Depth below gr d t top f con mina or L_t (m)	ENTER Depth below gr d t bott m f con amination L_b (ter alue of 0 if al is unknown)	ENTER T must dd up value L (G28) Thi kness f soil tum A, h (m)	ENTER Thi kness f soil tr tum B, h_B (En er va ue or 0) (m)	ENTER Thi kn f soil tum C h_C (En er value or 0) (m)	ENTER Soil tum A SCS oil type (us d m or po p rm b ty)	OR	ENTER U er-d fined tum oil vapo perm bl ty k_v (m²)
13.89	200	200	272.5	200	0	0	SIC		

MORE ↓

ENTER Str tum A SCS soil type (ocup Soil Parameters)	ENTER Str tum A soil dry bulk density (g/ m³)	ENTER Str tum A soil tal por sity n^A (unitl)	ENTER Str tum A oil w er fil d por sity θ_w (m / m³)	ENTER Str tum A soil organi arbon fr ti n. (unitless)	ENTER Str tum B SCS soil type (ocup Soil Parameters)	ENTER Str tum B oil dry bulk density ρ_b (g/ m³)	ENTER Str tum B oil tal por sity (uni ss)	ENTER S tum B oil w er fill d por sity θ_w (m / m³)	ENTER S tum B oil organi arbon fr ti n. (uni ss)	ENTER S tum C SCS soil type (ocup Soil Pa meters)	ENTER Str tum C oil dry bulk density ρ_b (g/ m³)	ENTER Str tum C soil to al por sity (unitl ss)	ENTER S tum C il w t fil d por sity θ_w (m / m³)	ENTER Str tum C soil organi arbon fr tion. (uni ess)
SIC	1.38	0 81	0216	0 002	S	1.66	0 375	0 05	0 002	S	1.66	0 376	0 05	0 002

MORE ↓

ENTER Enclosed spa floor thi kness. L_{crack} (m)	ENTER Soil-bldg pressur differential, ΔP (g/ m ²)	ENTER Enclosed space floor length. L_B (m)	ENTER Encl sed spa floor width. W (m)	ENTER Encl sed spa height. H (m)	ENTER R or-wall eam cr k width. w (m)	ENTER Indoor air chang at ER (1/h)	ENTER Ave ag vapor flow int bldg OR L ve bl k calcul t Q_{soil} (L/m)
10	40	1000	1000	366	0 1	0.25	5

ENTER Averaging time for arcinogens, AT (yrs)	ENTER Averaging time for noncarcinogen AT_{NC} (yrs)	ENTER Exposur dur tion. ED (yrs)	ENTER Exposur frequency EF (days/yr)	ENTER T ge ri k for arcinogens, TR (unitless)	ENTER T ge haza d qu ti for nonc inogens, THQ (unitless)
70	30	30	350	1.0E 06	1

Used t tcul te ri k-based soil oncentr tion

END

Attachment A 35 1
Johnson Ettinger Results for Site Wide Soils (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet 1 1 1 Trichloroethane

RISK BASED SOIL CONCENTRATION CALCULATIONS

1 1 1 Trichloroethane
1 10E+01 (µg/kg)

Indoor exposure soil conc carcinogen (µg/kg)	Indoor exposure soil conc noncarcinogen (µg/kg)	Risk based indoor exposure soil conc (µg/kg)	Soil saturation conc C_{sat} (µg/kg)	Final indoor exposure soil conc (µg/kg)
NA	NA	NA	6 14E+05	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
NA	3 6E-05

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

END

Attachment A 35-2
Johnson Ettinger Results for Site-Wide Groundwater (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
D ta E try Sh t 1 1 Dichl ro thyl

GW ADV
Version 3 0 02/03

Reset to Defaults

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" b x)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" i "YES box and nitial groundw t on belo

YES [X]

ENTER Chemi al CAS No (numb only dashes)	ENTER Initial groundw ter con C_w (µg/L)	Chemical
75354	3.40E+01	1,1 Dichloroethylene

MORE ↓

ENTER A g soil/ gr undw ter t mperature, T (°C)	ENTER Depth bei w gr d t bottom f enclosed spac floor L_f (cm)	ENTER Depth below grad t water tabl L_{wt} (cm)	ENTER T tals must dd p t atu f L_{wt} (cell G28) Th ckness f oil tr turn A, h (cm)	ENTER Thickness f oil tr turn B (E ter atu or 0) h_B (cm)	ENTER Thickness f oil tr turn C (E ter valu or 0) h_C (cm)	ENTER Soil tr turn directly ab w ter tabl (E ter A, B or C)	ENTER SCS soil typ directly abo e w ter tabl	ENTER Soil tr turn A SCS soil typ (ed t tim t soil vapor p rm bil ty)	OR	ENTER U er-defi ed tr turn A soil apor perm ability k_v (cm²)
13 89	200	272 5	272.5	0	0	A	SIC	SIC		

MORE ↓

ENTER tr turn A SCS soil typ ookup Soil Parame ers	ENTER tr turn A soil dry bulk density ρ (g/ m³)	ENTER soil t tal porosity n^A (unitles)	ENTER soil w ter filled poros ty θ_w (cm /cm³)	ENTER tr turn B SCS soil typ ookup Soil arame rs	ENTER soil dry bulk density ρ (g/ m³)	ENTER soil t tal porosity (un tl)	ENTER soil w t filled porosity θ_w (cm /cm³)	ENTER tr turn C SCS soil typ ooku Soil arame	ENTER soil dry bulk dens ty ρ (g/cm³)	ENTER soil t tal porosity (ttes)	ENTER soil w t filled por ity θ_w (cm /cm³)
SIC	1.38	0.481	0 216		1.5	0 43	0 3		1 5	0.43	0 3

MORE ↓

ENTER E closed spac floo thickness, L_{crack} (cm)	ENTER Soil-bldg p ssur differential, ΔP (g/cm ²)	ENTER Enclosed sp floor length L_B (cm)	ENTER Enclosed spac floo width, W (cm)	ENTER E closed spac height H_B (cm)	ENTER Floo wall se m crack width, w (cm)	ENTER I d or exch g te, ER (1/h)	ENTER A g apor flow t i t bldg. OR Leav blank t calc l t Q_{soil} (L/m)
10	40	1000	1000	366	0 1	0.25	5

MORE ↓

ENTER A er ging tim for carcinogen AT (yr)	ENTER A ging time for noncarci ogen AT_{NC} (yrs)	ENTER Exposur dur tion, ED (yrs)	ENTER Exp sur fr quency EF (days/yr)	ENTER Targ t risk for carcinogen TR (unitles)	ENTER Target hazard qu tient for noncarci ogen THQ (unitles)
70	30	30	350	1.0E-06	1

U ed t calcul t risk-basec gr undw t concentr tion

END

Attachment A 35 2
Johnson Ettinger Results for Site Wide Groundwater (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet 1 1 Dichloroethylene

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS
1 1 Dichloroethylene
3 40E+01 (µg/L)

Indoor exposure groundwater conc carcinogen (µg/L)	Indoor exposure groundwater conc noncarcinogen (µg/L)	Risk based indoor exposure groundwater conc (µg/L)	Pure component water solubility S (µg/L)	Final indoor exposure groundwater conc (µg/L)
NA	NA	NA	2 25E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
NA	1 4E-03

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

ERROR Enter correct soil stratum directly above water table or depth to water table minus capillary fringe thickness must be > depth to bottom of floor

END

Calculated capillary fringe thickness (cm) is 192 31

Attachment A 35-3
Johnson Ettinger Results for Srte-Wide Groundwater (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
D t E try Sh t 2 Dichl ro th

GW ADV
Version 3 0 02/0

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES b x)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" "YES b and hal gr undw t onc belo

YES [X]

ENTER Chemical CAS N (numbers only dashes)	ENTER Initial g undw t conc., C_w (µg/L)	Chemi al
107062	4 00E-01	1,2 Dichloroethane

MORE ↓

ENTER A er ge soil/ groundw ter temperature, T (°C)	ENTER Depth below gr d t bottom f enclosed spac floor L_F (cm)	ENTER Depth below gr d to wat table L_{WT} (cm)	ENTER T tals must dd p t vatu f L_{WT} (cell G28) Thickness of oil tr turn A, h (cm)	ENTER Thickness f oil tr turn B (E ter atu or 0) h_B (cm)	ENTER Thickness of oil tr turn C (E ter vatu or 0) h_C (cm)	ENTER Soil tr turn directly ab w ter tabl (E ter A, B or C)	ENTER SCS soil typ directly abo e w ter tabl	ENTER Soil tr turn A SCS soil typ (used t tim t soil por p rm bil ty)	OR	ENTER U er-d fi ed tr turn A soil apor perm ability k_v (cm²)
13 89	200	272 5	272 5	0	0	A	SIC	SIC		

ORE ↓

ENTER SCS soil typ (ookup Soil Parame ers)	ENTER soil dry bulk density ρ (g/cm³)	ENTER soil t tal porosity n^A (unities)	ENTER soil w t filled porosity θ_w (cm /cm³)	ENTER tr turn B SCS soil typ (ookup Soil arame ers)	ENTER soil dry bulk dens ty ρ (g/cm³)	ENTER soil t tal porosity (unitl)	ENTER soil wat filled poros ty θ_w (cm /cm³)	ENTER SCS soil typ (ookup Soil Parame rs)	ENTER tr turn C soil dry bulk dens ty ρ (g/cm³)	ENTER tr turn C soil t tal porosity (ities)	ENTER soil w t filled poros ty θ_w (cm / m³)
SIC	1.38	0.481	0 216		1.5	0 43	0 3		1 5	0.43	0 3

MORE ↓

ENTER E closed spac floo thicknes L_{crac} (cm)	ENTER Soil-bldg p ss differential, ΔP (g/ m ²)	ENTER E closed spa floo length L_B (cm)	ENTER E closed sp floor width, W (cm)	ENTER Enclosed sp height H_B (cm)	ENTER Floo wall seam cr ck width, w (cm)	ENTER I d or air exchang t ER (1/h)	ENTER A g apor flow at i t bldg. OR Leav blank t cal ul t Q_{soil} (L/m)
10	40	1000	1000	366	0 1	0.25	5

MORE ↓

ENTER A ging tim for carcinogen AT (yrs)	ENTER A aging tim for noncarcinogen AT_{NC} (yrs)	ENTER Exposur dur tion, ED (yrs)	ENTER Exposur fr quency EF (day /y)	ENTER Targ t risk for carcinogen TR (unities)	ENTER Targ t hazard quotie t for noarcinogen THQ (unities)
70	30	30	350	1.0E-06	1

END

U ed t calcul t risk-basec gr undw t co entr ti

Attachment A 35 3
Johnson Ettinger Results for Site Wide Groundwater (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet 1 2 Dichloroethane

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS
1 2 Dichloroethane
4 00E-01 (µg/L)

Indoor exposure groundwater conc carcinogen (µg/L)	Indoor exposure groundwater conc noncarcinogen (µg/L)	Risk based indoor exposure groundwater conc (µg/L)	Pure component water solubility S (µg/L)	Final indoor exposure groundwater conc (µg/L)
NA	NA	NA	8 52E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
5 1E-09	NA

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

ERROR Enter correct soil stratum directly above water table or depth to water table minus capillary fringe thickness must be > depth to bottom of floor

END

Calculated capillary fringe thickness (cm) is 192 31

Attachment A 35-4
Johnson Ettinger Results for Site-Wide Groundwater (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
D ta E try Sh t C rb T trachl rid

GW ADV
Version 3 0 02/0

Reset to Defaults

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" b x)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" I "YES box and nitial g undw ter con below

YES [X]

ENTER Chemical CAS N (numb only o dashes)	ENTER Initial groundwater conc. C_w (µg/L)	Chemical
56235	1 00E+00	Carbon tetrachloride

MORE ↓

ENTER A ge soil/ gr undw ter t mper ture, T (°C)	ENTER Depth bel w grad t b ttom of enclosed spac floor L_f (cm)	ENTER Depth bel w grade t wat tabl L_{wt} (cm)	ENTER T tals must add p t atu f L_{wt} (cell G28) Thickness f oil tr turn A, h (cm)	ENTER Thickness of oil t turn B (E ter atu or 0) h_B (cm)	ENTER Thickness f oil tr turn C (E ter atu or 0) h_C (cm)	ENTER Soil tr turn b w ter tabl (E ter A, B or C)	ENTER SCS soil typ directly ab e w ter table	ENTER Soil tr turn A SCS soil typ (used t trm t soil apor p rm ability)	OR	ENTER U er-d fi ed tr turn A soil por perm ability k_v (cm²)
13 89	200	272 5	272 5	0	0	A	SIC	SIC		

MOR ↓

ENTER tr t m SCS soil typ (ookup Soil Parameters)	ENTER trat m A soil dry bulk density ρ (g/ m³)	ENTER Str turn A soil t tal porosity n^ (unitles)	ENTER Str turn A soil w t filec porosity θ_w (cm /cm³)	ENTER Str turn B SCS soil typ (ookup Soil Parame ers)	ENTER Str turn B soil dry bulk density ρ (g/cm³)	ENTER Str turn B soil t tal poros ty (unitles)	ENTER Str turn B soil w t filec porosity θ_w (cm /cm³)	ENTER Str turn C SCS soil typ (Lookup Soil erame rs)	ENTER Str turn C soil dry bulk density ρ (g/cm³)	ENTER Str turn C soil t tal porosity (un tles)	ENTER Str turn C soil w t filec porosity θ_w (cm /cm³)
SIC	1.38	0.481	0 216		1.5	0 43	0 3		1 5	0 43	0 3

MORE ↓

ENTER E closed sp floor thickn L_{crac} (cm)	ENTER Soil-bldg p ssur differential, ΔP (g/cm ²)	ENTER E closed spac floor length, L_B (cm)	ENTER Enclosed sp floor width, W (cm)	ENTER E closed sp height H_B (cm)	ENTER Floo wall seam ck width, w (cm)	ENTER I d or air exchang te, ER (1/h)	ENTER A g apor flow t I t bldg, OR Leav bl k t cal I t Q_{soil} (L/m)
10	40	1000	1000	366	0 1	0.25	5

MORE ↓

ENTER A aging tim for carcinogens, AT (yr)	ENTER A aging tim for noncarcinogen AT (yr)	ENTER Exp sur dur tion ED (yrs)	ENTER Exp sur fr quency EF (day /y)	ENTER Targ t risk for carcinogen TR (un tles)	ENTER Targ t hazard quotient for no carcinogen THQ (unitles)
70	30	30	350	1.0E-06	1

END

Used t calcul t risk b sec gr undw te co entr tion

Attachment A 35 4
Johnson Ettinger Results for Site Wide Groundwater (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet Carbon Tetrachloride

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS
Carbon tetrachloride
1 00E+00 (µg/L)

Indoor exposure groundwater conc carcinogen (µg/L)	Indoor exposure groundwater conc noncarcinogen (µg/L)	Risk based indoor exposure groundwater conc (µg/L)	Pure component water solubility S (µg/L)	Final Indoor exposure groundwater conc (µg/L)
NA	NA	NA	7 93E+05	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
4 8E-08	NA

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

ERROR Enter correct soil stratum directly above water table or depth to water table minus capillary fringe thickness must be depth to bottom of floor

END

Calculated capillary fringe thickness (cm) is 192 31

Attachment A 35-5
Johnson Ettinger Results for Site-Wide Groundwater (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
D ta E try Sh t Chl rof rm

GW ADV
Version 3 0 02/0

Reset to Defaults

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" b x)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" I "YES box and i tial g undw t onc belo

YES [X]

ENTER Chemical CAS N (numbe only no dashes)	ENTER Initial groundw t con C_w (µg/L)	Chemical
67663	1 00E+01	Chloroform

MORE ↓

ENTER A age soil/ groundw t t mper ture, T (°C)	ENTER Depth below gr d t b ttom of enclosed sp fl or L_s (cm)	ENTER Depth bel w grad t w ter tabl L_{wt} (cm)	ENTER T tals must add p t atu f L_{wt} (cell G28) Thickness f oil tr turn A, h (cm)	ENTER Thickness f oil tr turn B (E ter al or 0) h_B (cm)	ENTER Th ckness f oil tr turn C (E ter alu or 0) h_C (cm)	ENTER Soil tr turn d ectly ab w ter tabl (E ter A, B or C)	ENTER SCS soil typ directly ab e w ter tabl	ENTER Soil tr turn A SCS soil typ (used t trm t soil apor p rm bil ty)	OR	ENTER User-d f ed tr turn A soil apor perm ability k_v (cm²)
13 89	200	272 5	272,5	0	0	A	SIC	SIC		

MORE ↓

ENTER turn A SCS soil typ (ookup Soil Parame ers)	ENTER turn A soil dry bulk density ρ (g/cm³)	ENTER tur A soil t tal porosity n^ (unities)	ENTER tr tu A soil w t filled porosity θ_w (cm /cm³)	ENTER I SCS soil typ (ookup Soil arameters)	ENTER tu soil dry bulk dens ty ρ (g/cm³)	ENTER tu B soil t tal porosity (unities)	ENTER tr turn B soil w t fill porosity θ_w (cm / m³)	ENTER SCS soil typ (ooku Soil arame)	ENTER soil dry bulk density ρ (g/cm³)	ENTER soil t tal por ity (unitl)	ENTER soil w t filled porosity θ_w (cm /cm³)
SIC	1,38	0,481	0 216		1 5	0 43	0 3		1 5	0,43	0 3

MORE ↓

ENTER E closed sp floor thicknes L_{crack} (cm)	ENTER Soil-bldg pr ssur differential, ΔP (g/cm ²)	ENTER Enclosed spac floor length L_B (cm)	ENTER Enclosed spac floor width, W (cm)	ENTER E closed spac height H_B (cm)	ENTER Floor wall seam ack width, w (cm)	ENTER I d or air exchang t ER (1/h)	ENTER A ge por flow t l t bldg. OR Leav blank t cal ul t Q_s (L/m)
10	40	1000	1000	366	0 1	0,25	5

MORE ↓

ENTER Averaging tim for carcinogen AT (yrs)	ENTER A ging tim for noncarci ogen AT_{NC} (yr)	ENTER Exp sur dur tion ED (y)	ENTER Exposur frequency EF (day /y)	ENTER Targ t risk for carcinogen TR (unities)	ENTER Target hazard quotient for noarci ogen THQ (unitless)
70	30	30	350	1,0E-06	1

END

Used t calcul te risk-basec groundwater concentr tio

Attachment A 35 5
Johnson Ettinger Results for Site Wide Groundwater (w/ Basement)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet Chloroform

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS

Chloroform
1 00E+01 (µg/L)

Indoor exposure groundwater conc carcinogen (µg/L)	Indoor exposure groundwater conc noncarcinogen (µg/L)	Risk based indoor exposure groundwater conc (µg/L)	Pure component water solubility S (µg/L)	Final indoor exposure groundwater conc (µg/L)
NA	NA	NA	7 92E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
2 0E-07	NA

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

ERROR Enter correct soil stratum directly above water table or depth to water table minus capillary fringe thickness must be depth to bottom of floor

END

Calculated capillary fringe thickness (cm) is 192 31

Att hment A 35 6
Johns n Ettinge R ult f Site-Wid S Il (l b n grad)
St Louis Army Ammunition Plant
St L ul Ml u i
D ta Entry Sh t 1 1 T lchloroethan

SL ADV
Version 3 0 02/03

Re t t
D f lt

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" bo)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" I "YES" bo and initial oil onc below)

YES [X]

ENTER Chemical CAS N (numbers only no dashes)	ENTER Initial soil conc C_s (µg/kg)	Chemi
71556	1 10E+01	1,1,1 Trichloroethan

MORE ↓

ENTER A ag soil temper tur T (°C)	ENTER Depth below gr de t b ttom f enclosed space floor L_F (m)	ENTER Depth below gr d top f cont mination, L_t (m)	ENTER Depth below gr d t bott m f on amination, (tar alu of if al la unknown) L_b (m)	ENTER T must dd up value f L (eil G28) Thi kn f soil tr tum A, h (m)	ENTER Thi kn f sol tum B, (Ent lue or 0) h_B (m)	ENTER Thi kness f so tr tum C (E er ue or 0) h_C (m)	ENTER Soil tum A SCS soil type (us d tim oil vapo p m b l ty)	OR	ENTER Use -d fined tum A oil po perm b ty k_v (m²)
13 89	16	16	272 5	16	0	0	SIC		

MORE ↓

ENTER Str tum A SCS oil type (dup Soil Parameters)	ENTER Str tum A soil dry bulk density ρ_b (g/ m³)	ENTER Str tum A soil t tal por sity n^A (unit)	ENTER S tum A oil water fl d por sity θ_w (m / m³)	ENTER Str tum A soil organi carbon fr n, f (unitless)	ENTER Str tum B SCS oil type (dup Soil Pa meters)	ENTER S tum B oil dry bulk d nsity (g/ m³)	ENTER Str tum B soil al por sity (unit ss)	ENTER Str tum B oil w er fl d por sity θ_w (m / m³)	ENTER S tum B oil organ arbon fr n, (uni ss)	ENTER Str tum C SCS oil type (dup Soil Par ters)	ENTER S tum C oil dry bulk d nsity ρ_b (g/ m³)	ENTER S tum C soil tal por sity (unities)	ENTER S tum C oil w fl d por sity w (m / m³)	ENTER S tum C soil organi arbon fl n, (uni)
SIC	1.38	0 81	0216	0002	S	1.66	0376	005	0 002	S	1.66	0375	005	002

MORE ↓

ENTER Encl sed space floor thi kness, L_{crack} (m)	ENTER Soil-bldg pressur differ tl L ΔP (g/ m ²)	ENTER Enclosed spa floor length, L_B (m)	ENTER Enclosed pa floor width, W (m)	ENTER Enclosed spa height, H (m)	ENTER R or w seam cr k w th, w (m)	ENTER Indoor air chang t ER (1/h)	ENTER A er g vapor flow int bldg OR L bl k cal ul Q_{soil} (L/m)
10	40	1000	1000	366	0 1	0.25	5

ENTER Averaging time for arcinogens, AT (yrs)	ENTER Averaging time for noncarcinogen AT_{NC} (yrs)	ENTER Exposur du tion, ED (yrs)	ENTER Exposur frequency EF (ays/yr)	ENTER T g t k for arcinogens, TR (unitless)	ENTER T get ha d qu tient for nonc cinogen THQ (unit)
70	30	30	350	1.0E-06	1

U ed t calcul te ri k-based oil oncen tion

END

Attachment A 35-6
Johnson Ettinger Results for Site-Wide Soils (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet 1 1 1 Trichloroethane

RISK BASED SOIL CONCENTRATION CALCULATIONS

1 1 1 Trichloroethane
1 10E+01 (µg/kg)

Indoor exposure soil conc carcinogen (µg/kg)	Indoor exposure soil conc noncarcinogen (µg/kg)	Risk based indoor exposure soil conc (µg/kg)	Soil saturation conc C_{sat} (µg/kg)	Final indoor exposure soil conc (µg/kg)
NA	NA	NA	6 14E+05	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
NA	7 5E 05

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

END

Attachment A 35-7
Johnson Ettinger Results for Site-Wide Groundwater (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
D ta E try Sh t 1 1 Dichl ro thyl

GW ADV
Version 3 0 02/0

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES b x)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" "YES b d initial gr undw t on belo

YES [X]

ENTER Chemical CAS No (number only dashes)	ENTER Initial gr undw t con C_w (µg/L)	Chem al
75354	3 40E+01	1,1 Dichloroethylene

MORE ↓

ENTER A erage soil/ gr undwater t mperature, T (°C)	ENTER Depth below grade t bottom of enclosed spac floor L_F (cm)	ENTER Depth below gr d t w ter tabl L_{WT} (cm)	ENTER I tals must dd p t atu f k_{WT} (cell G28) Th ckness of all tr turn A, h (cm)	ENTER Thickness f al tr turn B (E ter atu or 0) h_B (cm)	ENTER Thickness f oil tr turn C, (E ter atu or 0) h_C (cm)	ENTER Soil tr turn directly ab w ter tabl (E ter A, B or C)	ENTER SCS soil typ directly ab e w ter tabl	ENTER Soil tr turn A SCS soil typ (used t tim t il apor p rm bility)	OR	ENTER User-d f ed tr turn A soil vapor perm ability k_v (cm²)
13 89	15	272 5	272 5	0	0	A	SIC	SIC		

MOR ↓

ENTER Str turn A SCS soil typ (Lookup Soil arameters)	ENTER Strat m A soil dry b lk density ρ (g/cm³)	ENTER tr t m soil t tal porosity n^A (un ities)	ENTER tr turn A soil w t filec poros ty θ_w (cm /cm³)	ENTER tr turn B SCS il typ (Lookup Soil Parame ers)	ENTER Str turn B soil dry bulk density ρ (g/cm³)	ENTER Str t m B soil t tal porosity (unities)	ENTER Str t m B soil w t filec porosity θ_w (cm / m³)	ENTER Str turn C SCS soil typ (ookup Soil arame)	ENTER Str turn C il dry bulk d nsity ρ (g/ m³)	ENTER Stratum C soil t tal porosity (itles)	ENTER Str turn C soil w t filec poros ty θ_w (cm / m³)
SIC	1.38	0 481	0 216		1.5	0 43	0 3		1 5	0.43	0 3

MORE ↓

ENTER E closed spac floor thicknes L_{crack} (cm)	ENTER Soil-bldg pr ssur differential, ΔP (g/cm ²)	ENTER Enclosed spac floo length, L_B (cm)	ENTER Enclosed spac floor width, W (cm)	ENTER E closed spac height H_B (cm)	ENTER Floor wall cm cr ck width, w (cm)	ENTER I d or ai exchang t ER (1/h)	ENTER A g apor flow t i t bldg. OR Leav blank t calcul t Q (L/m)
10	40	1000	1000	366	0 1	0 25	5

MORE ↓

ENTER A er ging tim for carcinogen AT (y)	ENTER A ging tim for noncarci ogen AT_{NC} (y)	ENTER Exposur dur tion ED (y)	ENTER Exp sur fr quency EF (days/yr)	ENTER Targ t risk for carcinogen TR (unitles)	ENTER Targ t hazard qu tie t for noncarci ogen THQ (unitles)
70	30	30	350	1.0E-06	1

END

Used t calculat risk-basec gr undw ter concentr ti

Attachment A 35 7
Johnson Ettinger Results for Site Wide Groundwater (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet 1 1 Dichloroethylene

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS
1 1 Dichloroethylene
3 40E+01 (µg/L)

Indoor exposure groundwater conc carcinogen (µg/L)	Indoor exposure groundwater conc noncarcinogen (µg/L)	Risk based indoor exposure groundwater conc (µg/L)	Pure component water solubility S (µg/L)	Final indoor exposure groundwater conc (µg/L)
NA	NA	NA	2 25E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
NA	8 2E 04

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

END

Attachment A 35-8
Johnson Etting r Results for Site-Wide Gr undw ter (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
D ta E try Sh t 1 2 D chl ro tha

GW ADV
Version 3 0 02/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" b)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" i "YES b and nitial groundw t on below

YES [X]

ENTER Chemical CAS N (numb rs only d shes)	ENTER Initial g undw t conc. C_w (µg/l)	Chem l
107062	4 00E-01	1,2 Dichloroethane

MORE ↓

ENTER A age soil/ groundw ter temperature, T (°C)	ENTER Depth below grad t bottom of enclosed spac floor L_f (cm)	ENTER Depth below gr d t w ter tabl L_{wt} (cm)	ENTER T tals must add p t atu f k_{wt} (cell G28) Thickness of oil tr tum A, h (cm)	ENTER Thickness of soil tr tum B (E ter valu or 0) h_B (cm)	ENTER Thickn ss of oil tr tum C (E ter valu or 0) h_C (cm)	ENTER Soil tr tum directly ab w ter tabl (E ter A, B or C)	ENTER SCS soil typ directly ab e water tabl	ENTER Soil tr tum A SCS soil typ (ed t tim t soil apor p rm bility)	OR	ENTER User-d fi ed tr tum A soil apor perm ability k_v (cm²)
13 89	15	272 5	272 5	0	0	A	SIC	SIC		

MOR ↓

ENTER Stratum A SCS soil typ (Lookup Soil Parameters)	ENTER tr tum A soil dry bulk density ρ (g/cm³)	ENTER m A soil t tal porosity n^A (un tless)	ENTER m A oil wat filec porosity θ_w (cm /cm³)	ENTER Str m B SCS soil typ (ookup Soil Paramet rs)	ENTER tr t m B soil dry bulk density ρ (g/ m³)	ENTER Str h m B soil t tal poros ty (unitle)	ENTER Str tum B soil w t filec poros ty θ_w (cm /cm³)	ENTER Str tum C SCS soil typ (ookup Soil arame ers)	ENTER Str tum C soil dry bulk density ρ (g/cm³)	ENTER Stratum C soil t tal porosity (unitles)	ENTER Str tum C soil w t filec poros ty θ_w (cm /cm³)
SIC	1.38	0 481	0 216		1.5	0 43	0 3		1 5	0.43	0 3

MORE ↓

ENTER Enclosed spa floor thicknes L_{crack} (cm)	ENTER Soil-bldg pr ssur differential, ΔP (g/cm ³)	ENTER Enclosed spac floor length, L_B (cm)	ENTER Enclosed sp floo width, W (cm)	ENTER Enclosed spac height H_B (cm)	ENTER Floo wall arn crack width, w (cm)	ENTER I door air exchang ate, ER (1/h)	ENTER A g apor flow t i t bldg OR Leav blank t calcul t Q_s (L/m)
10	40	1000	1000	366	0 1	0.25	5

MORE ↓

ENTER A ging time for carcinogen AT (yrs)	ENTER A er ging tim for no carcinogen AT_{NC} (yrs)	ENTER Exposur dur tion, ED (yrs)	ENTER Exp sur fr quency EF (day /yr)	ENTER Targ t risk f carcinogen TR (un tles)	ENTER Target hazard qu tient for carci ogen THQ (itles)
70	30	30	350	1.0E-06	1

END

Used t calcul t risk-basec gr undw ter concentr tion

Attachment A 35 8
Johnson Ettinger Results for Site Wide Groundwater (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet 1 2 Dichloroethane

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS

1 2 Dichloroethane
4 00E-01 (µg/L)

Indoor exposure groundwater conc carcinogen (µg/L)	Indoor exposure groundwater conc noncarcinogen (µg/L)	Risk based indoor exposure groundwater conc (µg/L)	Pure component water solubility S (µg/L)	Final indoor exposure groundwater conc (µg/L)
NA	NA	NA	8 52E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
2 9E-09	NA

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

END

Attachment A 35-9
Johnson Ettinger Results for Site-Wide Groundwater (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
D ta E try Sh t C rbon T trachl rid

GW ADV
Version 3 0 02/0

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES b x)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" i "YES b and initial gr undw t onc belo

YES [X]

ENTER Chemical CAS N (numb only dashes)	ENTER Initial groundw t conc. C_W (µg/L)	Chem al
56235	1 00E+00	Carbon tetrachloride

MORE ↓

ENTER A g soil/ gr undw t temperature, T (°C)	ENTER Depth bel w gr de t bottom of enclosed spa floor L_f (cm)	ENTER Depth bel w grad t wate tabl L_{WT} (cm)	ENTER T tals must dd p t atu f L_{WT} (cell G28) Thickness of oil tr tum A, h (cm)	ENTER Th ckness f oil tr tum B (E ter atu or 0) h_B (cm)	ENTER Thickness f oil tr tum C (E ter atu or 0) h_C (cm)	ENTER Soil tr tum directly ab w ter tabl (E ter A, B or C)	ENTER SCS soil typ directly abo e w ter tabl	ENTER Soil tr tum A SCS soil typ (used t tim t soil apor p rm bility)	OR	ENTER U er-d fi ed tr tum A soil vapor perm bility k_v (cm²)
13 89	15	272 5	272.5	0	0	A	SIC	SIC		

O ↓

ENTER a m n SCS soil typ Lookup Soil arame ers	ENTER m n soil dry bulk density ρ (g/cm³)	ENTER m A soil t tal porosity n^A (un ties)	ENTER S m A oil wat fille por ty θ_w (cm /cm³)	ENTER tum B SCS soil typ ookup Soil arame ers	ENTER m B soil dry bulk density ρ (g/cm³)	ENTER tr m B soil t t l porosity (un ti)	ENTER tr t m B soil w t fill porosity θ_w (cm /cm³)	ENTER tr t m C SCS soil typ ooku Soil arameters	ENTER Str tum C soil dry bulk den ty ρ (g/cm³)	ENTER Str tum C soil t tal poros ty (ties)	ENTER Str tum C soil w t fillec por ty θ_w (cm / m³)
SIC	1.38	0.481	0 216		1.5	0 43	0 3		1 5	0 43	0 3

MORE ↓

ENTER Enclosed spa floo thicknes L_{crac} (cm)	ENTER Soil-bldg p ssur differential, ΔP (g/cm ²)	ENTER E closed sp floor length L_B (cm)	ENTER E closed sp floor width, W (cm)	ENTER E closed spac height H_B (cm)	ENTER Floor wall am crack width, w (cm)	ENTER I d or air exchang t ER (1/h)	ENTER A g apor flow t i t bldg OR Leav blank t cal ul t Q_s (L/m)
10	40	1000	1000	366	0 1	0.25	5

MORE ↓

ENTER A ging tim for carcinogen AT (y)	ENTER Ave aging time for noncarcinogen AT_{NC} (y)	ENTER Exposur duration, ED (y)	ENTER Exp sur fr quency EF (day /y)	ENTER Targ t risk f carcinogen TR (unities)	ENTER Targ t hazard quoti t for carci ogen THQ (unities)
70	30	30	350	1 0E-06	1

U ed t calcul t risk-basec gr undw t con entr ti

END

Attachment A 35 9
Johnson Ettinger Results for Site Wide Groundwater (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet Carbon Tetrachloride

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS
Carbon tetrachloride
1 00E+00 (µg/L)

Indoor exposure groundwater conc carcinogen (µg/L)	Indoor exposure groundwater conc noncarcinogen (µg/L)	Risk based indoor exposure groundwater conc (µg/L)	Pure component water solubility S (µg/L)	Final indoor exposure groundwater conc (µg/L)
NA	NA	NA	7,93E+05	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
2 8E-08	NA

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

END

Attachment A 35-10
Johnson Ettinger Results for Site-Wide Groundwater (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
D ta E try Sh t Chl rof rm

GW ADV
Version 3 0 02/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" i "YES" box and initial gr dw t on below

YES [X]

ENTER Chemical CAS No (numbe only dashes)	ENTER Initial gr undw t conc. C_w (µg/L)	Chemi al
67663	1 00E+01	Chloroform

MORE ↓

ENTER A er g soil/ groundw te t mper ture, T (°C)	ENTER Depth below grade to b ttom f enclosed spac floor L_f (cm)	ENTER Depth bel w gr d t w ter tabl L_{wt} (cm)	ENTER T tals must dd p t atu f I_w (cell G28) Thickness of oil tr tum A, h (cm)	ENTER Thickness f oil tr tum B (E ter atu or 0) h_B (cm)	ENTER Thickness of oil tr tum C (E ter atu or 0) h_C (cm)	ENTER Soil tr tum directly ab w ter tabl (E ter A, B or C)	ENTER SCS soil typ d ectly ab e w ter tabl	ENTER Soil tr tum A SCS soil typ (used t ttm t soil apor p rm bil ty)	OR	ENTER U er-d fi ed tr tum A soil apor perm ability k_v (cm²)
13 89	15	272 5	272 5	0	0	A	SIC	SIC		

MOR ↓

ENTER St tu A SCS soil typ (ookup Soil Paramet rs)	ENTER tr m n soil dry bulk density ρ (g/cm³)	ENTER tum A soil t tal porosity n^A (unitles)	ENTER tum A soil w ter filler poros ty θ_w (cm /cm³)	ENTER tr tum SCS soil typ (ooku Soil arame rs)	ENTER tr tum B soil dry bulk density ρ (g/ m³)	ENTER Str tum B soil t tal porosity (unitles)	ENTER Str tum B soil w t filled porosity θ_w (cm /cm³)	ENTER Str tum C SCS soil typ (ookup Soil arame ers)	ENTER Str tum C soil dry b lk den ty ρ (g/cm³)	ENTER Str tum C soil t tal porosity (tle)	ENTER Str tum C soil w t filled porosity θ_w (cm / m³)
SIC	1.38	0.481	0 216		1.5	0 43	0 3		1 5	0.43	0 3

MORE ↓

ENTER E closed spac floor thicknes L_{crack} (cm)	ENTER Soil-bldg pr ssur differential, ΔP (g/cm ³)	ENTER E closed spac floor length L_B (cm)	ENTER E closed spac floor wid th, W (cm)	ENTER E closed spac height H_B (cm)	ENTER Floo wall seam crack width, w (cm)	ENTER I door air chang t ER (1/h)	ENTER A g apor flow t t t bldg. OR Leav blank t cal ulat Q_s (L/m)
10	40	1000	1000	366	0 1	0.25	5

MORE ↓

ENTER A er ging tim for carcinogen AT (y)	ENTER A aging tim for carcinogen AT_{nc} (y)	ENTER Exposur dur tion ED (y)	ENTER Exp sur fr quency EF (day /yr)	ENTER Targ t risk f carcinogen TR (unitles)	ENTER Targ t hazard qu ti t for noncarcinogen THQ (unitles)
70	30	30	350	1.0E-06	1

U ed t calcul t sk basec gr undw t con entr ti

END

Attachment A-35 10
Johnson Ettinger Results for Site Wide Groundwater (slab on grade)
St Louis Army Ammunition Plant
St Louis Missouri
Results Sheet Chloroform

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS

Chloroform
1 00E+01 (µg/L)

Indoor exposure groundwater conc carcinogen (µg/L)	Indoor exposure groundwater conc noncarcinogen (µg/L)	Risk based indoor exposure groundwater conc (µg/L)	Pure component water solubility S (µg/L)	Final indoor exposure groundwater conc (µg/L)
NA	NA	NA	7 92E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
1 1E 07	NA

MESSAGE AND ERROR SUMMARY BELOW (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO END

END

Attachment A-36-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis , Missouri

Chemical	units	Maximum Detect	Monitoring Well Location	Frequency of Detection	Permeability Constant[a] (cm/hr)	Subchronic RfD_o[b] (mg/kg day)	Subchronic RfD_i[b c] (mg/kg day)	SF_o (mg/kg day)[1]	SF (mg/kg day)[1]
1 2 Diphenylhydrazine	mg/L	3 5E 4	08MW 01	2/13	1 3E 2	NTV	NA	8 0E 1	NA
Benzo(a)anthracene	mg/L	6 6E 5	08MW 02	13/13	4 7E 1	NTV	NA	7 3E 1	NA
Benzo(a)pyrene	mg/L	9 2E 5	08MW 02	13/13	7 0E 1	NTV	NA	7 3E+0	NA
Benzo(b)fluoranthene	mg/L	9 9E 5	08MW 02	13/13	7 0E 1	NTV	NA	7 3E 1	NA
Benzo(k)fluoranthene	mg/L	1 9E 4	08MW 02	13/13	7 0E 1	NTV	NA	7 3E 2	NA
Chrysene	mg/L	1 3E 4	08MW 02	13/13	4 7E 1	NTV	NA	7 3E 3	NA
Dibenz(a h)anthracene	mg/L	7 7E 5	08MW 02	13/13	1 5E+0	NTV	NA	7 3E+0	NA
Indeno(1 2 3 cd)pyrene	mg/L	1 1E 4	08MW 02	9/13	1 0E+0	NTV	NA	7 3E 1	NA
Arsenic	mg/L	7 8E 3	08MW 01	13/13	1 0E 3	3 0E 4	NA	1 5E+0	NA
1 1 Dichloroethene	mg/L	3 4E 2	02MW 01	1/13	1 2E 2	5 0E 2	5 7E 2	NTV	NTV
1 2 Dichloroethane	mg/L	4 0E 4	02MW 01	1/13	4 2E 3	3 0E 2	1 4E 3	9 1E 2	9 1E 2
Carbon tetrachloride	mg/L	1 0E 3	02MW 01	1/13	1 6E 2	7 0E 4	7 0E 4	1 3E 1	5 3E 2
Chloroform	mg/L	1 0E 2	02MW 01	1/13	6 8E 3	1 0E 2	8 6E 4	NTV	NTV

NTV No toxicity value

NA Not applicable

For evaluation of site wide groundwater the maximum detected concentration was used as the exposure point concentration for both RME and CTE

[a] Permeability constants for organic compounds from RAGS Part E Exhibit B 3 arsenic based on PC for water

[b] Chronic values were used if no subchronic values were available

[c] Oral RfD values were used for evaluating inhalation of carbon tetrachloride and chloroform

Attachment A-36-2
Future Excavation/Construction Worker
Estimated Risk for Incidental Ingestion of Shallow Groundwater
Reasonable Maximum Exposure (RME)
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = ((CW\ IR\ EF\ ED)/(BW\ AT_{nc}))\ (1/R_fD_{oral})$

Where HI = Hazard Index (unitless)
CW = Concentration of Chemical in Water (mg/L)
IR = Water Ingestion Rate (L/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens ((365 days/year) ED)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = ((CW\ IR\ EF\ ED)/(ATc\ BW))\ SF_{al}$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CW	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	HI	CR
1 2 Diphenylhydrazine	3 5E 4	0 002	60	1	70	84	25 550	NTV	8 0E 1	0 0E+0	1 9E 11
Benzo(a)anthracene	6 6E 5	0 002	60	1	70	84	25 550	NTV	7 3E 1	0 0E+0	3 2E 12
Benzo(a)pyrene	9 2E 5	0 002	60	1	70	84	25 550	NTV	7 3E+0	0 0E+0	4 5E 11
Benzo(b)fluoranthene	9 9E 5	0 002	60	1	70	84	25 550	NTV	7 3E 1	0 0E+0	4 8E 12
Benzo(k)fluoranthene	1 9E 4	0 002	60	1	70	84	25 550	NTV	7 3E 2	0 0E+0	9 3E 13
Chrysene	1 3E 4	0 002	60	1	70	84	25 550	NTV	7 3E 3	0 0E+0	6 4E 14
Dibenz(a h)anthracene	7 7E 5	0 002	60	1	70	84	25 550	NTV	7 3E+0	0 0E+0	3 8E 11
Indeno(1 2 3 cd)pyrene	1 1E 4	0 002	60	1	70	84	25 550	NTV	7 3E 1	0 0E+0	5 4E 12
Arsenic	7 8E 3	0 002	60	1	70	84	25 550	3 0E 4	1 5E+0	5 3E 4	7 9E 10
1 1 Dichloroethene	3 4E 2	0 002	60	1	70	84	25 550	5 0E 2	NTV	1 4E 5	0 0E+0
1 2 Dichloroethane	4 0E 4	0 002	60	1	70	84	25 550	3 0E 2	9 1E 2	2 7E 7	2 4E 12
Carbon tetrachloride	1 0E 3	0 002	60	1	70	84	25 550	7 0E 4	1 3E 1	2 9E 5	8 7E 12
Chloroform	1 0E 2	0 002	60	1	70	84	25 550	1 0E 2	NTV	2 0E 5	0 0E+0
									Total	5 9E 4	9 1E 10

Attachment A-36 3
Future Excavation/Construction Worker
Estimated Risk for Incidental Ingestion of Shallow Groundwater
Central Tendency Exposure (CTE)
Site Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = ((CW\ IR\ EF\ ED)/(BW\ AT_{nc}))\ (1/R_fD_{oral})$

Where HI = Hazard Index (unitless)
CW = Concentration of Chemical in Water (mg/L)
IR = Water Ingestion Rate (L/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (year)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens ((365 days/year) ED)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = ((CW\ IR\ EF\ ED)/(ATc\ BW))\ SF_{oral}$

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CW	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	HI	CR
1 2 Diphenylhydrazine	3 5E 4	0 001	30	1	70	42	25 550	NTV	8 0E 1	0 0E+0	4 7E 12
Benzo(a)anthracene	6 6E 5	0 001	30	1	70	42	25 550	NTV	7 3E 1	0 0E+0	8 1E 13
Benzo(a)pyrene	9 2E 5	0 001	30	1	70	42	25 550	NTV	7 3E+0	0 0E+0	1 1E 11
Benzo(b)fluoranthene	9 9E 5	0 001	30	1	70	42	25 550	NTV	7 3E 1	0 0E+0	1 2E 12
Benzo(k)fluoranthene	1 9E 4	0 001	30	1	70	42	25 550	NTV	7 3E 2	0 0E+0	2 3E 13
Chrysene	1 3E 4	0 001	30	1	70	42	25 550	NTV	7 3E 3	0 0E+0	1 6E 14
Dibenz(a h)anthracene	7 7E 5	0 001	30	1	70	42	25 550	NTV	7 3E+0	0 0E+0	9 4E 12
Indeno(1 2 3 cd)pyrene	1 1E 4	0 001	30	1	70	42	25 550	NTV	7 3E 1	0 0E+0	1 3E 12
Arsenic	7 8E 3	0 001	30	1	70	42	25 550	3 0E 4	1 5E+0	2 7E 4	2 0E 10
1 1 Dichloroethene	3 4E 2	0 001	30	1	70	42	25 550	5 0E 2	NTV	6 9E 6	0 0E+0
1 2 Dichloroethane	4 0E 4	0 001	30	1	70	42	25 550	3 0E 2	9 1E 2	1 4E 7	6 1E 13
Carbon tetrachloride	1 0E 3	0 001	30	1	70	42	25 550	7 0E 4	1 3E 1	1 5E 5	2 2E 12
Chloroform	1 0E 2	0 001	30	1	70	42	25 550	1 0E 2	NTV	1 0E 5	0 0E+0
									Total	3 0E 4	2 3E 10

Attachment A 36 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Shallow Groundwater
Reasonable Maximum Exposure (RME)
Site Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = ((CW CF PC ET SA EF ED)/(AT BW)) $(1/R_fD_{oral})$

Where HI = Hazard Index (unitless)
CW = Concentration of Chemical in Water (mg/L)
CF = Conversion Factor (L/cm^3)
PC = Permeability Constant (cm/hr)
ET = Exposure Time (hr/day)
SA = Surface Area of Exposed Skin (cm^2)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens ((365 days/year) ED)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = ((CW CF PC ET SA EF ED)/(AT BW)) SF_{oral}

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CW	CF	PC	ET	SA	EF	ED	BW	AT_c	AT_c	RfD_{oral}	SF_{oral}	HI	CR
1 2 Diphenylhydrazine	3 5E 4	0 001	1 3E 2	4	3300	60	1	70	84	25550	NTV	8 0E 1	0 0E+0	1 6E 9
Benzo(a)anthracene	6 6E 5	0 001	4 7E 1	4	3300	60	1	70	84	25550	NTV	7 3E 1	0 0E+0	1 0E 8
Benzo(a)pyrene	9 2E 5	0 001	7 0E 1	4	3300	60	1	70	84	25550	NTV	7 3E+0	0 0E+0	2 1E 7
Benzo(b)fluoranthene	9 9E 5	0 001	7 0E 1	4	3300	60	1	70	84	25550	NTV	7 3E 1	0 0E+0	2 2E 8
Benzo(k)fluoranthene	1 9E 4	0 001	7 0E 1	4	3300	60	1	70	84	25550	NTV	7 3E 2	0 0E+0	4 3E 9
Chrysene	1 3E 4	0 001	4 7E 1	4	3300	60	1	70	84	25550	NTV	7 3E 3	0 0E+0	2 0E 10
Dibenz(a h)anthracene	7 7E 5	0 001	1 5E+0	4	3300	60	1	70	84	25550	NTV	7 3E+0	0 0E+0	3 7E 7
Indeno(1 2 3 cd)pyrene	1 1E 4	0 001	1 0E+0	4	3300	60	1	70	84	25550	NTV	7 3E 1	0 0E+0	3 6E 8
Arsenic	7 8E 3	0 001	1 0E 3	4	3300	60	1	70	84	25550	3 0E 4	1 5E+0	3 5E 3	5 2E 9
1 1 Dichloroethene	3 4E 2	0 001	1 2E 2	4	3300	60	1	70	84	25550	5 0E 2	NTV	1 1E 3	0 0E+0
1 2 Dichloroethane	4 0E 4	0 001	4 2E 3	4	3300	60	1	70	84	25550	3 0E 2	9 1E 2	7 5E 6	6 8E 11
Carbon tetrachloride	1 0E 3	0 001	1 6E 2	4	3300	60	1	70	84	25550	7 0E 4	1 3E 1	3 1E 3	9 2E 10
Chloroform	1 0E 2	0 001	6 8E 3	4	3300	60	1	70	84	25550	1 0E 2	NTV	9 2E 4	0 0E+0
												Total	8 6E 3	6 6E 7

Attachment A 36 5
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Shallow Groundwater
Central Tendency Exposure (CTE)
Site Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI = ((CW CF PC ET SA EF ED)/(AT_{nc} BW)) (1/R_fD_{ral})

Where HI = Hazard Index (unitless)
CW = Concentration of Chemical in Water (mg/L)
CF = Conversion Factor (L/cm^3)
PC = Permeability Constant (cm/hr)
ET = Exposure Time (hr/day)
SA = Surface Area of Exposed Skin (cm^2)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT_{nc} = Averaging Time for Non Carcinogens ((365 days/year) ED)
R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = ((CW CF PC ET SA EF ED)/(AT_c BW)) SF_{oral}

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) [1]

Chemical	CW	CF	PC	ET	SA	EF	ED	BW	AT	AT	RfD_{ral}	SF_{ral}	HI	CR
1 2 Diphenylhydrazine	3 5E 4	0 001	1 3E 2	2	200	30	1	70	42	25 550	NTV	8 0E 1	0 0E+0	2 4E 11
Benzo(a)anthracene	6 6E 5	0 001	4 7E 1	2	200	30	1	70	42	25 550	NTV	7 3E 1	0 0E+0	1 5E 10
Benzo(a)pyrene	9 2E 5	0 001	7 0E 1	2	200	30	1	70	42	25 550	NTV	7 3E+0	0 0E+0	3 2E 9
Benzo(b)fluoranthene	9 9E 5	0 001	7 0E 1	2	200	30	1	70	42	25 550	NTV	7 3E 1	0 0E+0	3 4E 10
Benzo(k)fluoranthene	1 9E 4	0 001	7 0E 1	2	200	30	1	70	42	25 550	NTV	7 3E 2	0 0E+0	6 5E 11
Chrysene	1 3E 4	0 001	4 7E 1	2	200	30	1	70	42	25 550	NTV	7 3E 3	0 0E+0	3 0E 12
Dibenz(a h)anthracene	7 7E 5	0 001	1 5E+0	2	200	30	1	70	42	2 550	NTV	7 3E+0	0 0E+0	5 7E 9
Indeno(1 2 3 cd)pyrene	1 1E 4	0 001	1 0E+0	2	200	30	1	70	42	2 550	NTV	7 3E 1	0 0E+0	5 4E 10
Arsenic	7 8E 3	0 001	1 0E 3	2	200	30	1	70	42	25 550	3 0E 4	1 5E+0	1 1E 4	7 9E 11
1 1 Dichloroethene	3 4E 2	0 001	1 2E 2	2	200	30	1	70	42	25 550	5 0E 2	NTV	3 3E 5	0 0E+0
1 2 Dichloroethane	4 0E 4	0 001	4 2E 3	2	200	30	1	70	42	2 › 550	3 0E 2	9 1E 2	2 3E 7	1 0E 12
Carbon tetrachloride	1 0E 3	0 001	1 6E 2	2	200	30	1	70	42	25 550	7 0E 4	1 3E 1	9 3E 5	1 4E 11
Chloroform	1 0E 2	0 001	6 8E 3	2	200	30	1	70	42	25 550	1 0E 2	NTV	2 8E 5	0 0E+0
												Total	2 6E 4	1 0E 8

Attachment A 36 6
Future Excavation/Construction Worker
Estimated Risk for Inhalation of Volatilized Groundwater COPCs
Reasonable Maximum Exposure (RME)
Site Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $VF_{oc} = k_{LG}/(kNH)$

where

VF_{oc} = volatilization factor of volatile organic compound

k_{LG} = Aqueous mass transfer coefficient from the liquid phase to gas phase for VOC of interest (m/sec)

k = Mixing factor to account for incomplete air exchange in trench (unitless)

N = Number of air exchanges per unit time in the trench (sec^{-1})

H =Height of the trench (m)

assuming

$k_{LG} = 3 \times 10^{-6}$ m/sec (conservative estimate of mass transfer coefficient for VOC s from groundwater to air USEPA 1999)

Equation 2 $N = \upsilon/L$

where

υ = wind speed (m/sec)

L = length of trench (m)

Equation 3 $C_i = CW \quad VF_{oc} \quad CF$

where

C_i = Concentration of the chemical in the vapor phase (mg/m^3)

CW = Concentration of the chemical in the water phase (mg/L)

CF = Conversion Factor (L/m^3)

Equation 4 $HI = C_i \; EF \; ED \; IR_{ai} \; ET/(AT_{nc} \; BW \; RfD_{ih})$

Where HI = Hazard Index (unitless)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

IH = Inhalation Rate (m^3/hr)

ET = Exposure Time (hr/day)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_iD_{ih} = Inhalation Reference Dose (mg/kg/day)

Equation 5 $CR = C_{ai} \; EF \; ED \; IR_i \; ET \; SF_{ih}/(AT_c \; BW)$

Where CR = Cancer Risk (unitless)

AT = Averaging Time for Carcinogens (25 550 days)

SF_{ih} = Inhalation Cancer Slope Factor (mg/kg/day) [1]

Chemical	CW	K_{LG}	k	H	L	υ	N	VF_{oc}	CF	C_i	EF	ED	ET	IH	BW	ATnc	ATc	RfD_{ih}	SF_{ih}	HI	CR
1 1 Dichloroethene	3 4E 2	3E 6	0 5	3	30	4 5	0 15	1 3E 5	1E+3	4 5E 4	60	1	4	2 05	70	84	25 550	5 7E 2	NTV	6 7E 4	0 0E+0
1 2 Dichloroethane	4 0E 4	3E 6	0 5	3	30	4 5	0 15	1 3E 5	1E+3	5 3E 6	60	1	4	2 05	70	84	25 550	1 4E 3	9 1E 2	3 2E 4	1 3E 10
Carbon tetrachloride	1 0E 3	3E 6	0 5	3	30	4 5	0 15	1 3E 5	1E+3	1 3E 5	60	1	4	2 05	70	84	25 550	7 0E 4	5 3E 2	1 6E 3	1 9E 10
Chloroform	1 0E 2	3E 6	0 5	3	30	4 5	0 15	1 3E 5	1E+3	1 3E 4	60	1	4	2 05	70	84	25 550	8 6E 4	NTV	1 3E 2	0 0E+0
																			Total	1 6E 2	3 3E 10

Attachment A 36 7
Future Excavation/Construction Worker
Estimated Risk for Inhalation of Volatilized Groundwater COPCs
Central Tendency Exposure (CTE)
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $VF_{oc} = k_{LG}/(kNH)$

where

VF_{oc} = volatilization factor of volatile organic compound

k_{LG} = Aqueous mass transfer coefficient from the liquid phase to gas phase for VOC of interest (m/sec)

k = Mixing factor to account for incomplete air exchange in trench (unitless)

N = Number of air exchanges per unit time in the trench (sec^{-1})

H =Height of the trench (m)

assuming

$k_{LG} = 3 \times 10^{-6}$ m/sec (conservative estimate of mass transfer coefficient for VOC s from groundwater to air USEPA 1999)

Equation 2 $N = \upsilon/L$

where

υ = wind speed (m/sec)

L = length of trench (m)

Equation 3 $C_{ai} = CW \quad VF_{oc} \quad CF$

where

C_{ai} = Concentration of the chemical in the vapor phase (mg/m^3)

CW = Concentration of the chemical in the water phase (mg/L)

CF = Conversion Factor (L/m^3)

Equation 4 $HI = C_{ai} \; EF \; ED \; IH \; ET/(AT_{nc} \; BW \; RfD_{i\,h})$

Where HI = Hazard Index (unitless)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

IH = Inhalation Rate (m^3/hr)

ET = Exposure Time (hr/day)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

$R_fD_{i\,h}$ = Inhalation Reference Dose (mg/kg/day)

Equation 5 $CR = C_{ai} \; EF \; ED \; IH \; ET \; SF_{i\,h}/(AT \; BW)$

Where CR = Cancer Risk (unitless)

AT = Averaging Time for Carcinogens (25 550 days)

SF_i = Inhalation Cancer Slope Factor (mg/kg/day) [1]

Chemical	CW	K_{LG}	k	H	L	υ	N	VF	CF	C_i	EF	ED	ET	IH	BW	ATnc	ATc	$RfD_{i\,h}$	$SF_{i\,h}$	HI	CR
1 1 Dichloroethene	3 4E 2	3E 6	0 5	3	30	4 5	0 15	1 3E 5	1 0E+3	4 5E 4	30	1	2	1 3	70	42	25 550	5 7E 2	NTV	2 1E 4	0 0E+0
1 2 Dichloroethane	4 0E 4	3E 6	0 5	3	30	4 5	0 15	1 3E 5	1 0E+3	5 3E 6	30	1	2	1 3	70	42	25 550	1 4E 3	9 1E 2	1 0E 4	2 1E 11
Carbon tetrachloride	1 0E 3	3E 6	0 5	3	30	4 5	0 15	1 3E 5	1 0E+3	1 3E 5	30	1	2	1 3	70	42	25 550	7 0E 4	5 3E 2	5 1E 4	3 1E 11
Chloroform	1 0E 2	3E 6	0 5	3	30	4 5	0 15	1 3E 5	1 0E+3	1 3E 4	30	1	2	1 3	70	42	25 550	8 6E 4	NTV	4 1E 3	0 0E+0
																			Total	4 9E 3	5 2E 11

Attachment A-36-8
Summary of Cancer Risks and Non-Cancer Hazard Indices
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 0003	0 0086	1 0E 8	6 6E 7
Ingestion	0 00030	0 00059	2 3E 10	9 1E 10
Inhalation	0 0049	0 016	5 2E 11	3 3E 10
Total	0 0055	0 025	1 0E 8	6 6E 7

DRAFT

HUMAN HEALTH RISK ASSESSMENT ATTACHMENT B DATA EVALUATION AND COPC SELECTION ST. LOUIS ARMY AMMUNITION PLANT ST. LOUIS, MISSOURI

U.S. Army Corps of Engineers
Kansas City District

URS

PREPARED FOR:

Department of the Army
U.S. Army Engineer Dist.
Kansas City District

Department of the Army
Base Realignment & Closure

PREPARED BY:
URS GROUP, INC.

STATISTICAL METHODS FOR ESTIMATING 95% UCLs

Environmental exposure point concentrations (EPCs) are the exposure concentrations used in assessing risks EPA (1992) defines the exposure term as the upper 95% confidence limit (UCL) for the mean media concentration to which receptors could be exposed By definition this EPC is statistically derived The following statistical approach is presented in a flow chart format (**Figure C 1** and **Figure C 2**) and is based on recommendations made in recent publications (e g EPA 1997 Schulz and Griffin 1999 EPA 2002) and further evaluation of the referenced bootstrapping methods This approach includes distribution testing to determine whether a dataset best fits a parametric (*i e* normal lognormal) or non normal distribution and then applies the appropriate statistical methods to calculate the mean and 95% UCL In the process the lower of the maximum detected value and the 95% UCL is used to represent EPC

Data Usability and Adequacy of Samples

Datasets containing at least one detected value but fewer than 5 samples are considered inadequate for distribution testing and the maximum detected value is used to represent the dataset Datasets containing greater than 50% detection and 5 or more samples are subjected to distribution testing

Distribution Testing

Distribution testing is performed on datasets containing 5 or more samples Data sets are evaluated for the presence of non detects as discussed above prior to performing distribution testing Data sets are separated into the following subgroups

1) data sets containing less than 50% nondetect values
2) data sets containing from 50% to < 100% nondetects and
3) data sets containing 100% nondetects

Distribution testing are performed on each data set containing less than 50% nondetect values using all data Proxy values equal to one half of the reporting limit are used for nondetect data Elevated reporting limits for nondetect values are evaluated as potential statistical outliers using the extreme value (Dixon s) test in datasets of less than 25 and using Rosner s test for datasets with samples sizes greater than 25 (EPA 2000) If such reporting limits are found to be statistically significant outliers for the dataset and their proxy value (½ of their reporting limit) exceeds the maximum detected concentration reported within the dataset the maximum detected concentrations are used as their proxy values for statistical evaluation

Where datasets contain 50% or more nondetect data the dataset is considered inadequate to perform distribution testing and a non normal or mixed distribution[1] is assumed

[1] The potential interference associated with high levels of non detection is due to the potential for a biomodal distribution due to a mixing of the analytical method s reporting limit(s) and the distribution of the chemical concentrations – *i e* the data set represents a mixture of two distinct statistical populations

Distribution testing are performed using the following methodologies First the data and the natural log transforms of the data are tested using the Shapiro Wilks test (w test) for normality For data sets containing more than 50 samples the D agostino s test (the D test) is used The D agostino test is an extension of the w test The w test is based on the null hypothesis that the data are normally distributed The test is performed with a type I error rate of 5% The type I error rate (shown as the p value in the w test) is the probability of incorrectly rejecting the null hypothesis of normality In the w test a test value < 0 05 results in rejection of the null hypothesis and it is assumed that the data are not normally distributed For lognormally distributed data the log transformed data will fit a normal distribution The w test for normality can be used to test data for lognormal distribution using the natural log transforms of the data

The second method used is the Anderson Darling (A D) test for goodness of fit The goodness of fit test differs from the w test in that the null hypothesis is that the data do not fit a selected distribution Therefore the burden of proof in the goodness of fit test is to show that the data provide a good fit to a selected distribution whereas for the w test the burden of proof is to show that the data are not normal For goodness of fit tests such as the A D test a p value greater or equal to 0 9 is an indication of a good fit (Schulz and Griffin 1999)

The A D test provides a confirmation method of testing for a lognormal distribution The results of the A D test for lognormal fit are used to corroborate the results of the w test particularly in cases where the log transformed data appear not to be normal but the w test p value indicates that the null hypothesis of normality cannot be rejected However since the w test is reputed to be one of the most stringent test available for normality (Schulz and Griffin 1999) the w test p value takes precedence over the A D test results to identify non normal data

Datasets that Fit A Normal Distribution

The population mean (μ) is a measure of the central tendency of a distribution As such it is an appropriate measure of the concentration in a medium (e g sediment) that a receptor may contact throughout the duration of the assumed exposure The population mean typically is estimated using the mean of sample data (*i e* the average) and an upper confidence limit of the mean For datasets that are determined to fit a normal distribution the 95% UCL is calculated using the Student t statistic with the following equation (from EPA 1992)

$$UCL_{95} = \bar{x} + s \times t_{0.05} \Big/ \sqrt{n}$$

where	x	=	sample mean
	s	=	sample standard deviation
	$t_{0.05\ n-1}$	=	one sided t statistic for 5% type I error
	n	=	number of samples

Datasets that Fit a Lognormal Distribution

Datasets are considered lognormal where the w test is greater than 0 05 for log transformed data sets and an Anderson Darling test probability greater than 0 90 The 95% UCLs are calculated using the h statistic[2] as shown below (from EPA 1992a)

$$UCL_{95} = \exp\left(\bar{y} \times 0\ 5 S_y^{\ 2} + S_y \times H_{0\ 5\ \ Sy} \Big/ \sqrt{n-1}\right)$$

where	y	=	mean of ln transformed data
	Sy	=	standard deviation of ln transformed data
	$H_{0\ 95\ n\ Sy}$	=	h statistic for 95% confidence limit
	n	=	number of samples

Besides the h statistical method for datasets that fit a lognormal distribution Schulz and Griffin recommend that an alternative method specifically the Chebychev inequality method be considered The Chebychev method provides an alternative to and check on the h statistic and is considered a conservative estimate of the 95% UCL of a distribution EPA (2002) also provides additional information about the use of the Chebychev inequality to estimate the 95% UCL of log normally distributed data For log normally distributed data the mean and standard error of the mean may be estimated using Minimum Variance Unbiased Estimate (MVUE) equations presented in Gilbert (1987 pg 165) The Chebychev inequality 95% UCL has been shown to be more conservative than UCLs calculated using the other methods described above (EPA 1999) Therefore the Chebychev UCL provides a conservative estimate of the 95% UCL of lognormal data and is used to evaluate whether the h statistic generates a 95% UCL that is unrealistically large The Chebychev UCL equation is shown below

$$UCL_{95} = \mu_1 + 4\ 47 \times \sigma(\mu_1)$$

where	μ_1	=	Ln MVUE mean estimate (Gilbert 1987)
	$\sigma(\mu_1)$	=	Ln MVUE mean standard error (Gilbert 1987)

EPA (1997) has correlated the generation of unrealistic 95% UCLs based on the use of the h statistic with data sets that exhibit high coefficients of variation (CV) and small sample sizes A high CV is also problematic for the Chebychev inequality The CV is defined as the ratio between the standard deviation of the data and the mean expressed as a percentage A high CV according to EPA (1997) is one greater than 100% To correct for this EPA (1997) suggests the use of the Jackknife procedure in estimating the MVUE of the lognormal mean To perform the Jackknife the MVUE of the mean is calculated after deleting one observation at a time in sequence

[2] The h statistic is only functional for standard deviations between 0 10 and 10 If the dataset standard deviation is outside of the bounds the Chebychev and bootstrap methods are evaluated for use in lieu of the h statistic methodology

$$\phi = (n \bullet MVUE) - [(n-1) \bullet MVUE_{-}]$$

Where $MVUE_i$ is the MVUE estimate after deleting the ith sample observation The Jackknifed mean is then

$$\Phi = \frac{\sum(\phi)}{n}$$

The Jackknifed standard error of the MVUE is the sum of squares for the Jackknifed estimates

$$SE_{MVUE} = \sqrt{\frac{\sum(\phi_i - \Phi)^2}{n \bullet (n-1)}}$$

The UCL is then calculated based on the t distribution and the Jackknifed standard error

$$UCL_{95} = \Phi + t_{1\ 0\ 95\ \ 1} \bullet SE_{MVUE}$$

This method is recommended when unrealistic UCLs are suspected from the use of the h statistic on log normally distributed data – specifically when the CV is high (>100%) or when the sample size is low (<30 observations)(EPA 1997)

Datasets that do not Fit either a Normal or Lognormal Distribution

Use of the equations shown above are inappropriate for datasets that through distribution testing fit neither a normal or lognormal distribution or are based on a mixed population of detects and nondetects Therefore alternative methods are used for estimating 95% UCLs for datasets that are considered non normal Non normal data sets provide a poor fit to normal or lognormal distributions and particularly occur where data may be artificially skewed due to biased sampling or through the combination of samples from different populations that occur within a single exposure unit The alternative statistical procedures used for evaluating nonparametric distributions include

1) Bootstrap
2) Bootstrap t
3) Hall s Bootstrap t Transformation and
4) Jackknife

The major advantage of these methods is they can provide a robust approximation of the UCL without having to make assumptions regarding an underlying distribution to the data (EPA 1997) Any method can be used however the Jackknife method tends to be more robust and more conservative (and thus preferred) on datasets with fewer samples

(i e sample sizes less than 15[3]) All of the bootstrap methods assume that the random resampling of the dataset will result in a dataset (i e of bootstrap means t statistic or Q statistic) that will be normally distributed or nearly so For high levels of bias the bootstrap t is designed to normalize the resamples while if the raw dataset is highly skewed Hall s transformation is designed to normalize the resamples

The underlying premise of normality for the bootstrap methods can be comprised in highly mixed datasets (i e those with very high levels of nondetects) or by the presence of outliers within the dataset (see Frey and Burmmaster 1999 Kilian 1998 Kelly 1999) Outliers are particularly troublesome for the bootstrap methods causing violations of the assumptions required for the Edgeworth expansions used in the t bootstrap and Hall s transformed t (see Hall 1992 Davidson and Hinkley 1997) The presence of outliers can actually increase or exacerbate the skewness observed in the parent dataset within the resampled datasets and even cause complete method failure (where the 95th percentile of the bootstrapped distribution is an empty set – see Hall 1992) Similarly if the dataset contains a significant number of non detections whose proxy values are constant the bootstrap resampled dataset can be of n samples with exactly the same value If this occurs there is no variance within the dataset and the bootstrap methods will fail It has been observed that such failures occur most often in smaller datasets (e g < 15 samples) when the percent detection is less than 50% A final salient issue regarding the bootstrap methods is a high level of variability between simulations based on small sample sizes especially in wide ranging datasets Under such circumstances the jackknife method is far more stable (reproducible) and as such the preferred method

A basic discussion of these methods and the underlying assumptions of normality for the resampled data is provided in Efron and Gong (1983) Hall (1992) Davidson and Hinkley (1997) as well as by EPA (1997) with further discussion of the bootstrap methods described in Schulz and Griffin (1999)

Bootstrap Methods The standard bootstrap bootstrap t and Hall s bootstrap t transformation reflect a technique that involves random resampling with replacement of a data set of size *n* to generate many additional simulated data sets of size *n* that may be examined for variability or uncertainty (Schulz and Griffin 1999) The standard bootstrap may provide confidence intervals that have less than nominal coverage probability due to bias and skewness reflected in the data (Schulz and Griffin 1999) Bias is defined as the relative difference between the raw data mean and the bootstrapped mean Bias is not considered significant unless it exceeds 25% of the raw data variance (e g see Efron and Gong 1983) Sample skewness can be tested for significance using the methods presented in Gibbons (1994) If neither bias nor skewness is significant the standard bootstrap is the preferred method because the bootstrap extensions such as the Studentized (t bootstrap) and Hall s transformation (Edgeworth expansions) can result in variable results The bootstrap t method is preferred when bias is high and skewness is insignificant whereas when skewness is high Hall s transformation is the preferred method

[3] A sample size of 15 was selected as none of the validation exercises presented within the references have evaluated sample sizes less than 15 (see also Frey and Burmaster 1999)

The procedure for performing the aforementioned bootstrap methods for a data set containing n samples is described below

Step 1 Calculate the raw data mean standard deviation and skewness

$$\overline{X}_{raw} = \frac{\sum X}{n}$$

$$SD = \sqrt{\frac{\sum \left(X - \overline{X}_{w}\right)^2}{n}}$$

$$v = \frac{\sum \left(X - \overline{X}_{aw}\right)^3}{n \times SD^3}$$

Where X_{raw} equals the mean of the raw data SD_{raw} equals the standard deviation of the dataset and v equals the skewness of the dataset

Step 2 Randomly select n samples (with replacement) from the original n data and calculate the mean and standard deviation Repeat at least1000 times

Step 3 Calculate the mean and standard deviation of each randomly drawn resample of the data set Then calculated a W value as follows

$$W = \frac{\left(\overline{X}_B - \overline{X}_{w}\right)}{SD}$$

Where X_{Bi} and SD_i are the mean and standard deviation of the ith resample of the data set and X_{raw} is the mean of the original data set Repeat at least 1000 times

Step 4 Calculate the Q statistic as a function of W for Hall s adjustment for skewness Repeat 1000 times

$$Q(W_i) = W + \frac{v \times W^2}{3} + \frac{v^2 \times W^3}{27} + \frac{v}{6 \times n}$$

Step 5 Rank the values W_i and $Q(W_i)$ from smallest to largest

For the standard bootstrap calculate the bootstrap mean and standard error

$$\overline{\overline{X}}_{GB} = \frac{\sum_{i=0}^{t} \overline{X}_B}{it}$$

Where it equals the number of iterations (resamples e g 1000) X_{Bi} equals the mean of the ith resample and X_{GB} equals the bootstrap mean The bootstrap standard error is

$$\sigma_B = \sqrt{\frac{1}{it-1} \times \sum_{=0}^{i} \left(\overline{X}_B - \overline{\overline{X}}_{GB}\right)^2}$$

The standard bootstrap 95% UCL is then calculated using the z statistic

$$95\%UCL = \overline{\overline{X}}_{GB} + Z_{0\,05} \times \sigma_B$$

Considering the bootstrap t method the 50th ranked value[4] of W is used to represent $t_{0\,05}$ in the following equation for the 95% UCL

$$95\%UCL = \overline{X}_{\ w} - t_{0\,05} \times SD_{\ w}$$

Hall s bootstrap t transformation proceeds by calculating the inverse of the Q(W) function of the ordered $Q(W_i)$ values

$$W(Q) = \frac{3 \times \left\{ \left[1 + v \times \left(\frac{Q - v}{6 \times n} \right) \right]^{1/3} - 1 \right\}}{v}$$

Here again if 1000 resamples were taken the 50th value represents the 5th percentile such that the 95% UCL is calculated as follows

$$95\%UCL = \overline{X}_{\ w} - W(Q)_{0\,05} \times SD_{\ w}$$

These bootstrap approaches have the advantage that they do not rely on the assumption of a special parametric form for the distribution of the population (EPA 1997) The underlying assumption is however that the calculated X_{Bi} s t statistics (W_i s) and Q(W) s are normally distributed Subsequent to the bootstrap calculations the distribution of the bootstrap statistics (X_{Bi} s W_i s and Q(W) s) is evaluated for departure from normality using the correlation between the expected quantiles of the normal distribution for the bootstrap output and the observed quantiles for the resampled datasets ($Q_{expected}$ $Q_{observed}$ plots see EPA 2002) Such Q Q plots are considered one of the most effective means of evaluating the bootstrap normality fit (see Davidson and Hinkley 1997) If the assumption of normality or near normality cannot be met the more robust jackknife procedure is used (more robust in its sensitivity to departure from normality)

[4] The 50th W value represents the 5th percentile given 1000 resamples

Jackknife Method

The Jackknife procedure is similar to the standard bootstrap as described above When the data cannot be defined as normal or lognormal and the sample size is below 15 the Jackknife is preferred as a more reproducible method The jackknifed mean and standard error are calculated as follows

Step 1 n pseudovalues (ϕ) are first calculated by leaving out each of the observations i in turn

$$\phi = (n \times \overline{X}) - [(n-1) \times \overline{X}_{-i}]$$

Step 2 The jackknifed estimate of the mean is then

$$\Phi = \sum(\phi) - n$$

Step 3 The standard error of the mean is calculated as

$$SE_{mean} = \sqrt{\sum(\phi_i - \Phi)^2 / [n \bullet (n-1)]}$$

Step 4 The upper confidence limit of the jackknifed mean is calculated as

$$UCL_{\alpha} = \Phi + t_{1-\alpha,\ n-1} \bullet SE_m$$

SUMMARY OF METHODS FOR CALCULATING EXPOSURE POINT CONCENTRATIONS

In light of the information presented above the following procedure for calculating EPCs is used The following procedure reflects the methods recommended by EPA (1997 2002) and Schulz and Griffin (1999)

Step 1 Data Evaluation

Prepare summary statistics describing maximum and minimum concentration mean standard deviation minimum reporting limits and percentages of detected concentrations The number of samples is reviewed to determine whether a sufficient number of samples is available for distribution testing

Step 2 Review of Nondetects and Distribution Testing

Data Sets Containing Greater than 50% Nondetect Values Data sets containing greater than 50% non detects are considered nonparametric and either the bootstrap or jackknife statistical procedures is used to determine the 95% UCL If the sample size is below 15 the jackknife procedure is used If bias and skewness are low the standard boostrap is used given high bias and low skewness the bootstrap t method is used and if skewness is high Hall s transformed t bootstrap method is used The resampled dataset is further

assessed for normality (i e the bootstraped mean t statistic and/or Q(W) statistic) using normal $Q_{expected}$ $Q_{observed}$ correlation If the Q Q correlation is poor for either the bootstrap t or Hall s transformed t bootstrap and if the fit is good for the standard bootstrap the standard bootstrap method is used If none of the bootstrap methods are found to be at least approximately normal the more robust jackknife method is used

Evaluation of Data Sets Containing less than 50% Nondetect Values
Data sets containing less than 50% non detects will be evaluated as follows

1 The detected values are tested for normality using the Shapiro Wilks test (w test) For data sets containing more than 50 detected values the D agostino s d test is used A p value of >0 05 is used as the criterion to indicate that the data are normally distributed
2 An untransformed dataset that fails the w test or d test for normality is log transformed and evaluated for lognormality A p value of >0 05 is used as the criterion in the test to indicate that the data are lognormally distributed If the result suggests a lognormally distributed dataset the assumption is validated using the Anderson Darling test If confirmed the dataset is treated as lognormally distributed If not confirmed the dataset is evaluated using nonparametric techniques incorporating lognormal theory
3 Data that do not fit either a normal or lognormal distribution are designated nonparametric data

Step 3 Calculation of the 95% upper confidence limit

1 For normally distributed data (i e the underlying distribution of detected data is normal) the arithmetic mean and standard deviation are calculated The Students t statistic is used to calculate the 95% UCL

2 For lognormally distributed data

   i If the CV is less than 100% the mean and standard deviation of the log transformed data are calculated The 95% UCL is calculated using the h statistic from EPA (1992) Also the Chebychev inequality equation for 95% UCL (EPA 1999) is calculated to validate the results of the h statistic The 95% UCLs from both lognormal theory based equations are compared with the maximum detected concentration If the 95% UCL based on the h statistic exceeds the maximum concentration the lower of the maximum concentration or the Chebychev lognormal 95% UCL value is used as the EPC

   ii If the CV is greater than 100% then the jackknife procedure is used to calculate the standard mean of the MVUE of the lognormal mean from which a 95% UCL is derived

3 When a dataset passes the initial test for lognormality but fails the Anderson Darling conformation test the nonparametric jackknife procedure is used to calculate the

standard mean of the MVUE of the lognormal mean from which a 95% UCL is derived

4 When the underlying distribution is nonparametric then the entire data set including nondetect proxies is considered nonparametric and the nonparametric method (either a bootstrap or jackknife method) for estimating the 95% UCL of uncensored data described above is used to calculate the EPC following the procedures outlined for data sets containing greater than 50% nondetect values

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FIGURE C 1

LOGIC DIAGRAM FOR SELECTING A PARAMETRIC METHOD FOR ESTIMATING THE 95% UPPER CONFIDENCE LIMIT FOR SITE ANALYTICAL RESULTS

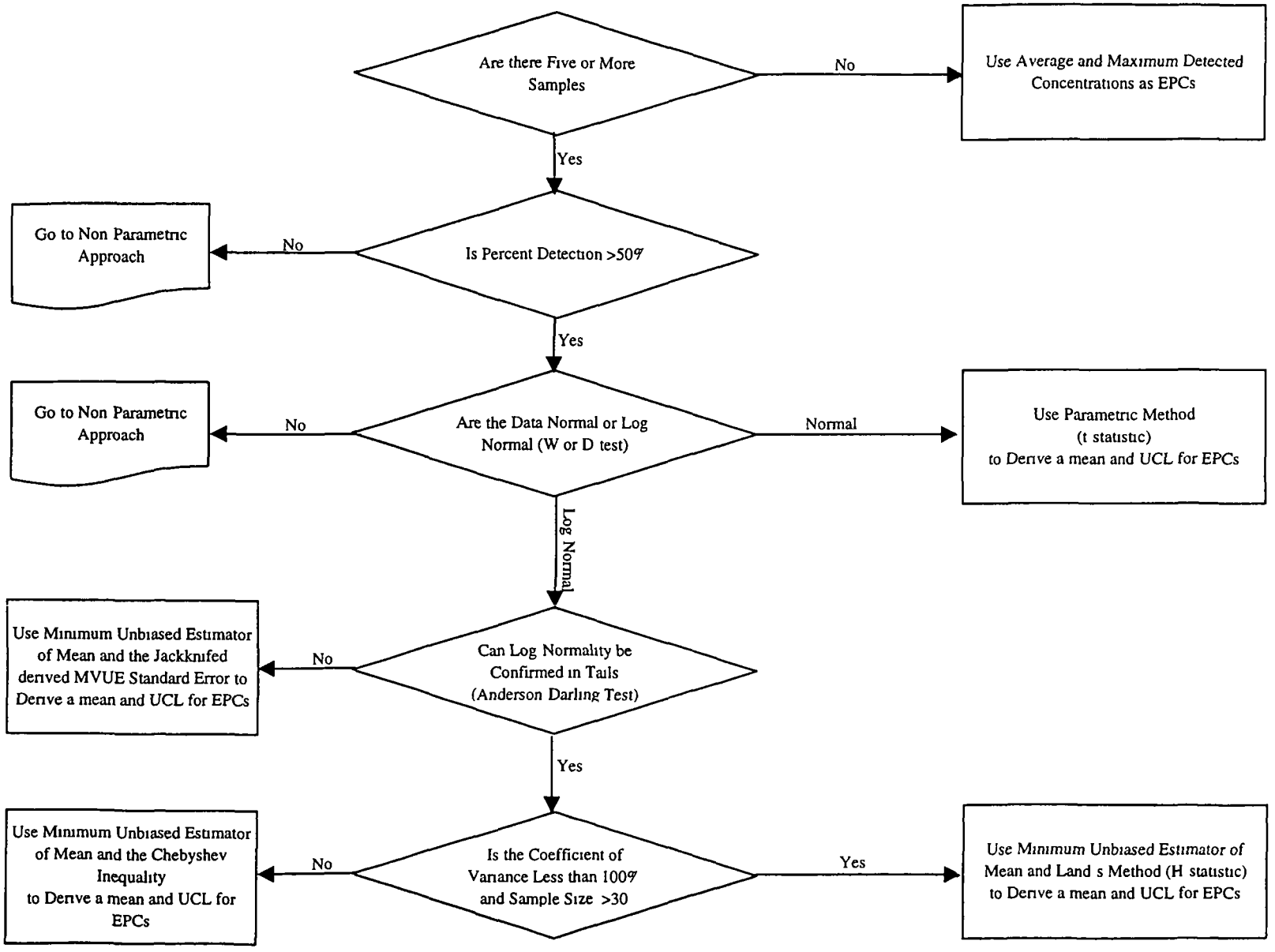
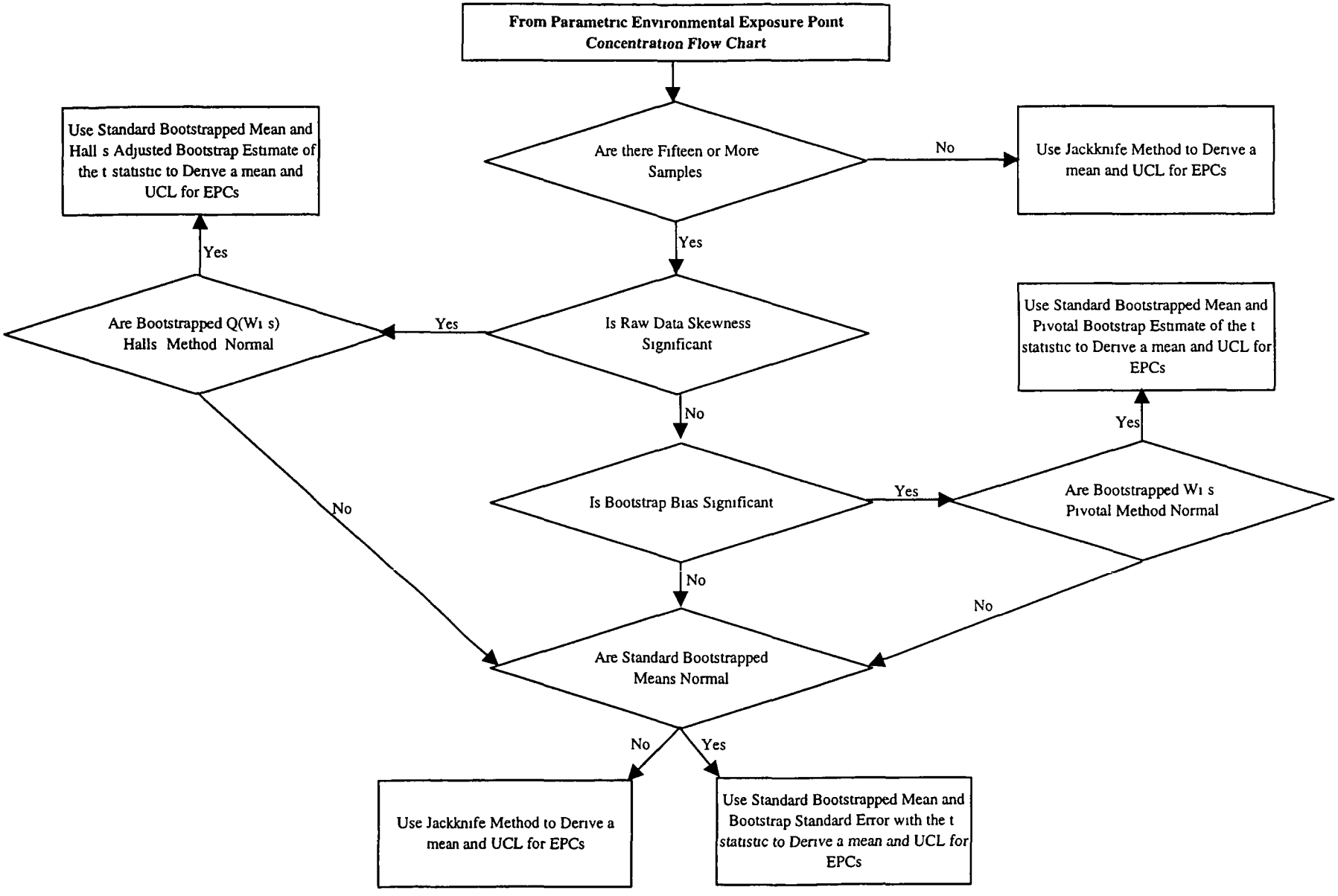


FIGURE C 2

LOGIC DIAGRAM FOR SELECTING A NONPARAMETRIC METHOD FOR ESTIMATING THE 95% UPPER CONFIDENCE LIMIT FOR SITE ANALYTICAL RESULTS