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REPLY TO
ATTENTION OF

September 1, 2000

Hazardous, Toxic and Radioactive
Waste Branch

Ms. Gwen Massenburg (SR-6J)
Remedial Project Manager
USEPA, Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Dear Ms. Massenburg:

Enclosed is the revision to the Himco Dump/Construction Debris Area Supplemental Human Health Risk Assessment. Per discussions among Judy Strawhecker, yourself, and Pat VanLeeuwen, Chapters 5 and 6 and Appendix G have been combined. The text and associated figures and tables describing the methodology/approach have been revised.

Revisions to the calculations and the risk characterization section will be completed after we receive your comments to this revision. In order to prevent continuous changes to the report due to updates to toxicity databases, it is our intent to finalize the report using the toxicity factors presented in the enclosed revised tables. These toxicity factors were current as of August 2000, the date of the revised tables. Please provide your comments NLT September 29, 2000.

If you have any questions regarding the revisions, please contact the Project Manager, Dr. Hugh Stirts, at telephone number (402) 221-7706.

Sincerely,

Douglas A. Plack
Chief, Hazardous, Toxic and
Radioactive Waste Branch
Planning, Programs and Project
Management Division

Enclosure

5. HIMCO DUMP/CDA SUPPLEMENTAL HUMAN HEALTH RISK ASSESSMENT

A supplemental risk assessment (SRA) was conducted for the Himco Dump Superfund Site, located in Elkhart County, Elkhart, Indiana. The objectives of this SRA were to determine the current and future potential human health risks of residual contamination detected in: (1) the CDA area soils to the south of the landfill; (2) shallow ground water south (downgradient) of the landfill, and (3) soil gas along the southern and eastern perimeter of the landfill. The SRA was performed in accordance with USEPA's Risk Assessment Guidance for Superfund (RAGS) (EPA, 1989a) and other relevant USEPA risk assessment guidance documents.

5.1 Previous Risk Evaluations

The analytical data collected during the Himco Dump Remedial Investigation/Feasibility Study (SEC Donohue Inc., 1992), and the baseline risk assessment (BRA) performed indicate the presence of contaminants in various media that may present a risk to human health. The baseline risk assessment assumed no corrective action would take place and that no site-use restrictions or institutional controls such as fencing, ground water use restrictions or construction restrictions would be imposed. The risk assessment then determined actual or potential carcinogenic risks or toxic effects the chemical contaminants at the site pose under either current or future land use scenarios for the landfill property and surrounding area.

The following pathways were selected for detailed evaluation in the BRA under current-use conditions:

- Inhalation of airborne particulates or VOCs released from the site (residents northeast of the site and dirt-bike riders on-site),
- Incidental ingestion of surface soil by trespassers while dirt-bike riding,
- Ingestion of surface water and sediment while wading or fishing,
- Dermal contact with surface water while wading.

The following pathways were selected for detailed evaluation in the BRA under future-use conditions and included future residential, commercial, agricultural, or recreational scenarios. Future residents and workers were evaluated both on the landfill area and south of the landfill. Agricultural workers were evaluated on the landfill area only. The pathways were:

- Inhalation of airborne particulates or VOCs released from the site, including evaluation to a downwind resident as part of an agricultural future use.
- Incidental ingestion of surface soil,
- Ingestion of ground water,
- Inhalation of volatiles released during indoor uses of ground water,
- Dermal exposures to ground water.

The results of the BRA indicate the potential excess lifetime cancer risk for the Himco site exceeds the acceptable Superfund carcinogenic risk range of 1E-04 to 1E-06 principally from the use of contaminated groundwater under the future use scenario. Risks from ingestion, dermal contact and inhalation of volatiles from the ground water present carcinogenic risks in the range of 1E-01. South of the landfill, downgradient, the estimated excess cancer risks to a future resident are approximately 5E-03. As described in the RI report, the method for calculating risks included the assumption that chemicals detected in soil or elsewhere in groundwater (including leachate samples), but not in the wells located south of the landfill, were evaluated at one-half the detection limit. Therefore, approximately 80% of the estimated risk downgradient of the landfill is attributable to "not detected" chemicals. If these chemicals are truly absent, total population cancer risks would be estimated at 1E-03 due primarily to the presence of arsenic and beryllium in ground water and PAHs in soil. The Hazard Index (HI) for humans interacting with the Himco site exceed the acceptable HI of 1.0. For future use of the ground water under the landfill, the HI values are approximately 500 to 1,000. Antimony is the primary contributor to this risk. Other chemicals include arsenic, beryllium, cadmium, chromium, vanadium, alpha-chlordane and nitrate/nitrite.

In addition to ground water, there is an estimated excess cancer risk of 4 to 6E-04 to a future resident living south of the landfill where PAHs were detected in the soil.

An ecological risk assessment was conducted to characterize the biological resources at the site and adjacent habitats, and identify actual and potential impacts to these resources associated with releases of chemical contaminants from the site. Contaminants present in the soil where the prairie communities are located are unlikely to pose adverse impacts to resident species of plants and animals. The greatest hazard to resident organisms (small mammals) occurs in the south/southeast area of the site where contamination levels are increased and more varied. This area is highly disturbed and unlikely to support ecologically significant populations. Other areas of the site were determined to be unlikely to pose a significant threat of adverse effects to exposed organisms.

5.2 Purpose and Scope

The overall objectives of the current supplemental investigation were to gather additional chemical data to complement existing data sets and complete additional human health risk evaluations for specific areas south of the Himco site. The purpose of this current SRA was to conduct human health risk evaluations for specific Himco off-site areas utilizing: 1) previous shallow ground water data south (downgradient) of the landfill, from the September 1995 sampling event conducted by USACE (as documented in the *Final Design Technical Memorandum, Himco Dump Site, Elkhart, Indiana* (USACE, 1996)), and 2) the current investigation characterization data involving CDA soils, soil gas, and shallow ground water south (downgradient) of the landfill, as presented in Section 3. The investigative data and risk evaluation will provide EPA Region 5 with additional information for determining whether further remedial elements are necessary and warranted in the Himco CDA area and for area ground water south and downgradient of the landfill.

5.3 Human Health Supplemental Risk Assessment Methods

This SRA provides a framework for developing the risk information necessary to assist additional decision-making at the Himco site. For this SRA, chronic risks posed by site-related chemicals to current and future potential receptors, known or likely to frequent the CDA area under prevailing land use scenarios, were evaluated assuming that no further engineered remediation of site contamination (as characterized to date) will take place. Because the purpose of a risk assessment is the protection of human health, the methodology of the assessment is designed to be conservative. This protectiveness is achieved by the use of assumptions and models that result in upper bound estimates of risk (i.e., the true or actual risk is expected to fall between the estimated value and zero). A reasonable maximum exposure (RME) was evaluated using both residential and industrial parameters.

As stated above, both current and future use exposure scenarios are developed for the site. The current scenario reflects human exposure pathways to the chemicals of potential concern (COPCs) for each affected site matrix (i.e., soil, ground water, and soil gas) that presently exist. Likewise, the future use scenario represents exposure pathways that are conceivable in the future (potential residential consumption and indoor household use of ground water, or home improvement construction activities).

5.3.1 Conceptual Site Model

Conceptual site models (CSMs) are effective tools for defining dynamics of contaminant migration at sites, streamlining the risk evaluation, establishing hypotheses, and developing appropriate response actions. Such models are mechanisms for identifying completed exposure pathways between physical medial affected by site-related contamination and potential receptors. The CSM (Figure 5-1) is intended to aid in understanding and describing the site and present assumptions regarding:

- Suspected sources and types of contaminants present,
- Contaminant release and transport mechanisms,
- Affected media,
- Potential routes of exposure, and
- Potential receptors that could contact site-related contaminants in affected media under current and future land use scenarios.

The first step in developing the CSM specific to this SRA was to characterize the site with respect to operational, environmental, and chemical characteristics. The next step was to identify which potential receptor exposure pathways are (or may be) completed and which are (and are likely to

remain) incomplete. A pathway is not considered to be completed unless all four of the following elements are present:

- A source and mechanism for chemical release;
- An environmental transport/exposure medium;
- A receptor exposure point; and
- A receptor and a likely route of exposure at the exposure point.

Only completed pathways for which adequate data were available are quantitatively evaluated in the SRA. Principal elements of the CSM for the Himco CDA/downgradient groundwater are reviewed below.

5.3.1.1 Sources, Release Mechanisms, and Affected Media

The Himco Dump Superfund Site is a closed landfill adjacent to Elkhart, IN. The site covers approximately 100 acres and is bounded on the north by a tree line and the northernmost extent of a gravel pit pond; on the south by County Road 10 and private residences; on the east by the Nappanee Street Extension; and a section of land west of two ponds comprise the western boundary.

The landfill was privately operated by Himco Waste Away Service Inc. From 1960 to September 1976 accepting primarily calcium sulfate from Miles Laboratories. Other wastes accepted at the landfill included demolition/construction debris, household refuse, industrial wastes, and hospital wastes. Having stopped receiving waste in 1976, the landfill was then covered with approximately one foot of sandy soil. The western half of the landfill cover is vegetated with grasses; the eastern half with grasses, bushes, and young trees. An area south of the landfill and north of County Road 10, the construction debris area, contains many small piles of rubble, concrete, asphalt, and metal debris. The construction debris area extends across the landfill boundary and onto property owned by adjacent landowners.

Contaminants identified in site soils and/or ground water in previous investigations include pesticides, PCBs, VOCs, SVOCs, and metals. The CSM (Figure 5-1) specifically developed for the CDA area south of the landfill, considers receptor exposure pathways associated with all site environmental media known or inferred to be affected by site-related chemicals, as determined during previous investigations. Potentially affected media include soils, ground water, and air.

Chemical release mechanisms are dependent on the nature of the contaminants and the media in which they occur. Common contaminant release mechanisms include direct discharge, volatilization, generation of fugitive dust, leaching, dissolution into and migration with ground water, and surface runoff. Contaminants could have been directly discharged into environmental media through surface releases and leakage of wastes from the landfill into subsurface media.

Partitioning of contaminants from one phase to another is another type of release/fate mechanism. Soluble chemicals can be leached from soils by infiltrating precipitation or contact with ground water, or may dissolve from free-phase products into underlying ground water. Volatile organic compounds can volatilize into soil gas or the atmosphere. Surface contamination may be spread by overland runoff or precipitation. Nonvolatile chemicals sorbed to surface soils may become entrained in the air as particulates in fugitive dust and then redeposited.

Specific site conditions influence chemical release mechanisms and contaminant migration pathways. For example, surface topography, hydrology, vegetation, and impermeable surfaces such as pavement can control surface runoff, leaching, and the generation of fugitive dust. Climate, soil type, and depth to ground water also affect contaminant leaching. Hydrogeological characteristics and ground water chemistry affect the vertical and horizontal extent and rate of dissolved contaminant plume migration. As environmental media at a site become contaminated, they may serve as secondary sources of contamination by acting as reservoirs of chemicals that are slowly released into other media.

5.3.1.2 Current and Future Land Use Scenarios

Currently, there are residences near the Himco site (east, west, south, and southeast) and industrial and commercial properties southeast of the site (Figure 2-1). The residences located east of the site are downwind and side-gradient (with respect to ground water flow); residents and workers south of the site are upwind and downgradient. With respect to the Himco CDA specifically, the area extends south across the landfill boundary and onto property owned by adjacent landowners.

Several hypothetical future land uses are possible for the Himco site, but may not be technically and/or financially reasonable. Possible future scenarios include development of residences or commercial/industrial properties on site. The composition of the natural soils in combination with the shallow water table and fill material would make construction on the site difficult and potentially costly. Construction along the perimeter of the site (not on the landfill) would be more feasible. Other hypothetical future land uses include recreational or agricultural.

For purposes of this SRA, receptors are defined as humans residing nearby that potentially could be exposed to site-related contaminants in environmental media. Based on current and expected future land uses at or near the site, human receptors include off-site residents to the south in the CDA (with a potable ground water source), and off-site construction workers to the south in the CDA.

5.3.1.3 Characterization of Exposure Pathways

For a site contaminant to pose a potential risk to receptors, there must be a completed exposure pathway form the affected media to the receptor. Receptor exposure pathways potentially associated with affected media are generally described herein. Potentially completed exposure pathways for human receptors are summarized below in the respective human health risk subsections.

Soil Exposure Pathways

Soil represents a transport medium for and a secondary source of site-related contaminants at the subject sites. Potential release mechanisms for contaminants in soil include tracking, excavation, fugitive dust, and volatilization. Many factors affect release and bioavailabiltiy, of soil contaminants. Soil geochemistry, including temperature, pH, organic content, particle size, and moisture content, and contaminant characteristics such as vapor pressure, solubility, and adsorption/desorption rates, are examples of such factors. Uptake of soil contaminants also is affected by the biology of the receptor, including variables such as age, size, sex, lipid content, and metabolic and excretion rates.

Three soil exposure intervals were developed to maximize use of the available CDA soil data and to better quantitatively assess the types of exposures for different receptors: surface soils (0 to 0.5 feet bgs), and mixed soils (0 to 2 feet bgs and 0 to 6 feet bgs). Potential receptors could be exposed to contaminants in soil via ingestion and dermal contact with soil, as well as via inhalation of contaminants in fugitive dust and/or contaminants volatilizing from the soil into the surrounding air.

Ground Water Exposure Pathways

The release mechanisms for ground water include direct releases at or below the water table and leaching of contaminants from soil in infiltrating precipitation. Completed exposure pathways from ground water were assumed to be possible for human receptors (e.g. future off-site residents) that use extracted ground water from the shallow aquifer for potable purposes. (Currently off-site residents in the Himco CDA are on municipal water.) The probability of contact by intrusive workers during construction was considered to be low. It was assumed that if any water in a construction area was encountered, it would be pumped out of the excavation, thereby reducing receptor contact to insignificant levels.

Air Exposure Pathways

Air represents a potential medium for contaminant transport from soils and ground water at the Himco CDA. Release mechanisms could include fugitive dust generation by wind or surface disturbances, and emission of VOCs into the atmosphere. Emissions of VOCs from soil vapors may be triggered or enhanced by ground surface disturbing activities, which serve to loosen near-surface soils. Volatilization of contaminants located in subsurface soils or in ground water, and the subsequent mass transport of these vapors into indoor air spaces also constitutes a potential inhalation exposure pathway.

Receptors evaluated at the subject site could be exposed (via the inhalation route) to contaminants in fugitive dust and VOCs volatilizing from soils or ground water that could migrate through the soil medium and discharge into ambient air and indoor spaces. When considering fugitive dust in particular, two phenomena give rise to dust in air to which a receptor might be exposed:

- Activity on the site; and
- Action of the wind.

Airborne (fugitive) dust to which a construction worker would be exposed is more likely to be raised by the nature of the activities on the site (excavating soil) rather than the action of the wind. Residential receptors in contrast, are more likely to be exposed to fugitive dust via wind erosion. However, because most resident yards typically have ground cover/vegetation, for this investigation it was assumed that levels of airborne dust to which a resident is exposed is insignificant when compared to other routes of exposure.

The discharge of volatiles from soil vapor into ambient air or indoor air was not assessed in this SRA. Although soil gas data were collected in this investigation (and discussed in Section 3), the objectives were to determine if soil gas was indeed migrating from the landfill boundary, and to aid in evaluating remedies proposed from the site. However, these data are not suitable for modeling volatile gas concentrations in ambient air and homes and therefore not quantified in this SRA.

5.3.2 Exposure Areas

The SRA evaluates multimedia risks to receptors for the Himco CDA. Initially during Data Evaluation/Chemicals of Potential Concern (COPC) Selection, the Himco CDA was evaluated as a single operable unit for ground water and soil. After the COPCs had been selected, the CDA was then divided into exposure areas or sub-sites. The exposure areas evaluated in the SRA are associated with the following sources of soil and ground water contamination at the Himco CDA:

- **Individual residences/land parcel soils off-site in the Himco CDA.** Land parcel soils M, O, N, P, S, F, and D (refer to Figure 2-1) were individually (quantitatively) assessed.

- **Ground water well or well-pair locations.** For ground water, individual monitoring wells or well-pairs were selected in order to quantitatively determine exposure to receptors drawing water from different locations of the shallow ground water aquifer south of the Himco site. These various area locations were chosen because previous investigations have indicated ground water contamination at the Himco site is not homogeneous. Monitoring wells WT114A and WT101A were considered one area location (refer to Figure 2-2 for monitoring well locations). Similarly, monitoring well WT115A was considered a second area location. Finally, monitoring wells WT116A and new well WT119A were a third area location.

5.3.3 Data Evaluation

This section briefly reviews the methods used to evaluate data for the SRA. Previous analytical data collected from the shallow ground water aquifer south of the Himco site from the September 1995 sampling event conducted by USACE (as documented in the *Final Design Technical Memorandum, Himco Dump Site, Elkhart, Indiana,* 1996), and present supplemental investigation soil and ground

water (Section 3), were included in the SRA data sets. SRA data sets were developed for the shallow ground water aquifer south of the Himco site and entire CDA soils encompassing 0 to 6 feet bgs. The quality of the data was evaluated with respect to EPA CLP data contract-required quantitation limits (CRQLs) or sample quantitation limits (SQLs), laboratory qualifiers, and blanks. All data collected by USACE and selected for use in the evaluation were validated by EPA in accordance with USEPA Contract Laboratory Program National Functional Guidelines. Validated sample data were treated as follows for risk analysis:

- Rejected ("R"-qualified) data were excluded from the SRA data sets.

- Chemicals which were analyzed for but were not detected were reported with a "U". These sample results, including those qualified with a "UJ", were used in the risk assessment as nondetects.

- Any detected value for an organic chemical which was also detected in the associated blank was qualified with a "B". The sample value was compared to the blank value according to the procedures outlined by EPA (1994b).

- If a single, unqualified analyte value was provided for a given sample/location/date, this value was included in the SRA data sets.

- Values reported as estimated ("J" qualified) were included in the data sets if they were the only value provided for a sample.

- If a chemical was detected at least once in ground water and soil exposure interval, surrogate values for any nondetects for that analyte in the matrix were included in the risk data sets at one-half the CRQL or the SQL.

- For duplicate soil and ground water sample pairs, the most conservative (i.e., greater) value was used. If all values were nondetects, the value representing the highest CRQL or SQL was used, following the SQL surrogate method described above.

5.3.4 Identification of Chemicals of Potential Concern

All chemicals detected in sampled media in the Himco CDA were evaluated to identify preliminary COPCs for human receptors. Several screening steps were performed to focus the SRA on chemicals with a potential to pose a risk to human health. The screening steps included:

- Elimination of essential nutrients;

- Comparison of site concentrations to upgradient concentrations of metals in like media (i.e. site-attribution analysis). This was performed with ground water only;

- Toxicity screening.

5.3.4.1 Essential-Nutrient Screening

A chemical may be excluded as a COPC if it is an essential trace element or dietary requirement, and conservative exposure to the element in site media would result in intakes at or less than health-protective levels. If essential nutrients were present in soil or groundwater, screening was performed by comparing maximum detected concentrations of these analytes to the screening level derived using recommended daily allowances (RDAs) or adequate daily dietary intake levels established for mineral and trace nutrients for children ages 1-10 (if available) and adults (NRC, 1989). To make this comparison, the RDA was first converted to a soil concentration by dividing by the daily intake rate of 0.0002 kg soil/day (the EPA default residential soil ingestion rate for children). For nutrients in groundwater, the screening level was derived by dividing the RDA by 2 L water/day (the EPA default residential drinking water ingestion rate for adults). If the maximum detected concentration was $\geq$ to the RDA-based screening level, the nutrient was listed as a COPC or analyzed further by other screening criteria in the SRA. If the maximum detected concentration was < the RDA, no further analysis was required.

No essential nutrients were retained as site-related COPCs in soil. Only two essential nutrients were retained as site-related COPCs in ground water: calcium and iron. Both calcium and iron were present in ground water at Himco at concentrations above their respective intakes at health-protective levels. The calcium screening exceedence only occurred in 1995 in WT116A. When the 1995 and 1998 (current) data were averaged from the individual wells or well-pairs for the determination of an exposure point concentration, average calcium concentrations were well below the RDA screening value. Although no adverse effects have been observed in many healthy adults consuming up to 2,500 mg of calcium per day, high intakes may induce constipation and place up to half of otherwise healthy hypercalciuric males at increased risk of urinary stone formation. A high calcium intake may inhibit the intestinal absorption of iron, zinc, and other essential nutrients (NRC, 1989).

Iron RDA screening exceedences in ground water were consistently seen in well-pair WT101A/WT114A in both 1995 and in the current investigation. With excess dietary intake, iron overload may include disturbances of liver function, diabetes mellitus, endocrine disturbances, and cardiovascular effects (Amdur *et al.*, 1991).

5.3.4.2 Site-Attribution Analysis

Validated analytical results for non-nutritive metals detected in upgradient and downgradient ground water were compared to identify constituents present at concentrations above upgradient levels (i.e. site-related). All organic chemicals detected were considered to be site-related, and were not subject to site-attribution analysis. A site-attribution evaluation was not performed for the soil medium due to the fact that background soil data (0-2 feet bgs) presented in the RI/FS (SEC Donohue Inc., 1992), were only based upon three sampling points.

Upgradient shallow aquifer ground water data were collected in this investigation and from the 1995 USACE ground water sampling event (as documented in the *Final Design Technical Memorandum, Himco Dump Site, Elkhart, Indiana* (USACE, 1996)). Data from both sampling events for upgradient wells WT102A and WT112A were combined and averaged (arithmetic mean) to determine upgradient ground water quality. The maximum detected concentration of a chemical constituent from the combined 1995/1998 shallow aquifer ground water data set south of the Himco site were then compared to the average upgradient shallow aquifer ground water concentration as part of the COPC selection process. If the maximum detected concentration was greater than the average upgradient concentration for an analyte, then the analyte was retained as a COPC.

A summary of site-related non-nutritive metals in Himco downgradient shallow aquifer ground water is as follows:

-Aluminum	-Manganese
-Antimony	-Selenium
-Arsenic	-Thallium
-Barium	-Vanadium
-Cobalt	-Zinc
-Lead	-Cyanide

The results of the site-related ground water screening information are discussed in Section 5.4.1.2.

5.3.4.3 Toxicity Screening/Risk-Based Screening Comparisons

Maximum detected concentrations and risk-based screening values for preliminary COPCs in each medium for CDA soils and ground water shallow aquifer south of the site were compared to focus the SRA on those chemicals with a potential to pose an unacceptable risk to the receptors evaluated. Chemicals that exceeded their respective risk-based screening values were retained for further analysis. The risk-based screening values were based on chronic receptor-specific exposures.

The analytical data were compared to Preliminary Remediation Goals (PRGs) generated by EPA Region 9 (EPA 1999) for residential exposure to soil (via ingestion, inhalation, and dermal absorption) and groundwater (via ingestion and inhalation). The screening process is based upon the PRGs having an excess cancer risk of 10^{-6} and an adjustment to reflect a hazard quotient (HQ) of 0.1 for non-carcinogens. These adjustments are made to provide additional protection for simultaneous exposure to multiple chemicals. For carcinogens, the method for calculating PRGs uses an age-adjusted soil ingestion factor that takes into account the difference in daily soil ingestion rates, body weights, and exposure duration for children from 1 to 6 years old and others 7 to 31 years old. This health-protective approach is chosen to take into account the higher daily rates of soil ingestion in children as well the longer duration of exposure that is anticipated for a long-term resident. For non-carcinogenic concerns, the more protective method of calculating a soil PRG is to evaluate childhood exposures separately from adult exposures. In other words, an age-adjustment factor is not applied as was done for carcinogens. This approach is considered conservative because

it combines the higher 6-year exposure for children with chronic toxicity criteria which in most cases is considered overly protective.

If no PRG exists for a given chemical constituent, this means there is no toxicity information available for determining an appropriate value protective of human health. Those chemicals with no toxicity data available were eliminated from the COPC toxicity evaluation.

Soil screening levels for the protection of ground water were not included in the screening process because ground water was directly sampled and analyzed in past and present USACE Himco investigations.

Chemical-Specific Screening Considerations

Inorganic lead-For surface and near surface soils, the EPA Office of Solid Waste and Emergency Response (OSWER) 400 mg/kg lead screening level for residential soil was used as the screening level for inorganic lead (EPA, 1998, 1994c). The 15 μg/L action level for lead in drinking water was used to screen inorganic lead in groundwater.

For soils, lead was detected above the residential screening level in Land Parcel F in only one surface soil sample at 695 mg/kg-which was "J" qualified, or estimated below the reporting limit. This concentration, being over the 400 mg/kg screening level would warrant additional investigation. Although lead toxicity has been well-studied, toxic effects from chronic low-level exposure are subtle and normally cannot be detected in children and adults. Hence, establishing a clear toxicity threshold has proven difficult. The adverse effects of lead on the central nervous system and intellectual potential in young children are long-lasting and may be permanent. For investigating childhood lead exposure, the Integrated Exposure Uptake Biokinetic (IEUBK) model would be used to predict blood levels associated with site-related data (EPA, 1994d). The blood lead levels estimated by this model are used as an indicator of risk, where risk is defined as the percent probability of exceeding the blood level of concern (i.e., 10 μg/dL). Due to the fact this lead level is confined to only one location and only in surface soil, it does not represent a site-related or widespread occurrence and will not be investigated further.

Screening Considerations for Non-Detects

In some cases, the SQL or CRQLs for certain analytes were equal to, or greater than, the risk-based screening levels (RBSLs) of the corresponding analytes. In such cases where the quantitation limit was ≥ to the RBSL, and <u>all</u> analytical results for a particular contaminant and medium for the entire Himco CDA were reported as "non-detects", it was not appropriate to remove these analytes from the risk assessment process.

The compounds not detected in the entire Himco CDA soils and area ground water that have detection limits greater than RBSLs (analyzed at a dilution factor of one), are listed in Table 5-1. These chemicals are noted as being COPCs, but were eliminated from the quantitative risk assessment. If the chemical was able to be detected at a lower quantitation limit, then its presence and concentration could in fact be toxic and contribute significantly to the reported estimated risks.

5.3.5 Exposure-Point Concentrations

Exposure-point concentrations (EPCs) are intended to be representative of the concentrations of chemicals in a given medium to which a receptor may be exposed at a specific site (i.e., the exposure point). For the SRA, EPCs were estimated using analytical data obtained from site sampling or using modeling (e.g., outdoor air concentrations derived from chemical concentrations in soil, or indoor air concentrations derived from chemical concentrations in ground water). The EPCs for ingestion and dermal contact were equal to the representative site conditions for the affected exposure media. Exposure point concentrations for human exposures to particulates and VOCs in air were estimated as described in *Soil Screening Guidance: Technical Background Document* (EPA, 1996) and the Andelman model (1990). Current concentrations in soil and ground water were assumed to be representative of future concentrations. Table 5-2 summarizes the potentially exposed receptors, and how the EPCs were developed for this SRA.

5.3.5.1 Exposure-Point Concentrations for Soil

Once COPCs were selected, the maximum chemical concentration in each exposure interval from each individual residence/parcel of land was used as the EPC in site soils. (Please refer to Figure 2-1 for individual residences/land parcel locations.) The maximum chemical value was chosen because the individual land parcel data sets had fewer than 10 samples, and thus provide poor estimates of the arithmetic mean concentration. Table 5-2 summarizes the potentially exposed receptors and the exposure intervals used for determining the EPC for the quantitative risk assessment.

5.3.5.2 Exposure-Point Concentrations for Ground Water

The results of the current shallow ground water investigation and those from the September 1995 sampling event conducted by USACE (as documented in the *Final Design Technical Memorandum, Himco Dump Site, Elkhart, Indiana* (USACE, 1996)), were utilized in the risk assessment to determine risk via ground water.

Because multiple sampling results were available for individual wells in the shallow aquifer south of the Himco site, average data from individual wells or well-pairs were used to obtain the best approximation of the EPC for chemicals in ground water. This approach was utilized to compensate for quarterly or yearly variations in data such as changing climatic or hydrogeological conditions. For this SRA, after ground water COPCs were determined, individual monitoring wells or well-pairs were selected to quantitatively determine exposure to receptors drawing water from different locations of the shallow ground water aquifer south of the Himco site. These various area locations were chosen because present and past investigations have indicated ground water contamination at the Himco site is not homogeneous. 1995 and 1998 (current) ground water data from shallow aquifer wells WT114A and WT101A were averaged together to estimate an EPC for one exposure location. (Please refer to Figure 2-2 for monitoring well locations). Similarly, 1995 and 1998

shallow aquifer data from well WT115A were also averaged together to estimate an EPC for a second exposure location. Finally, 1995 and 1998 ground water data from shallow aquifer wells WT116A and WT119A (a well installed in 1998) were also averaged together to estimate and EPC for a third exposure location.

5.4 HUMAN HEALTH SRA

The human health SRA provides an evaluation of potential risks to human health posed by chemicals identified at each of the exposure areas within the Himco CDA and ground water shallow aquifer downgradient of the Himco Dump site. As presented in EPA guidance documents, this SRA will follow a four-step evaluation process that includes:

- Data evaluation and identification of COPCs;
- Exposure Assessment;
- Toxicity assessment; and
- Risk characterization.

Each of these steps is discussed in detail below.

5.4.1 Data Evaluation/Selection of Chemicals of Potential Concern

All chemicals detected in soil and ground water in the entire CDA were evaluated to identify COPCs. The chemicals remaining upon completion of the data evaluation steps (see Section 5.3.3) and essential-nutrient and site-attribution analysis steps (see Section 5.3.4) were retained for further evaluation for the site-specific human health SRA. A comparison was made between the maximum detected concentrations and RBSLs for each media. Chemicals that exceeded their respective RBSLs were retained as COPCs. The following subsections summarize the human health chronic toxicity screens used to determine COPCs for soil and ground water at the Himco CDA.

5.4.1.1 Soil

A soil chronic toxicity screen was conducted for the entire CDA mixed (0 to 6 foot bgs) soil interval. Maximum detected preliminary COPC concentrations were compared to EPA Region 9 (1999) residential PRGs. For analytes with a PRG based on non-carcinogenic effects, an adjusted value of one-tenth the PRG was used to account for any possible additive adverse effects from multiple contaminant exposure. Chemicals with soil concentrations less than the applicable PRGs were eliminated from further risk analysis.

The comparison of maximum detected mixed soil chemical concentrations to the PRG screening criteria for the Himco CDA soils is presented in Table 5-3. The chemicals that exceeded their

respective screening criteria and are retained as COPCs for the quantitative risk evaluation are the following:

-Aluminum	-Benzo(a)anthracene
-Antimony	-Benzo(b)fluoranthene
-Arsenic	-Benzo(k)fluoranthene
-Copper	-Benzo(a)pyrene
-Manganese	-Indeno(1,2,3-cd)pyrene
-Mercury	-Dibenz(a,h)anthracene
-Nickel	

5.4.1.2 Ground Water

Downgradient shallow aquifer ground water data were evaluated for Himco. Toxicity screening based upon potential ingestion of ground water was performed by comparing the maximum detected chemical concentration in ground water to EPA Region 9 (1999) residential tap water PRGs. For analytes with a PRG based on non-carcinogenic effects, an adjusted value of one-tenth the PRG was used to account for any possible additive adverse effects from multiple contaminant exposure. Those chemicals with maximum concentrations in ground water less than the applicable tap water PRGs were eliminated from further risk analysis.

The comparison of maximum detected chemical concentrations in ground water to the PRG screening criteria for Himco is presented in Table 5-4. The chemicals that exceeded their respective screening criteria and are retained as COPCs for the quantitative risk evaluation are the following:

-Antimony
-Arsenic
-Calcium
-Iron
-Manganese
-Thallium
-1,2-Dichloropropane
-Benzene
-Carbazole
-bis(2-Ethylhexyl)phthalate

5.4.2 Exposure Assessment

The exposure assessment consists of three main steps:

- Evaluation of exposure pathways and identification of receptors;
- Estimation of exposure-point concentrations; and
- Estimation of human intake.

Each of these steps is described in detail in the following subsections.

5.4.2.1 Evaluation of Exposure Pathways and Receptor Identification

A site-specific CSM was used to qualitatively define the type of potential exposures to contaminants at or migrating from a site (i.e., to systematically evaluate the impact of chemicals in relevant media to potential receptors). Such models are mechanisms for identifying potentially completed exposure pathways between physical media affected by site-related contamination and potential receptors. A general description of CSMs is provided in Section 5.3.1, and the potentially complete exposure pathways and human receptors at the Himco CDA are identified in this section.

Consistent with RAGS (EPA, 1989a), current and future land-use scenarios were considered for each sub-site. Potential receptors at the Himco CDA include current and future off-site residents (adult and child) and current and future off-site construction workers involved in resident home improvement projects.

Current and Future Off-Site Resident

Current and future off-site residents were defined as individuals that reside nearby the Himco CDA; specifically, the Himco CDA extends south across the landfill boundary and onto property (off-site) owned by adjacent landowners. Current and future off-site residents were assumed to be exposed to surface soils, and mixed soils (gardening) in the land parcel areas (designated in Figure 2-1), and exposed to ground water at various monitoring well or well-pair locations previously discussed and illustrated in Figure 2-2. Current and future off-site residents were assumed to be exposed to surface soils, and mixed soils (down to 2 feet bgs) via ingestion, and dermal contact. Inhalation of particulate matter and volatiles were not quantified because: 1) typically residences have some sort of vegetative cover and it was assumed that levels of airborne dust to which a resident is exposed is insignificant when compared to other routes of exposure, and 2) soil COPCs identified in the CDA were not volatile (defined as having a Henry's Law constant greater than 10^{-5} atm-m^3/mol and a molecular weight less than 200 g/mol (EPA 1999)). In addition, future residents were assumed to be exposed to ground water via ingestion (drinking water), dermal contact, and inhalation of volatiles while performing household activities, showering, or bathing.

Current and Future Off-Site Construction Worker

A current and future off-site construction worker was defined as an individual who works in the CDA near the Himco landfill site, and is involved in resident home improvement construction projects. Intrusive workers (i.e., construction workers) were assumed to be exposed to mixed soils (0 to 6 feet bgs) via ingestion of soil, dermal contact with soil, and inhalation of VOCs and dust. Inhalation of VOCs was not quantified because none of the soil COPCs were volatile. It was assumed that any construction activities involving mixed soil disturbances would (conservatively) encompass 188 days for less than one year. Because the depth to ground water is approximately 10

feet bgs, there is a low probability of contact by a construction worker during excavation activities. Given modern construction techniques, the use of dewatering pumps, and Occupational Safety and Health Agency (OSHA) prohibitions against working in excavations with free standing water, exposure to ground water was assumed to be incomplete for the construction worker.

5.4.2.2 Estimation of Exposure-Point Concentrations

In assessing the possible exposures of receptors to site contaminants for the SRA, an EPC was calculated for each chemical in each medium and shown in Tables 5-5 and 5-6. As previously stated, once the COPCs were selected, the maximum chemical concentration in each exposure interval from each individual residence/parcel of land was used as the EPC in site soils. For ground water, after ground water COPCs were determined, data from two sampling rounds were available for individual wells in the shallow aquifer south of the Himco site. Therefore, average data from individual wells or well-pairs from two rounds of sampling the shallow aquifer south of the Himco site were used to obtain the best approximation of the EPC for COPCs in ground water. Exposure point concentrations are the concentrations of chemicals in a given medium to which a receptor may be exposed at a specific location known as the "exposure point". Exposure point concentrations can be based on analytical data obtained from site sampling or estimated using modeling. Section 5.3.5 describes the estimation of EPCs for soil and ground water. Exposure point concentrations for the inhalation route are described below.

Contaminants Volatilized from Soil

Since there were no volatiles identified as COPCs in surface or subsurface soil, inhalation of vapors from the soil is considered incomplete and was not evaluated further in this SRA.

Contaminants in Fugitive Dust

Exposure point concentrations for fugitive dust inhalation (for the construction worker) were calculated using the following equation based on EPA (1996).

$$C_a = \frac{C_S}{PEF} \qquad \textbf{(1)}$$

where:

C_a = contaminant concentration in outdoor air at the exposure point (mg/m^3);
C_s = contaminant concentration in soil (mg/kg);
PEF = activity-specific soil-to-air particulate emission factor (m^3/kg) (1.42E+09 m^3/kg)

The particulate emission factor (PEF) relates the concentration of the soil COPC with the

concentration of dust particles in the air. This calculation addresses dust generated from open sources, which is termed "fugitive" because it is not discharged into the atmosphere in a confined flow. Particulate emission factor calculations included standard default values and the Q/C term specific to the site's sizes and meteorological conditions (specifically, the Q/C term for Chicago, IL, and a 0.5 acre contaminated area). As such, particulate concentrations in air were calculated by dividing the mixed soil concentrations for each COPC in each land parcel by the default PEF of 1.42E+09.

Contaminants Volatilized from Ground Water

Exposure-point concentrations of VOCs in air due to volatilization from ground water were estimated for showering and whole-house use exposures, (applicable to the off-site resident receptor), using the Andelman models (Andelman, 1990). Although a child residential receptor may typically take baths rather than shower, the shower model (using a bath duration time) was still assumed to be an adequate and conservative estimate for deriving VOC EPCs in air from ground water for a child resident. This assumption is based on the following: 1) water volumes from a shower versus a bath are comparable (150 L); as well as 2) comparable water use transfer efficiencies (percent volatilization) as determined for radon by Prichard and Gesell (1981) as referenced by Andelman (1990) (shower - 63% vs. bath - 47%).

The Andelman models for a shower and whole-house exposures are simple models. It employs the use of a one-compartment area and assumes the rate of volatilization is constant. It further assumes that all volatile constituents (i.e., constituents with a Henry's law constant of 2E-6 atm-m^3/mol or greater) are equally volatilized and that below a threshold Henry's law constant of 2E-6 atm-m^3/mol no volatilization occurs. In the case of very volatile compounds, this approach may be adequate, but it will tend to overestimate exposure if semivolatile constituents are included in risk assessment.

Exposure point concentrations of VOCs in air due to volatilization from ground water during showering were calculated with the following equation:

$$C_a = \frac{C_w \times f \times F_w \times t}{2\,V_a} \qquad \textbf{(2)}$$

where:

C_a	=	air concentration in shower (μg/m^3);
C_w	=	concentration of chemicals in the ground water (μg/L);
f	=	fraction volatilized in the shower (unitless);
F_w	=	flow rate of the shower water (L/hr);
t	=	time in the shower (hr); and
V_a	=	volume of the shower chamber (m^3).

Exposure-point concentrations of VOCs in air due to volatilization from ground water during

household use activities, applicable to the resident, were estimated with the following equation:

$$C_{a-h} = \frac{C_w \times F_{w-h} \times f_h}{HV \times k \times ER} \quad \textbf{(3)}$$

where:

C_{a-h}	=	Air concentration in the house ($\mu g/m^3$);
C_w	=	concentration of COPC in the ground water ($\mu g/L$);
F_{w-h}	=	water use rate in the house (L/day);
f_h	=	fraction volatilized in the house (unitless);
HV	=	volume of the house (m^3);
k	=	mixing coefficient (unitless); and
ER	=	air exchange rate (exchanges/day).

5.4.2.3 Estimation of Human Intake

Human intake, expressed as milligrams of chemical per kilogram of body weight per day (mg/kg-day), is obtained by multiplying the EPC by several exposure factors with are specific to an exposure scenario.

EPA (1992) defines two types of exposure estimates currently used for Superfund risk assessments: a reasonable maximum exposure (RME) and a central tendency (CT) exposure. The RME is defined as the highest exposure that reasonably could be expected to occur for a given exposure pathway at a site, and is intended to account for both uncertainty in the contaminant concentration and variability in the exposure parameters. Given the fact that this is a supplemental risk evaluation and there are residences near the site (off-site), only the RME scenario was estimated. This approach is conservative because the RME is based on the upper bound estimates of the input parameters.

In accordance with EPA guidance (1989a), human intakes for carcinogens were calculated differently from those for noncarcinogens. For carcinogens, human intake was averaged over an assumed lifetime of 70 years. This is appropriate because cancer is considered to be a non-threshold phenomenon and because multiple individual chemical exposures which could result in the development of cancer are accrued over a lifetime. The probability of developing cancer is believed to be proportional to the duration and intensity of exposure. That is to say, the probability of developing cancer is proportional to the dose of chemical absorbed into the body, the frequency of exposure, and the length of exposure.

Because contact rates, body weights, and exposure durations are different for children and adults, carcinogenic risks for residential receptors during the first 30 years of life were calculated using an

age-adjusted factor for each exposure route. This factor estimates the total exposure to an individual by combining contact rates, body weights, and exposure durations for children 1 to 6 years old and others from 7 to 31 years old. The models used for estimating the age-adjusted factors for the ingestion, dermal contact, and inhalation pathways are discussed in further detail later in this section.

For non-carcinogens, the intake was averaged over the duration of exposure. This reflects the assumption that non-carcinogenic effects have a toxicity threshold. Adverse health effects would result if the toxicity threshold were exceeded for a period of time during an average lifetime. That is, lifetime exposure of a receptor to a chemical at a concentration below the threshold is not expected to result in adverse effects.

In this SRA, a childhood-only exposure scenario was used to evaluate off-site residential non-cancer hazards. This approach is considered conservative because it combines the higher 6-year exposure (and hence higher intake) for children with chronic toxicity criteria. The issue of using a chronic reference dose (RfD) to evaluate childhood exposures was explored by EPA (1996) for developing Soil Screening Levels (SSLs), which does use the childhood-only approach. EPA (1996) noted that this approach was appropriate for chemicals such as nitrate/nitrite and fluoride, for which the verified chronic oral RfDs are based on empirical data from childhood exposures, and for chemicals with steep dose-response curves. For most other chemicals EPA determined that this approach may be overly protective.

The primary exposure parameters used to estimate risk/hazard per the equations presented below, the justification for the parameter values used, and the references for the values selected are summarized in Tables 5.7 and 5.8.

Incidental Ingestion of Soil

Incidental soil ingestion is a plausible exposure pathway for the off-site construction worker and the adult and child resident. The ingested intake of COPC in soil for the construction worker (cancer and non-cancer evaluation) and child resident (non-carcinogenic) was estimated from the equation:

$$I_s = \frac{C_s \times IR_s \times FI_s \times EF \times ED \times CF}{BW \times AT} \qquad \textbf{(4)}$$

where:

I_s	=	intake, the amount of COPC in soil (mg/kg-day);
C_s	=	concentration of COPC in soil (mg/kg);
IR_s	=	ingested rate of soil (mg/day);
FI_s	=	fraction of exposure attributed to site soil (unitless);
EF	=	exposure frequency (days/year);

ED	=	exposure duration (years);
CF	=	conversion factor (1E-6 kg/mg);
BW	=	body weight (kg); and
AT	=	averaging time (days).

The FI from the source medium is defined as the fraction of soil or dust contacted that is presumed to be contaminated (EPA, 1989a). If site-specific considerations should indicate that exposure exists for two or more media, then the value of FI would be less than one for each source media. The fraction of exposure attributed to soil was assumed to be 1.

Because daily soil ingestion rates are different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age-adjusted factors. These factors approximate the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations for two age groups, small children and adults. The equation used to calculate the age-adjusted factor for the ingestion pathway for the off-site resident is shown below:

$$IFS_{adj} = \frac{ED_{child} \times IR_{child}}{BW_{child}} + \frac{(ED_{tot} - ED_{child}) \times IR_{adult}}{BW_{adult}} \quad \textbf{(5)}$$

where:

IFS_{adj}	=	age adjusted ingestion rate factor for soil ingestion(mg-yr/kg-day);
ED_{child}	=	exposure duration for a child (years);
IR_{child}	=	ingestion rate of a child (mg/day);
BW_{child}	=	body weight of a child (kg);
ED_{tot}	=	exposure duration for a resident (years);
IR_{adult}	=	ingestion rate of an adult (mg/day); and
BW_{adult}	=	body weight of an adult (kg).

The equation used for estimating the intake for carcinogenic constituents via ingestion of soil for the age-adjusted resident is:

$$I_s = \frac{C_s \times IFS_{adj} \times EF \times CF \times FI_s}{AT} \quad \textbf{(6)}$$

where:

I_s	=	intake of COPC in soil (mg/kg-day);
C_s	=	concentration of COPC in soil (mg/kg);
IFS_{adj}	=	age-adjusted ingestion rate factor for soils (mg-yr/kg-day);

EF	=	exposure frequency (days/year);
CF	=	conversion factor (1E-6 kg/mg);
FI_s	=	fraction of exposure attributed to site soil (unitless); and
AT	=	carcinogenic averaging time (days).

Dermal Contact with Soil

Dermal exposure to COPCs from soil is a potential exposure pathway for the off-site construction worker and the adult and child resident. Dermal exposure to contaminants in soil was estimated using the methodology and algorithms described in *Dermal Exposure Assessment: Principles and Applications* (EPA, 1992).

The dermally absorbed dose for the construction worker (cancer and noncancer evaluations) and resident (noncancer evaluation) of a soil COPC was estimated from the equation (EPA, 1992):

$$DAD = \frac{DA_{event} \times SA \times EF \times ED}{BW \times AT} \quad \textbf{(7)}$$

where:

DAD	=	average dermally absorbed dose of COPC (mg/kg-day);
DA_{event}	=	dose absorbed per event (mg/cm^2-event);
SA	=	surface area of the skin available for contact with the soil (cm^2);
EF	=	exposure frequency (events/year);
ED	=	exposure duration (years);
BW	=	body weight (kg); and
AT	=	averaging time (days).

DA_{event} (mg/cm^2-event) for contaminants in soil was calculated using the following equation (EPA, 1992):

$$DA_{event} = C_s \times CF \times AF \times ABS \quad \textbf{(8)}$$

where :

DA_{event}	=	dose absorbed per event (mg/cm^2-event);
C_s	=	concentration of COPC in soil (mg/kg);
CF	=	conversion factor (1E-6 kg/mg);
AF	=	soil-to-skin adherence factor (mg/cm^2-event);
ABS	=	absorption fraction (unitless, chemical-specific value);

Absorption fraction (ABS) values have been empirically determined for very few chemicals. EPA default values were used where chemical-specific data are unavailable.

The dermally absorbed dose for the age-adjusted off-site resident (cancer evaluation) was calculated by:

$$DAD = \frac{DA_{event} \times SFS_{adj} \times EF}{AT} \quad \textbf{(9)}$$

where:

DAD	=	average dermally absorbed dose of COPC (mg/kg-day);
DA_{event}	=	dose absorbed per event (mg/cm^2-event);
SFS_{adj}	=	age-adjusted soil skin contact factor (cm^2-year/kg);
EF	=	exposure frequency (events/year); and
AT	=	carcinogenic averaging time (days).

The age-adjusted soil skin contact factor is as follows:

$$SFS_{adj} = \frac{ED_c \times SA_{sc}}{BW_c} + \frac{(ED_{tot} - ED_c) \times SA_{sa}}{BW_a} \quad \textbf{(10)}$$

where:

SFS_{adj}	=	age-adjusted soil skin contact factor (cm^2-year/kg);
ED_c	=	exposure duration, residential child (years);
SA_{sc}	=	surface area of skin available for contact with soil, residential child (cm^2);
BW_c	=	body weight, child (kg);
ED_{tot}	=	exposure duration, resident, total (years);
SA_{sa}	=	surface area of skin available for contact with soil, residential adult (cm^2); and
BW_a	=	body weight, adult (kg).

Inhalation of Particulates/Fugitive Dust

The construction worker may be exposed to airborne dust from surface and subsurface soils. Recent EPA (1996) guidance does not recommend estimating intakes (i.e., mg/kg-day) for the air inhalation pathway. Rather, risks and hazards were determined by comparing estimated particulate air concentrations (see Section 5.4.2.1) adjusted for exposure frequencies/durations/time with inhalation toxicity values. Refer to the risk characterization section (Section 5.4.4) for specific methods used to estimate risks/hazards for the fugitive dust air inhalation pathway.

Ingestion of Ground Water

Ingestion of COPCs in drinking water is a plausible exposure pathway for the off-site adult and child resident. The ingested intake of COPC in ground water for the child resident (non-cancer) was estimated as follows:

$$I_w = \frac{C_w \times IR_w \times EF \times ED \times CF}{BW \times AT} \qquad \textbf{(11)}$$

where:

I_w	=	ingested intake of COPC in drinking water (mg/kg-day);
C_w	=	concentration of COPC in ground water (µg/L);
IR_w	=	drinking water ingestion rate (L/day);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
CF	=	conversion factor (1E-3 mg/µg);
BW	=	body weight (kg); and
AT	=	averaging time (days).

The ingested carcinogenic dose was calculated using an age-adjusted ingestion rate factor to reflect an average daily lifetime exposure for the resident. The age-adjusted water ingestion rate factor is as follows:

$$IFW_{adj} = \frac{ED_{child} \times IRW_{child}}{BW_{child}} + \frac{(ED_{tot} - ED_{child}) \times IRW_{adult}}{BW_{adult}} \qquad \textbf{(12)}$$

where:

IFW_{adj}	=	age-adjusted ingestion rate factor for drinking water (L-yrs/kg-day);
Ed_{child}	=	exposure duration for a child (years);
IRW_{child}	=	drinking water ingestion rate of a child (L/day);

BW_{child}	=	child's body weight (kg);
Ed_{tot}	=	exposure duration total (years);
IRW_{adult}	=	drinking water ingestion rate of an adult (L/day); and
BW_{adult}	=	adult's body weight (kg).

The ingested dose of COPCs in ground water for the off-site age-adjusted resident (cancer evaluation only) was estimated as follows:

$$I_w = \frac{C_w \times IFW_w \times EF \times CF}{AT} \quad \textbf{(13)}$$

where:

I_w	=	ingested intake of COPC in drinking water (mg/kg-day);
C_w	=	concentration of COPC in ground water (μg/L);
IFW_{adj}	=	age-adjusted drinking water ingestion factor (L-year/kg-day);
EF	=	exposure frequency (days/year);
CF	=	conversion factor (1E-3 mg/μg); and
AT	=	carcinogenic averaging time (days).

Dermal Contact with Ground Water

Quantification of dermal uptake of constituents from water depends on a permeability coefficient (Kp), which describes the rate of movement of a constituent from water across the dermal barrier to the systemic circulation (EPA, 1992). Ground water dermal uptake applies to the off-site adult and child resident (i.e. showering/bathing). The equation for dermal uptake of chemicals from water is the same as the equation for dermal uptake of chemicals from soil. An additional equation, however, must be derived to account for the off-site age-adjusted resident for dermal exposure to ground water (cancer evaluation).

The age-adjusted water skin contact factor, SFW_{adj}, is derived by analogy to the age-adjusted soil skin contact factor as follows:

$$SFW_{adj} = \frac{ED_c \times SA_{wc}}{BW_c} + \frac{(ED_{tot} - ED_c) \times SA_{wa}}{BW_a} \quad \textbf{(14)}$$

where:

SFW_{adj}	=	age-adjusted water skin contact factor (cm^2-year/kg);
ED_c	=	exposure duration, residential child (years);

SA_{wc} = surface area of skin available for contact with water, residential child (cm^2);
BW_c = body weight, child (kg); and
ED_{tot} = exposure duration, resident, total (years);
SA_{wa} = surface area of skin available for contact with water, residential adult (cm^2); and
BW_a = body weight (kg), adult.

The age-adjusted off-site resident dermal exposure to ground water (cancer evaluation) equation is as follows:

$$DAD = \frac{DA_{event} \times SFW_{adj} \times EF}{AT} \quad \textbf{(15)}$$

where:

DAD = average dermally absorbed dose of COPC (mg/kg-day);
DA_{event} = dose absorbed per event (mg/cm^2-event);
SFW_{adj}= age-adjusted water skin contact factor (cm^2-year/kg);
EF = exposure frequency (events/year); and
AT = carcinogenic averaging time (days).

Separate calculation methods were applied to estimate DA_{event} for inorganic and organic chemicals in water. For inorganic chemicals, the average dermally absorbed dose of COPC was calculated from:

$$DA_{event} = C_w \times Kp \times ET \times CF_1 \times CF_2 \quad \textbf{(16)}$$

where:

DA_{event}= dose absorbed per event (mg/cm^2-event);
C_w = concentration of COPC in water (µg/L);
Kp = permeability coefficient (cm/hour);
ET = dermal exposure time (hours/event);
CF_1 = conversion factor (0.001 L/cm^3);
CF_2 = conversion factor (0.001 mg/µg);

Kp has been determined for very few inorganic compounds. For those inorganic compounds for which empirical data are not available, EPA (1992) recommends a default of 1E-3 cm/hour.

Kp for organic chemicals varies by several orders of magnitude (EPA, 1992). Kp for organic

chemicals is highly dependent on lipophilicity, expressed as a function of the octanol/water partition coefficient (K_{ow}). Because the stratum corneum (the outer skin layer) is rich in lipid content, it may act as a sink, initially reducing the transport of chemical to the systemic circulation. With continued exposure and the attainment of steady state conditions, the rate of dermal uptake increases. Therefore, different equations are used to estimate DA_{event}, depending on whether the exposure time is less than or greater than the estimated time to reach steady state.

When steady state has not been reached, which is the case for the receptors identified having relatively short exposure times, DA_{event} is calculated from the following equation (EPA, 1992):

$$DA_{event} = 2 \times Kp \times C_w \times CF_1 \times CF_2 \times \sqrt{\frac{6\tau \times t^*}{\pi}} \qquad \textbf{(17)}$$

where:

DA_{event}	=	dose absorbed per event (mg/cm^2-event);
Kp	=	permeability coefficient (cm/hour);
C_w	=	concentration of constituent in water (µg/L);
CF_1	=	conversion factor (0.001 L/cm^3);
CF_2	=	conversion factor (0.001 mg/µg);
τ	=	chemical absorption lag time (hours)
t^*	=	time to reach steady state absorption (hours);

The values for Kp and τ were taken from EPA (1992).

Inhalation of VOCs in Ground Water

The off-site resident may be exposed to airborne VOCs released from ground water during showering/bathing and household uses. Recent EPA (1996) guidance does not recommend estimating intakes (i.e., mg/kg-day) for the air inhalation pathway. Rather, risks and hazards were determined by comparing estimated volatilized air concentrations (see Section 5.4.2.2) adjusted for exposure frequencies/durations/time with inhalation toxicity values. Refer to the risk characterization section (Section 5.4.4) for specific methods used to estimate risks/hazards for the fugitive dust air inhalation pathway.

The off-site resident may be exposed to airborne VOCs released from ground water during showering/bathing and household uses. The following equation was used to estimate the inhaled intake of COPCs in air:

$$I_a = \frac{C_a \times IR_a \times ET_a \times EF \times ED}{BW \times AT} \quad \textbf{(18)}$$

where:

I_a	=	inhaled intake of COPC (mg/kg-day);
C_a	=	concentration of COPC in air (mg/m^3);
IR_a	=	inhalation rate (m^3/hour, or in some instances, m^3/day);
ET_a	=	exposure time (hours/day);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight (kg); and
AT	=	averaging time (days).

The age-adjusted factor for inhalation is:

$$InhF_{adj} = \frac{ED_{child} \times IR_{child}}{BW_{child}} + \frac{(ED_{total} - ED_{child}) \times IR_{adult}}{BW_{adult}} \quad \textbf{(19)}$$

where:

$InhF_{adj}$	=	age adjusted inhalation factor (m^3-year/kg-hour, or m^3-year/kg-day where applicable);
ED_{child}	=	exposure duration for a child (years);
IR_{child}	=	inhalation rate of a child (m^3/hour, or in some instances, m^3/day);
BW_{child}	=	body weight of a child (kg);
ED_{total}	=	exposure duration for a resident (years);
IR_{adult}	=	inhalation rate of an adult (m^3/hour, or in some instances, m^3/day); and
BW_{adult}	=	body weight of an adult (kg).

The age-adjusted resident inhalation exposure to VOCs in ground water (cancer evaluation) risk equation is as follows:

$$I_a = \frac{C_a \times InhF_{adj} \times EF}{AT} \quad \textbf{(20)}$$

where:

I_a	=	inhaled dose of COPC (mg/kg-day);
C_a	=	concentration of COPC in air from volatilization from ground water (mg/m^3);
$InhF_{adj}$	=	age-adjusted inhalation factor (m^3-year/kg-day);
EF	=	exposure frequency for ground water (days/year); and
AT	=	carcinogenic averaging time (days).

Justification of Intake Model Variables

Justification for each of the variables used in the intake equations described in the previous section is presented in the following text. The variables are summarized in Tables 5-7 and 5-8 .

Current and Future Off-Site Resident

The cancer assessments were based on an age-adjusted resident using algorithms supplied by EPA (2000b). The non-cancer evaluations assumed a child, as described above. The RME evaluations assume a 70-kg adult exposed for 30 years (EPA, 1991a) and a 15-kg child exposed for 6 years (EPA, 1991a). An RME exposure frequency of 350 days/year (EPA, 1991a) , was used for cancer and non-cancer evaluations.

The RME incidental soil ingestion factor for the age-adjusted resident is 114 mg-yrs/kg-day which is calculated based on the RME ingestion rate for the adult of 100 mg/day (EPA, 1991a) and RME for a child of 200 mg/day (EPA, 1991a).

The drinking water ingestion factor for the age-adjusted adult is 1.09 L-years/kg-day calculated based on the drinking water rate for the adult of 2 L/day and child of 1 L/day (EPA, 1991a).

The age-adjusted water skin contact factor, SFW_{adj}, is derived by analogy to the age adjusted inhalation and drinking water ingestion factors as follows:

$$SFW_{adj} = \frac{ED_c \times SA_{wc}}{BW_c} + \frac{(ED_{tot} - ED_c) \times SA_{wa}}{BW_a} \quad \textbf{(21)}$$

where:

SFW_{adj}= age adjusted water skin contact factor (cm^2-year/kg);
ED_c = exposure duration, residential child (years);
SA_{wc} = surface area of the skin available for contact with water, residential child (7300 cm^2);
BW_c = body weight, child (kg); and
ED_{tot} = exposure duration, resident (years).
SA_{wa} = surface area of the skin available for contact with water, residential adult (20,000 cm^2); and
BW_a = body weight, adult (kg).

The average total adult body surface area is approximately 20,000 cm^2 (EPA, 1992). The average total body surface area for children ages 2 to 6 years is estimated at 7,300 cm^2 (EPA, 1992), which was adopted as the surface area of the skin available for contact with water in a bathing scenario. From the equation above and exposure durations defined earlier for the adult resident, an RME age-adjusted water skin contact factor of 9,777 cm^2-year/kg was estimated. The total exposure time in the shower room for the adult was 12 minutes (EPA, 1989b).

The age-adjusted soil skin contact factor, SFS_{adj}, was calculated in a similar manner. The RME value of 2720 cm^2-yr/kg was calculated using the RME exposure durations and body weights given above and a surface area of 5800 cm^2 for the adult (EPA, 1992) and a surface area of 1825 cm^2 for the child. The child surface area is calculated as 25% of the mean total surface for a male child aged 2-6 years (EPA, 1992).

The RME inhalation factor for determining the risk of inhalation of VOCs from ground water while showering/bathing for the age-adjusted resident is xxx m^3-year/kg-hr. This age-adjusted inhalation factor was calculated using the algorithm provided by EPA (2000b), the exposure durations defined above, an exposure time of 12 minutes for a showering adult and 45 minutes for a bathing child (EPA, 1997), and an inhalation rate of 0.6 m^3/hour for both the adult, and child (EPA, 1989b).

The RME inhalation factor for determining the risk of inhalation of VOCs from ground water in indoor air from household uses for the age-adjusted resident is xxx m^3-year/kg-day. This age-adjusted inhalation factor was also calculated using the algorithm provided by EPA (2000b), the exposure durations defined above, and an inhalation rate of 30 m^3/day for the adult, and 20 m^3/day for the child (EPA, 1989b).

Current and Future Off-Site Resident Involved in Gardening and Digging Activities

The majority of the exposure parameters used for the off-site resident gardeners are identical to those used for the off-site resident. The only instances where the resident and resident-gardener parameters differ are: 1) the adult soil ingestion rate, 480 mg/day, is recommended for adults engaged in outdoor activities (EPA, 1989b), and 2) the exposure frequency for gardening activities for both adults and children is 40 days/year (EPA,1989b).

Current and Future Off-Site Construction Worker

A current and future off-site construction worker was defined as an individual who works in the CDA near the Himco landfill site, and is involved in resident home improvement construction projects. Therefore, individuals assigned to short-term intrusive construction projects needed to be evaluated. The construction worker was assumed to be an average adult with a body weight of 70 kg who was exposed to site elements 8 hours per day, 5 days per week. It is likely that a construction worker would work at the site 188 days/year for one year for a home-improvement construction project. An incidental soil ingestion rate of 480 mg/day was based on adult ingestion of soil and dust engaged in outdoor activities (EPA, 1989b). The fraction of exposure attributed to site soil ingestion was assumed to be 1. Finally, a respiratory rate of 2.5 m^3/hr was used based on EPA guidance (EPA 1991a).

Clothing provides protection against dermal contact with soil, restricting potential contact largely to the head, hands, and forearms; therefore, the available surface area for dermal contact was estimated to be 3300 cm^2, which is the central tendency for outdoor soil contact (EPA, 1997b). Based on studies cited in the *Dermal Exposure Assessment: Principles and Applications* (EPA, 1992), a default soil adherence factor of 1.0 mg/cm^2 was used (for all receptors) as an upper bound value.

5.4.3 Toxicity Assessment

The most current available toxicity data were used to calculate carcinogenic and non-carcinogenic risks/hazards, including the most recent IRIS (EPA, 2000b) updates and HEAST values (EPA, 1997). Provisional toxicity values provided by EPA were also used as appropriate. Toxicity assessment for carcinogenic PAHs was performed with Toxicity Equivalence Factor (TEF) methodology relative to that of benzo(a)pyrene (1993). Toxicity values and additional physical chemical values for all COPCs are listed in Table 5-9.

Oral toxicity values provided by EPA reflect administered-dose values, that is they represent concentrations that will be protective following ingestion. Inhalation toxicity values provided by EPA are representative air concentrations that will be protective following inhalation (24 hours/day). The dermal route of exposure, however, evaluates the toxicity of concentrations of chemicals in the blood (absorbed). Therefore, the absorbed-dose concentrations identified for dermal exposure must be compared to absorbed-dose toxicity values. The absorbed-dose toxicity values are derived by applying (multiplying) gastrointestinal absorption factors (GAFs) to administered-dose toxicity values. EPA (Dan Stralka Region 9, personal communication) recommends adjustment of the oral toxicity value when the (GAF) is less than 0.5. The GAFs used in this human health SRA were obtained per EPA (EPA, 1992). Default GAFs of 10 percent for organics and 1 percent for inorganics were used if literature values were unavailable.

5.4.4 Risk Characterization

To characterize potential non-carcinogenic effects, comparisons were made between projected intakes of substances and toxicity values. To characterize potential carcinogenic effects, the incremental probability of an individual developing cancer over a lifetime was calculated from projected intakes and chemical-specific dose-response information. For each COPC having available toxicity values, a cancer risk (for carcinogenic risk) and hazard quotient (HQ) (for non-cancer risk) estimate was calculated. The methods used to estimate risk/hazard and the carcinogenic and non-carcinogenic results (including risk summaries by pathway and receptor for current and future receptors) are presented herein.

5.4.4.1 Non-carcinogenic Effects

The potential for non-carcinogenic effects was evaluated by comparing an exposure level or intake (chronic daily intake, or CDI) over a specified time period with a reference dose (RfD) derived for a similar exposure period. This ratio is termed the HQ. In other words, the HQ equals the intake divided by the reference value, or:

- Oral HQ = exposure intake (administered dose)/oral RfD (administered dose);
- Dermal HQ = intake (absorbed dose)/oral RfD (absorbed dose);
- Inhalation HQ = modeled air concentration x exposure parameters/inhalation reference concentration (RfC)

where:

$$Hazard = \left(\frac{(C_{air})(EF)(ED)(ET)}{(AT)(365\ days/year)} \right) \times \frac{1}{RfC}$$

where:

C_{air}	=	modeled particulate or volatile air concentration;
EF	=	Exposure frequency (days/year);
ED	=	Exposure duration (years)
ET	=	Fraction of EF time breathing air at the site
AT_n	=	Averaging time for non-carcinogens (years)

The HQ assumes that there is a level of exposure (i.e., RfD or RfC) below which it is unlikely for even sensitive populations to experience adverse health effects. If the exposure level exceeds the threshold (i.e., if HQ exceeds unity), there may be a concern for potential non-cancer effects.

To assess the overall potential for non-carcinogenic effects posed by more than one chemical, a hazard index (HI) approach has been developed by EPA (1989a). This approach assumes that simultaneous sub-threshold exposures to several chemicals could result in an adverse health effect, while acting on the same target organ. The HI is calculated as follows:

$$HI = HQ_1 + HQ_2 + ... + HQ_i$$

where:

HQ_i = the hazard quotient for the *i*th toxicant.

It should be noted that exposure intake is taken to mean "chronic" exposure. Chronic exposure is defined as exposure that occurs over at least 7 years (EPA, 1989a).

Calculation of an HI in excess of 1 indicates the potential for adverse health effects. Indices greater than 1 will be generated anytime intake for any of the COPCs exceeds its RfD or RfC. However, if there are two or more chemicals involved, it is possible to generate a HI greater than 1, even if none of the individual chemical intakes or concentrations exceed their respective RfDs or RfCs.

5.4.4.2 Carcinogenic Effects

Carcinogenic risk is expressed as an increased probability of developing cancer as a result of lifetime exposure. For a given chemical and route of exposure, carcinogenic risk is calculated as follows:

- Oral HQ (administered dose) = exposure intake (administered dose) x oral slope factor;
- Dermal HQ = intake (absorbed dose) x oral slope factor (absorbed dose);
- Inhalation HQ = modeled air concentration x exposure parameters x inhalation unit risk factor (URF),

where:

$$Risk = \left(\frac{(C_{air})(EF)(ED)(ET)}{(AT)(365\ days/year)} \right) \times URF$$

where:

C_{air}	=	modeled particulate or volatile air concentration;
EF	=	Exposure frequency (days/year);
ED	=	Exposure duration (years)
ET	=	Fraction of EF time breathing air at the site
AT_n	=	Averaging time for non-carcinogens (years)

For simultaneous exposure to several carcinogens, cumulative risk is calculated using the following information.

RiskT = Risk1 + Risk2 +...+ Risk*i*

where:

RiskT = the total cancer risk, expressed as a unitless probability, and

Risk*i* = the risk estimate for the *i*th substance.

Addition of carcinogenic risks are valid when the following assumptions are met:

- Doses are low;
- No synergistic or antagonistic interactions occur; and
- Similar endpoints are evaluated.

EPA's (1991b) target range for carcinogenic risk associated with CERCLA sites is one-in-ten thousand (1E-04) to one-in-one million (1E-06). These risk ranges and threshold hazard value were used for comparative purposes in this SRA.

5.4.4.3 Risk Characterization Results

The pathway-specific and cumulative cancer risks and non-cancer hazards for the receptors quantitatively evaluated are summarized in Tables xxx through xxx. Calculations supporting these risk/hazard results are located in Appendix x.

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6.4.3 Himco CDA Land Parcel M Site-Related Chemical Risk Characterization-Carcinogens

For Land Parcel M, the estimated risk for the adult resident is 2 in 10,000 (2E-04). The only other applicable receptor evaluated for site-related risk at Land Parcel M was the construction worker who is less than 1 in 1,000,000. The adult resident scenario for Land Parcel M is discussed in greater detail below.

Table 6-7 summarizes the cancer risk estimates for each exposure scenario at Land Parcel M. Table 6-8 provides a risk summary for soil site risk that includes chemical- and pathway-specific risk estimates for each applicable scenario. Table 6-23 provides a risk summary for ground water site risk for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at the Himco CDA.

Adult Resident - The estimated risk for an age-adjusted adult resident at Land Parcel M is 2 in 10,000. This cumulative site risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil risk for an adult resident at Land Parcel M for this scenario is 1 in 100,000. This risk is based on the adult resident's exposure to surface soils (0-0.5 ft) which is estimated to be 9E-06, and his exposure to 0-2 ft soils (2E-06) while gardening. The site-related soil risk estimate is due to ingestion of surface soil (8.5E-06) and attributable predominantly to arsenic, benzo(a)pyrene, and dibenz(a,h)anthracene. When assessing analytical detections that contribute to the risk in Land Parcel M, arsenic detected at 1.6 mg/kg, is below the background arsenic 95% UTL (2.2 mg/kg) as referenced in the *Himco Dump Remedial Investigation/Feasibility Study* (SEC Donohue Inc., 1992). Benzo(a)pyrene and dibenz(a,h)anthracene were not detected in Land Parcel M, but the risks are attributable to using one-half the CRQL in the qualitative risk assessment.

6.4.4 Himco CDA Land Parcel M Site-Related Chemical Risk Characterization--Non-Carcinogens

For Land Parcel M, the estimated total media risk for the adult/child resident is a hazard index of 13.76. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The only other applicable receptor evaluated for site-related non-cancer risk at Land Parcel M was the construction worker with a HI less than 1. The adult/child resident scenario for Land Parcel M is

discussed in greater detail below.

Table 6-7 summarizes the non-cancer hazard estimates for each exposure scenario at Land Parcel M. Table 6-8 provides a hazard summary for soil that includes chemical- and pathway-specific hazard estimates for each applicable scenario. Table 6-23 provides a summary for ground water site hazards for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at the Himco CDA.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at Land Parcel M is a hazard index of 13.76. This cumulative site hazard risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil non-cancer risk estimate for a child resident (the most conservative assumption) at Land Parcel M has a HI less than 1. Estimated hazard indices lower than 1 are considered negligible and do not warrant remedial action.

6.4.5 Himco CDA Land Parcel O Site-Related Chemical Risk Characterization-Carcinogens

For Land Parcel O, the estimated risk for the adult resident is 2 in 10,000 (2E-04). The only other applicable receptor evaluated for site-related risk at Land Parcel O was the construction worker whose cumulative risk is 1 in 1,000,000. The adult resident scenario for Land Parcel O is discussed in greater detail below.

Table 6-9 summarizes the cancer risk estimates for each exposure scenario at Land Parcel O. Table 6-10 provides a risk summary for soil site risk that includes chemical- and pathway-specific risk estimates for each applicable scenario. Table 6-23 provides a risk summary for ground water site risk for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are.the sums associated with all carcinogenic COPCs that were detected at the Himco CDA.

Adult Resident - The estimated risk for an age-adjusted adult resident at Land Parcel O is 2 in 10,000. This cumulative site risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil risk for an adult resident at Land Parcel O for this scenario is 1 in 100,000. The risk is based on the adult resident's exposure to surface soils (0-0.5 ft) which is estimated to be 1E-05, and his exposure to 0-2 ft soils (3E-06) while gardening. This site-related soil risk estimate is due to ingestion of surface soil (9.6E-06) and attributable predominantly to arsenic,

benzo(a)pyrene, and dibenz(a,h)anthracene. When assessing analytical detections that contribute to the risk in Land Parcel O, arsenic detected at 2.1 mg/kg, is similar to the background arsenic 95% UTL (2.2 mg/kg) as referenced in the *Himco Dump Remedial Investigation/Feasibility Study* (SEC Donohue Inc., 1992). Benzo(a)pyrene was detected in one surface soil sample in Land Parcel O, but the risk is attributable to using one-half the CRQL which was the maximum concentration in the qualitative risk assessment. Dibenz(a,h)anthracene was not detected in Land Parcel O, but the risk is attributable to using one-half the CRQL in the qualitative risk assessment.

6.4.6 Himco CDA Land Parcel O Site-Related Chemical Risk Characterization--Non-Carcinogens

For Land Parcel O, the estimated total media risk for the adult/child resident is a hazard index of 14. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The only other applicable receptor evaluated for site-related non-cancer risk at Land Parcel O was the construction worker with a HI of 2.54. The adult/child resident scenario and the construction worker scenario for Land Parcel O are discussed in greater detail below.

Table 6-9 summarizes the non-cancer hazard estimates for each exposure scenario at Land Parcel O. Table 6-10 provides a hazard summary for soil that includes chemical- and pathway-specific hazard estimates for each applicable scenario. Table 6-23 provides a summary for ground water site hazards for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at the Himco CDA.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at Land Parcel O is a hazard index of 14. This cumulative site hazard risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil non-cancer risk estimate for a child resident (the most conservative assumption) at Land Parcel O has a HI less than 1. Estimated hazard indices lower than 1 are considered negligible and do not warrant remedial action.

Construction Worker - The estimated soil non-cancer risk estimate for a construction worker at Land Parcel O is a HI of 2.54. The soil risk hazard estimate is due to exposure to surface and subsurface soils (0-6 ft) and attributable predominantly to the inhalation of manganese (HQ = 1.95). When assessing analytical detections that contribute to the risk in Land Parcel O, manganese detected at 337 mg/kg, is below the background manganese 95% UTL (569 mg/kg)

as referenced in the Himco Dump Remedial Investigation/Feasibility Study (SEC Donohue Inc., 1992).

6.4.7 Himco CDA Land Parcel N

In the present Supplemental Field Investigation, no samples were taken in Land Parcel N. Since samples were taken at nearby locations, USACE Omaha District and the USACE Hazardous Toxic and Radioactive Waste Center of Expertise conducted a geostatistical analysis in order to estimate soil concentrations to be used in the risk assessment. For the resident, the estimated soil risks in the other land parcels appeared to be driven by arsenic and benzo(a)pyrene. Therefore, the geostatistical analysis focused on deriving arsenic and benzo(a)pyrene concentrations. The locations and sample results for arsenic and benzo(a)pyrene for the Himco CDA 18 soil borings were compiled. Values for the 0-2 ft samples were used as reported. Values for the 2-4 and 4-6 ft samples were averaged for each borehole to account for the subsurface exposure pathway for those depths and to account for the inconsistent sampling at the 4-6 ft depth. These data were then analyzed using the Geo-Eas software from EPA. For a detailed description of the geostatistical analysis and the arsenic and benzo(a)pyrene derived concentrations for Land Parcel N, please refer to Appendix I.

Based upon how the data were compiled for the geostatistical analysis, the arsenic or benzo(a)pyrene maximum concentrations were chosen from the derived Land Parcel N concentrations for the exposure point concentrations in the quantitative risk assessment. The maximum concentration of arsenic or benzo(a)pyrene in the 0-2 ft depth was used for the child and adult resident/gardener, and the maximum concentration of arsenic or benzo(a)pyrene in all depths (0-6 ft) was used for the construction worker.

6.4.8 Himco CDA Land Parcel N Site-Related Chemical Risk Characterization-Carcinogens

For Land Parcel N, the estimated risk for the adult resident is 2 in 10,000 (2E-04). The only other applicable receptor evaluated for site-related risk at Land Parcel N was the construction worker whose risk to arsenic and benzo(a)pyrene is less than 1 in 1,000,000. The adult resident scenario for Land Parcel N is discussed in greater detail below.

Table 6-11 summarizes the cancer risk estimates for arsenic and benzo(a)pyrene for each exposure scenario at Land Parcel N. Table 6-12 provides a risk summary for soil site risk that includes chemical- and pathway-specific risk estimates for arsenic and benzo(a)pyrene for each applicable scenario. Table 6-23 provides a risk summary for ground water site risk for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at the Himco CDA.

Adult Resident - The estimated risk for an age-adjusted adult resident at Land Parcel N is 2 in

10,000. This cumulative site risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil risk for arsenic and benzo(a)pyrene for an adult resident at Land Parcel N for this scenario is 9 in 1,000,000. The risk is based on the adult resident's exposure to 0-2 ft soils which is estimated to be 7E-06, and his exposure to 0-2 ft soils (2E-06) while gardening. This site-related soil risk estimate is due predominately to ingestion of soils. When assessing the derived analytical detections that contribute to the risk in Land Parcel N, arsenic's derived maximum at 1.88 mg/kg, is is below the background arsenic 95% UTL (2.2 mg/kg) as referenced in the *Himco Dump Remedial Investigation/Feasibility Study* (SEC Donohue Inc., 1992). Benzo(a)pyrene's derived maximum concentration is identical to using one-half the CRQL in the qualitative risk assessment (as seen in the other land parcels when the constituent was reported as "not detected").

6.4.9 Himco CDA Land Parcel N Site-Related Chemical Risk Characterization--Non-Carcinogens

For Land Parcel N, the estimated total media risk for the adult/child resident is a hazard index of 13.45. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The only other applicable receptor evaluated for site-related arsenic non-cancer risk at Land Parcel N was the construction worker with a HI of less than 1. The adult/child resident scenario for Land Parcel N is discussed in greater detail below.

Table 6-11 summarizes the non-cancer hazard estimates for each exposure scenario at Land Parcel N. Table 6-12 provides a hazard summary for soil that includes chemical- and pathway-specific hazard estimates for arsenic for each applicable scenario. Table 6-23 provides a summary for ground water site hazards for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at the Himco CDA.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at Land Parcel N is a Hazard Index of 13.45. This cumulative site hazard risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil non-cancer risk estimate for a child resident (the most conservative assumption) at Land Parcel N has a HI less than 1. Estimated hazard indices lower than 1 are considered negligible and do not warrant remedial action.

6.4.10 Himco CDA Land Parcel P Site-Related Chemical Risk Characterization-Carcinogens

For Land Parcel P, the estimated risk for the adult resident is 2 in 10,000 (2E-04). The only other applicable receptor evaluated for site-related risk at Land Parcel P was the construction worker who is less than 1 in 1,000,000. The adult resident scenario for Land Parcel P is discussed in greater detail below.

Table 6-13 summarizes the cancer risk estimates for each exposure scenario at Land Parcel P. Table 6-14 provides a risk summary for soil site risk that includes chemical- and pathway-specific risk estimates for each applicable scenario. Table 6-23 provides a risk summary for ground water site risk for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at the Himco CDA.

Adult Resident - The estimated risk for an age-adjusted adult resident at Land Parcel P is 2 in 10,000. This cumulative site risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil risk for an adult resident at Land Parcel P for this scenario is 1 in 100,000. The risk is based on the adult resident's exposure to surface soils (0-0.5 ft) which is estimated to be 9E-06, and his exposure to 0-2 ft soils (2E-06) while gardening. This site-related soil risk estimate is due to ingestion of surface soil (8.8E-06) and attributable predominantly to arsenic, benzo(a)pyrene, and dibenz(a,h)anthracene. When assessing analytical detections that contribute to the risk in Land Parcel P, arsenic detected at 1.5 mg/kg, is slightly above below the background arsenic 95% UTL (2.2 mg/kg) as referenced in the *Himco Dump Remedial Investigation/Feasibility Study* (SEC Donohue Inc., 1992). Benzo(a)pyrene and dibenz(a,h)anthracene were not detected in Land Parcel P, but the risks are attributable to using one-half the CRQL in the qualitative risk assessment.

6.4.11 Himco CDA Land Parcel P Site-Related Chemical Risk Characterization--Non-Carcinogens

For Land Parcel P, the estimated total media risk for the adult/child resident is a hazard index of 14. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The only other applicable receptor evaluated for site-related non-cancer risk at Land Parcel P was the construction worker with a HI of 2.48. The adult/child resident scenario and the construction worker scenario for Land Parcel P are discussed in greater detail below.

Table 6-13 summarizes the non-cancer hazard estimates for each exposure scenario at Land Parcel P. Table 6-14 provides a hazard summary for soil that includes chemical- and pathway-specific hazard estimates for each applicable scenario. Table 6-23 provides a summary for ground water site hazards for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at the Himco CDA.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at Land Parcel P is a Hazard Index of 14. This cumulative site hazard risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil non-cancer risk estimate for a child resident (the most conservative assumption) at Land Parcel P has a HI less than 1. Estimated hazard indices lower than 1 are considered negligible and do not warrant remedial action.

Construction Worker - The estimated soil non-cancer risk estimate for a construction worker at Land Parcel P is a HI of 2.48. The soil risk hazard estimate is due to exposure to surface and subsurface soils (0-6 ft) and attributable predominantly to the inhalation of manganese (HQ = 1.85). When assessing analytical detections that contribute to the risk in Land Parcel P, manganese detected at 319 mg/kg, is below the background manganese 95% UTL (569 mg/kg) as referenced in the Himco Dump Remedial Investigation/Feasibility Study (SEC Donohue Inc., 1992).

6.4.12 Himco CDA Land Parcel S Site-Related Chemical Risk Characterization-Carcinogens

For Land Parcel S, the estimated risk for the adult resident is 2.5 in 10,000 (2E-04). The only other applicable receptor evaluated for site-related risk at Land Parcel S was the construction worker whose cumulative risk is 6 in 1,000,000. The adult resident scenario and the construction worker scenario for Land Parcel S are discussed in greater detail below.

Table 6-15 summarizes the cancer risk estimates for each exposure scenario at Land Parcel S. Table 6-16 provides a risk summary for soil site risk that includes chemical- and pathway-specific risk estimates for each applicable scenario. Table 6-23 provides a risk summary for ground water site risk for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at the Himco CDA.

Adult Resident - The estimated risk for an age-adjusted adult resident at Land Parcel S is 2.5 in 10,000. This cumulative site risk is predominately due to exposure to ground water and will be

explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil risk for an adult resident at Land Parcel S for this scenario is 6 in 100,000. The risk is based on the adult resident's exposure to surface soils (0-0.5 ft) which is estimated to be 4.2E-05, and his exposure to 0-2 ft soils (1.4E-05) while gardening. This site-related soil risk estimate is due to ingestion of surface and subsurface soils and attributable predominantly to arsenic, benzo(a)pyrene, and dibenz(a,h)anthracene.

Construction Worker - The estimated soil risk for a construction worker at Land Parcel S for this scenario is 6 in 1,000,000. The risk is based on the construction worker's ingestion of surface and subsurface soils (0-6 ft), and is attributable to ingestion of arsenic and benzo(a)pyrene.

6.4.13 Himco CDA Land Parcel S Site-Related Chemical Risk Characterization--Non-Carcinogens

For Land Parcel S, the estimated total media risk for the adult/child resident is a hazard index of 15.87. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The only other applicable receptor evaluated for site-related non-cancer risk at Land Parcel S was the construction worker with a HI of 4.11. The adult/child resident scenario and the construction worker scenario for Land Parcel S are discussed in greater detail below.

Table 6-15 summarizes the non-cancer hazard estimates for each exposure scenario at Land Parcel S. Table 6-16 provides a hazard summary for soil that includes chemical- and pathway-specific hazard estimates for each applicable scenario. Table 6-23 provides a summary for ground water site hazards for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at the Himco CDA.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at Land Parcel S is a hazard index of 15.87. This cumulative site hazard risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil non-cancer risk estimate for a child resident (the most conservative assumption) at Land Parcel S has a HI of 2.52. This site-related soil hazard estimate is due to ingestion of surface soil (0-0.5 ft) and attributable to a total exposure of detected metals (antimony, arsenic, copper, and manganese). However, when the total Land Parcel S HI is separated by target organ (i.e. antimony-blood and arsenic-skin), there are no unacceptable HIs.

Construction Worker - The estimated soil non-cancer risk estimate for a construction worker at Land Parcel S is a HI of 4.11. The soil risk hazard estimate is due to exposure to surface and subsurface soils (0-6 ft) and attributable predominantly to the inhalation of manganese (HQ = 3.51). When assessing analytical detections that contribute to the risk in Land Parcel S, manganese detected at 539 mg/kg, is below the background manganese 95% UTL (569 mg/kg) as referenced in the Himco Dump Remedial Investigation/Feasibility Study (SEC Donohue Inc., 1992).

6.4.14 Himco CDA Land Parcel F Site-Related Chemical Risk Characterization-Carcinogens

For Land Parcel F, the estimated risk for the adult resident is 2.5 in 10,000 (2E-04). The only other applicable receptor evaluated for site-related risk at Land Parcel F was the construction worker whose cumulative risk is 2 in 100,000. The adult resident scenario and the construction worker scenario for Land Parcel F are discussed in greater detail below.

Table 6-17 summarizes the cancer risk estimates for each exposure scenario at Land Parcel F. Table 6-18 provides a risk summary for soil site risk that includes chemical- and pathway-specific risk estimates for each applicable scenario. Table 6-23 provides a risk summary for ground water site risk for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at the Himco CDA.

Adult Resident - The estimated risk for an age-adjusted adult resident at Land Parcel F is 2.5 in 10,000. This cumulative site risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil risk for an adult resident at Land Parcel F for this scenario is 5.5 in 100,000. The risk is based on the adult resident's exposure to surface soils (0-0.5 ft) which is estimated to be 4E-05, and his exposure to 0-2 ft soils (1.4E-05) while gardening. This site-related soil risk estimate is due to ingestion of surface and subsurface soils and attributable to arsenic, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenz(a,h)anthracene.

Construction Worker - The estimated soil risk for a construction worker at Land Parcel F for this scenario is 2 in 100,000. The risk is based on the construction worker's ingestion of surface and subsurface soils (0-6 ft), and is attributable to the ingestion of arsenic, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene.

6.4.15 Himco CDA Land Parcel F Site-Related Chemical Risk Characterization--Non-Carcinogens

For Land Parcel F, the estimated total media risk for the adult/child resident is a Hazard Index of 14.62. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The only other applicable receptor evaluated for site-related non-cancer risk at Land Parcel F was the construction worker with a HI of 9.71. The adult/child resident scenario and the construction worker scenario for Land Parcel F are discussed in greater detail below.

Table 6-17 summarizes the non-cancer hazard estimates for each exposure scenario at Land Parcel F. Table 6-18 provides a hazard summary for soil that includes chemical- and pathway-specific hazard estimates for each applicable scenario. Table 6-23 provides a summary for ground water site hazards for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at the Himco CDA.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at Land Parcel F is a hazard index of 14.62. This cumulative site hazard risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil non-cancer risk estimate for a child resident (the most conservative assumption) at Land Parcel F has a HI of 1.27. This site-related soil hazard estimate is due to ingestion of surface soil (0-0.5 ft) and attributable to a total exposure of detected metals (antimony, arsenic, copper, and manganese). However, when the total Land Parcel F HI is separated by target organ (i.e. antimony-blood and arsenic-skin), there are no unacceptable HIs.

Construction Worker - The estimated soil non-cancer risk estimate for a construction worker at Land Parcel F is a HI of 9.71. The soil risk hazard estimate is due to exposure to surface and subsurface soils (0-6 ft) and attributable predominantly to the inhalation of manganese (HQ = 8.17).

6.4.16 Himco CDA Land Parcel D Site-Related Chemical Risk Characterization-Carcinogens

For Land Parcel D, the estimated risk for the adult resident is 2 in 10,000 (2E-04). The only other applicable receptor evaluated for site-related risk at Land Parcel D was the construction worker whose cumulative risk is 4 in 1,000,000. The adult resident scenario and the construction worker scenario for Land Parcel D are discussed in greater detail below.

Table 6-19 summarizes the cancer risk estimates for each exposure scenario at Land Parcel D. Table 6-20 provides a risk summary for soil site risk that includes chemical- and pathway-

specific risk estimates for each applicable scenario. Table 6-23 provides a risk summary for ground water site risk for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at the Himco CDA.

Adult Resident - The estimated risk for an age-adjusted adult resident at Land Parcel D is 2 in 10,000. This cumulative site risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil risk for an adult resident at Land Parcel D for this scenario is 3 in 100,000. The risk is based on the adult resident's exposure to surface soils (0-0.5 ft) which is estimated to be 2E-05, and his exposure to 0-2 ft soils (1E-05) while gardening. This site-related soil risk estimate is due to: 1) ingestion of surface and subsurface soils and attributable to arsenic, benzo(a)pyrene, and dibenz(a,h)anthracene, and 2) dermal contact with surface soil due to arsenic.

Construction Worker - The estimated soil risk for a construction worker at Land Parcel D for this scenario is 4 in 1,000,000. The risk is based on the construction worker's ingestion of surface and subsurface soils (0-6 ft), and is attributable to the ingestion of arsenic and benzo(a)pyrene.

6.4.17 Himco CDA Land Parcel D Site-Related Chemical Risk Characterization--Non-Carcinogens

For Land Parcel D, the estimated total media risk for the adult/child resident is a hazard index of 14.18. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The only other applicable receptor evaluated for site-related hazard risk at Land Parcel D was the construction worker with a HI of 2.84. The adult/child resident scenario and the construction worker scenario for Land Parcel D are discussed in greater detail below.

Table 6-19 summarizes the non-cancer hazard estimates for each exposure scenario at Land Parcel D. Table 6-20 provides a hazard summary for soil that includes chemical- and pathway-specific hazard estimates for each applicable scenario. Table 6-23 provides a summary for ground water site hazards for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at the Himco CDA.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child

resident at Land Parcel D is a hazard index of 14.18. This cumulative site risk is predominately due to exposure to ground water and will be explained in further detail in Sections 6.4.22 and 6.4.23.

The estimated soil non-cancer risk estimate for a child resident (the most conservative assumption) at Land Parcel D has a HI less than 1. Estimated hazard indices lower than 1 are considered negligible and do not warrant remedial action.

Construction Worker - The estimated soil non-cancer risk estimate for a construction worker at Land Parcel D is a HI of 2.84. The soil risk hazard estimate is due to exposure to surface and subsurface soils (0-6 ft) and attributable predominantly to the inhalation of manganese (HQ = 2.16). When assessing analytical detections that contribute to the risk in Land Parcel D, manganese detected at 373 mg/kg, is below the background manganese 95% UTL (569 mg/kg) as referenced in the Himco Dump Remedial Investigation/Feasibility Study (SEC Donohue Inc., 1992).

6.4.18 Himco Dump/CDA Downgradient Ground Water Shallow Aquifer Well Locations: Well-Pair WT101A/WT114A Hypothetical Exposure Location Chemical Risk Characterization-Carcinogens

For well-pair WT101A/WT114A ground water hypothetical exposure location, the estimated cumulative risk for the adult resident is 4 in 10,000 (4E-04). The adult resident scenario for this exposure location is discussed in greater detail below.

Table 6-21 provides a risk summary for ground water site risk for well-pair WT101A/WT114A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at this location at the Himco site.

Adult Resident - The estimated cumulative ground water risk for an age-adjusted adult resident at hypothetical exposure location WT101A/WT114A is 4 in 10,000. The risk is based on: 1) ingestion of arsenic, carbazole, benzene, and 1,2-dichloropropane (3E-04), 2) dermal exposure to arsenic, bis(2-ethylhexyl)phthalate, and carbazole (4E-05), and 3) inhalation exposure to benzene (2E-05). When assessing analytical detections that contribute to the risk at this hypothetical exposure location, bis(2-ethylhexyl)phthalate was also detected in the associated method blanks in the 1995 sampling event (USACE, 1996). As discussed in the National Functional Guidelines (EPA, 1994b), phthalate esters are considered by EPA to be common laboratory contaminants. In addition, 1,2-dichloropropane and carbazole were not detected in well-pair WT101A/WT114A, but the risks are attributable to using one-half the CRQL in the qualitative risk assessment.

6.4.19 Himco Dump/CDA Downgradient Ground Water Shallow Aquifer Well Locations: Well-Pair WT101A/WT114A Hypothetical Exposure Location Chemical Risk

Characterization--Non-Carcinogens

For well-pair WT101A/WT114A ground water hypothetical exposure location, the estimated cumulative non-cancer risk for the adult/child resident is a hazard index of 18.82. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The adult/child resident scenario for well-pair WT101A/WT114A exposure location is discussed in greater detail below.

Table 6-21 provides a summary for ground water site hazards for well-pair WT101A/WT114A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at this location at the Himco site.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at well-pair WT101A/WT114A hypothetical exposure location is a hazard index of 18.82. This cumulative site risk is predominately due to 1) the adult's inhalation exposure to 1,2-dichloropropane (HI = 1.3), 2) the child's ingestion of antimony, arsenic, iron, manganese, and thallium (HI = 15.56), and 3) the child's total dermal exposure to non-carcinogenic COPCs (HI = 1). When the child's total HI is separated by target organ (i.e., antimony-blood, arsenic-skin, bis(2-ethylhexyl)phthalate-liver, and benzene-blood), the unacceptable target organ HIs are: 1) blood HI = 2.40, and 2) skin HI = 3.16. When assessing analytical detections that contribute to the hazards at this hypothetical exposure location, antimony's mean concentration (13.8 μg/L) is less than the mean concentration (17.6 μg/L) determined from the upgradient/background well-pair WT102A/112A. Similarly, thallium's mean concentration of 2.4 μg/L is also comparable to the mean background concentration of 2.5 μg/L. 1,2-dichloropropane was not detected in well-pair WT101A/WT114A, but the risk is attributable to using one-half the CRQL in the qualitative risk assessment.

6.4.20 Himco Dump/CDA Downgradient Ground Water Shallow Aquifer Well Locations: Well WT115A Hypothetical Exposure Location Chemical Risk Characterization-Carcinogens

For well WT115A ground water hypothetical exposure location, the estimated cumulative risk for the adult resident is 8 in 100,000 (8E-05). The adult resident scenario this exposure location is discussed in greater detail below.

Table 6-22 provides a risk summary for ground water site risk for well WT115A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at this location at the Himco site.

Adult Resident - The estimated cumulative ground water risk for an age-adjusted adult resident at hypothetical exposure location WT115A is 8 in 100,000. The risk is based predominantly on: 1) ingestion of arsenic, carbazole, benzene, and 1,2-dichloropropane (4E-05), 2) dermal exposure to bis(2-ethylhexyl)phthalate and carbazole (3E-05), and 3) inhalation exposure to benzene (2E-05). When assessing analytical detections that contribute to the risk at this hypothetical exposure location, bis(2-ethylhexyl)phthalate was also detected in the associated method blanks in the 1995 sampling event (USACE, 1996). As discussed in the National Functional Guidelines (EPA, 1994b), phthalate esters are considered by EPA to be common laboratory contaminants. In addition, arsenic's mean concentration (1.2 μg/L) is the same as the mean concentration determined from the upgradient/background well-pair WT102A/112A. Finally, 1,2-dichloropropane and carbazole were not detected in well WT115A, but the risks are attributable to using one-half the CRQL in the qualitative risk assessment.

6.4.21 Himco Dump/CDA Downgradient Ground Water Shallow Aquifer Well Locations: Well WT115A Hypothetical Exposure Location Chemical Risk Characterization--Non-Carcinogens

For well WT115A ground water hypothetical exposure location, the estimated cumulative non-cancer risk for the adult/child resident is a hazard index of 9.51. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The adult/child resident scenario for well WT115A exposure location is discussed in greater detail below.

Table 6-22 provides a summary for ground water site hazards for well WT115A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at this location at the Himco site.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at well WT115A hypothetical exposure location is a hazard index of 9.51. This cumulative site risk is predominately due to 1) the adult's inhalation exposure to 1,2-dichloropropane (HI = 1.3), and 2) the child's ingestion of antimony, manganese, and thallium (HI = 6). When the child's total HI is separated by target organ (i.e., antimony-blood, arsenic-skin, bis(2-ethylhexyl)phthalate-liver, and benzene-blood), the unacceptable target organ HI is a blood HI of 2.40. When assessing analytical detections that contribute to the hazards at this hypothetical exposure location, antimony's mean concentration (13.8 μg/L) is less than the mean concentration (17.6 μg/L) determined from the upgradient/background well-pair WT102A/112A. Similarly, thallium's mean concentration of 2.8 μg/L is also comparable to the mean background concentration of 2.5 μg/L. 1,2-dichloropropane was not detected in well WT115A, but the risk is attributable to using one-half the CRQL in the qualitative risk assessment.

6.4.22 Himco Dump/CDA Downgradient Ground Water Shallow Aquifer Well Locations: Well-Pair WT116A/WT119A Hypothetical Exposure Location Chemical Risk Characterization-Carcinogens

For well-pair WT116A/WT119A ground water hypothetical exposure location, the estimated cumulative risk for the adult resident is 2 in 10,000 (2E-04). The adult resident scenario for this exposure location is discussed in greater detail below.

Table 6-23 provides a risk summary for ground water site risk for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific risk estimates for each applicable scenario. The Subtotal and Cumulative risk values are the sums associated with all carcinogenic COPCs that were detected at this location at the Himco site.

Adult Resident - The estimated cumulative ground water risk for an age-adjusted adult resident at hypothetical exposure location WT116A/WT119A is 2 in 10,000. The risk is based on: 1) ingestion of arsenic, bis(2-ethylhexyl)phthalate, carbazole, benzene, and 1,2-dichloropropane (9E-05), 2) dermal exposure to bis(2-ethylhexyl)phthalate, and carbazole (7E-05), and 3) inhalation exposure to benzene (4E-05). When assessing analytical detections that contribute to the risk at this hypothetical exposure location, bis(2-ethylhexyl)phthalate was also detected in the associated method blanks in the 1995 sampling event (USACE, 1996). As discussed in the National Functional Guidelines (EPA, 1994b), phthalate esters are considered by EPA to be common laboratory contaminants.

6.4.23 Himco Dump/CDA Downgradient Ground Water Shallow Aquifer Well Locations: Well-Pair WT116A/WT119A Hypothetical Exposure Location Chemical Risk Characterization--Non-Carcinogens

For well-pair WT116A/WT119A ground water hypothetical exposure location, the estimated cumulative non-cancer risk for the adult/child resident is a hazard index of 13.35. The child resident was evaluated for all non-carcinogenic media hazards except the ground water inhalation pathway because it is the most conservative assessment. The adult resident was only assessed for the non-carcinogenic ground water inhalation pathway because adults are exposed through showering and performing household chores. The adult/child resident scenario for well-pair WT116A/WT119A exposure location is discussed in greater detail below.

Table 6-23 provides a summary for ground water site hazards for well-pair WT116A/WT119A hypothetical exposure location that includes chemical- and pathway-specific hazard summary estimates for each applicable scenario. The Subtotal and Cumulative risk numbers include the hazards associated with all non-carcinogenic COPCs that were detected at this location at the Himco site.

Adult/Child Resident - The estimated total non-cancer hazard risk estimate for an adult/child resident at well-pair WT116A/WT119A hypothetical exposure location is a hazard index of

13.35. This cumulative site risk is predominately due to 1) the adult's inhalation exposure to benzene and 1,2-dichloropropane (HI = 2.5, and target organ (blood) HI = 1.29), 2) the child's ingestion of antimony, manganese, and thallium (HI = 8), and 3) the child's total dermal exposure to non-carcinogenic COPCs (HI = 1). When the child's total HI is separated by target organ (i.e., antimony-blood, arsenic-skin, bis(2-ethylhexyl)phthalate-liver, and benzene-blood), the unacceptable target organ HI is a blood HI of 5.50. When assessing analytical detections that contribute to the hazards at this hypothetical exposure location, thallium's mean concentration (1.5 μg/L) is less than the mean concentration (2.5 μg/L) determined from the upgradient/background well-pair WT102A/112A. Similarly, antimony's mean concentration of 32 μg/L is also comparable to 2x the mean background concentration of 17.6 μg/L.

6.5 Uncertainty Analysis

The risk characterization results are not fully probabilistic estimates of risk but rather conditional estimates of risk that should be interpreted in light of the considerable number of assumptions required to quantify exposure, intake, and dose-response. Uncertainties associated with identification of COPCs, the exposure assessment, and the toxicity assessment all contribute to the level of confidence that can be placed in the risk characterization results.

In general, risk assessment uncertainty is addressed in the BRA by:

- Using conservatism when defining the reasonable maximum case; and

- Identifying and discussing the major sources of uncertainty and their effect on the risk estimates so that the results can be properly interpreted.

Table 5-5 summarizes the primary sources of uncertainty specific to this assessment and the likely impact on risk assessment.

6.6 Results and Conclusions of the Human Health Risk Assessment

6.6.1 Himco CDA Soils

For the construction worker, the estimated cumulative incremental lifetime cancer risks (ILCRs) due to site-related chemicals in soils at Land Parcels S, F, and D are above 1 in 1,000,000 (1E-06). The estimated risks to chemicals at Land Parcels S and D are below 1 in 100,000 (1E-05). Only the cancer risk at Land Parcel F exceeds 1 in 100,000, but does not exceed the upper end of the acceptable Superfund carcinogenic risk range (1 in 10,000 (1E-04)). Overall, the only unacceptable soil non-cancer hazard risk (HQ > 1) to the future construction worker is also in Land Parcel F and is due to manganese.

Estimated site-related cumulative ILCRs for the adult resident for soils at Land Parcels S, F, and

D are above 1 in one million (1E-06) and are attributable to arsenic, benzo(a)pyrene, and dibenz(a,h)anthracene. Although these risks exceed 1 in one million, they do not exceed the upper end of the acceptable Superfund carcinogenic risk range of 1E-04. The non-cancer risks in all land parcels for the child resident (the more conservative non-carcinogenic assessment) has a total HI by target organ of less than 1. Estimated hazard indices lower than 1 are considered negligible and do not warrant remedial action.

For surface soils, EPA Region V has adopted the EPA Office of Solid Waste and Emergency Response 400 mg/kg lead screening level for residential soil as an appropriate screening level for inorganic lead (EPA, 1998a, 1994c). For Himco CDA, lead was detected above the residential screening level in Land Parcel F in one surface soil sample at 695 mg/kg-which was "J" qualified, or estimated below the reporting limit.

6.6.2 Himco Dump/CDA Downgradient Shallow Aquifer Ground Water

Environmental contamination in the Himco downgradient area ground water does appear to pose an unacceptable health risk to the adult and child resident if used for drinking and household activities.
Estimated site-related cumulative ILCR for the adult resident to ground water at well-pair WT101A/WT114A hypothetical exposure location is above 1 in 10,000 (1E-04), and the total HI non-cancer risk for detected compounds for the adult resident is less than 1. For the child resident, the total HI is greater than 1. The unacceptable cancer risks to the adult are due to benzene and arsenic, and the non-cancer hazard risks to the child are due to arsenic, iron, and manganese.

Estimated site-related cumulative ILCR for the adult resident to ground water at well WT115A hypothetical exposure location is above 1 in 100,000 (1E-05), and the total HI non-cancer risk for detected compounds for the adult resident is less than 1. For the child resident, the total HI is greater than 1. The cancer risk to the adult is due to benzene, but does not exceed the upper end of the acceptable Superfund carcinogenic risk range of 1E-04. The unacceptable non-cancer hazard risk to the child resident is due to manganese.

Estimated site-related cumulative ILCR for the adult resident to ground water at well-pair WT116A/WT119A hypothetical exposure location is above 1 in 10,000 (1E-04), and the total HI non-cancer risk for detected compounds for the adult resident is greater than 1. For the child resident, the total HI is also greater than 1. The unacceptable cancer risks to the adult are due to benzene, 1,2-dichloropropane, carbazole, and arsenic, and the unacceptable non-cancer hazard risks are due to the benzene and 1,2-dichloropropane. The unacceptable non-cancer hazard risk to the child resident is due to manganese.

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Figure 5-1
Human Health Conceptual Site Model, Construction Debris Area/Himco Dump Superfund Site

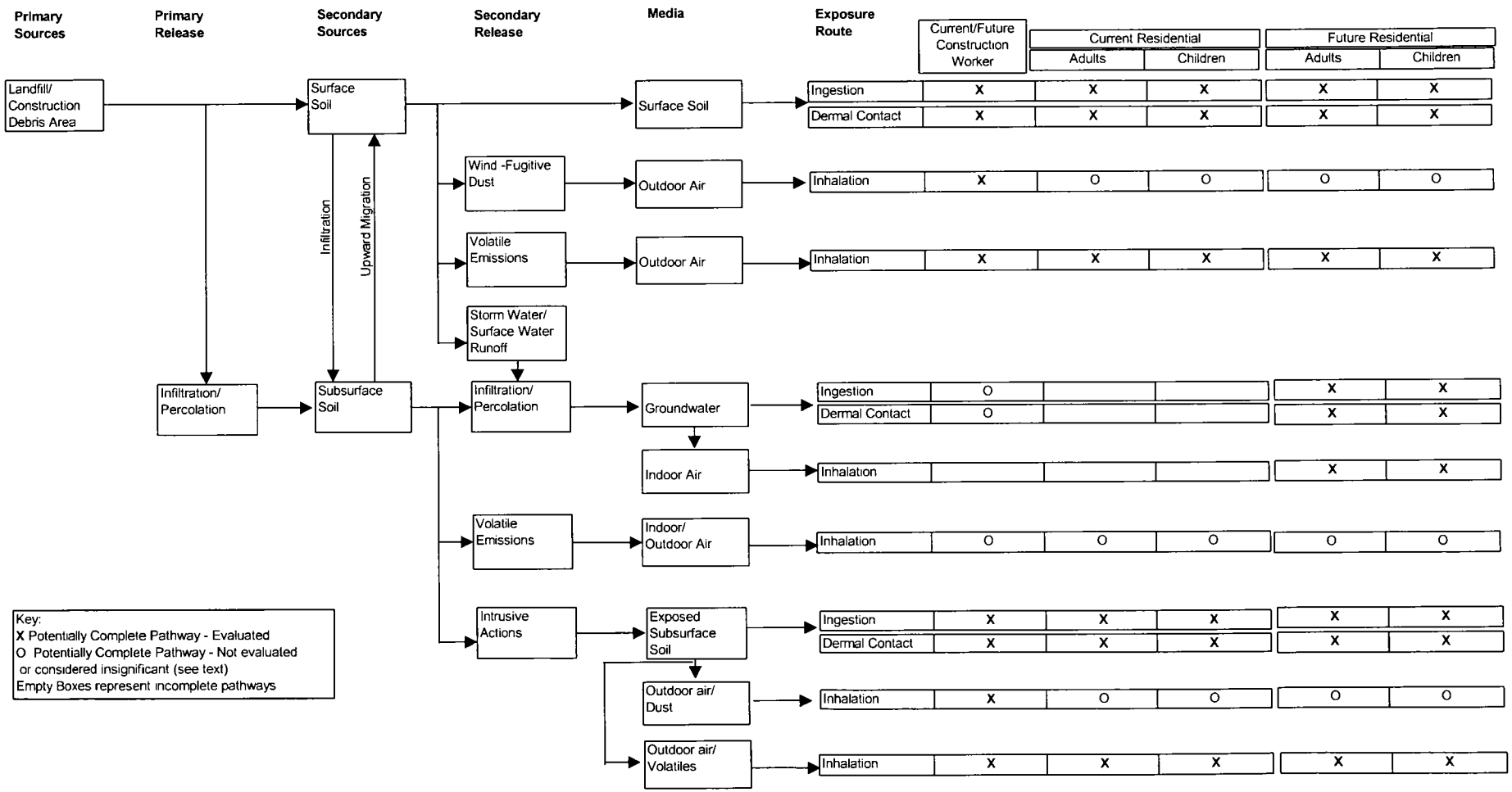

Table 5-1
Compounds Not Detected in Himco CDA Soils or Downgradient Ground Water Samples With Detection Limits Greater Than Risk-Based Screening Levels

Matrix	Analysis/Compound	Maximum Detection Limit[a]	Human Health Risk-Based Screening Level[b]	Background[c]	QAPP Quantitation Limit[d]
Soils	**CLP SOW OLM03.1 TCL Semivolatile Organic Compounds, µg/kg**				
	bis(2-Chloroethyl)ether	690	180	NC	330
	N-Nitroso-di-n-propylamine	690	63	NC	330
	2-Nitroaniline	1700	330	NC	330
	Hexachlorobenzene	690	280	NC	330
Ground Water	**CLP SOW OLM03.1 TCL Volatile Organic Compounds, µg/L**				
	Chloromethane	10	1.5	NC	10
	Bromomethane	10	0.87	NC	10
	Vinyl Chloride	10	2	NC	10
	1,1-Dichloroethene	10	0.046	NC	10
	Chloroform	10	0.16	NC	10
	1,2-Dichloroethane	10	0.12	NC	10
	Carbon Tetrachloride	10	0.17	NC	10
	Bromodichloromethane	10	0.18	NC	10
	cis-1,3-Dichloropropene	10	0.081	NC	10
	Dibromochloromethane	10	1	NC	10
	1,1,2-Trichloroethane	10	0.2	NC	10
	trans-1,3-Dichloropropene	10	0.081	NC	10
	Bromoform	10	8.5	NC	10
	Tetrachloroethene	10	1.1	NC	10
	1,1,2,2-Tetrachloroethane	10	0.055	NC	10
	CLP SOW OLM03.1 TCL Semivolatile Organic Compounds, µg/L				
	bis(2-Chloroethyl)ether	10	0.0098	NC	10
	2-Chlorophenol	10	3.8	NC	10
	1,3-Dichlorobenzene	10	1.7	NC	10
	1,4-Dichlorobenzene	10	0.047	NC	10
	2,2'-Oxybis(1-chloropropane)	10	0.27	NC	10
	N-Nitroso-di-n-propylamine	10	0.0096	NC	10
	Hexachlorobenzene	10	4.8	NC	10
	Nitrobenzene	10	0.34	NC	10
	Hexachlorobutadiene	10	0.86	NC	10
	2,4,6-Trichlorophenol	10	6.1	NC	10
	2-Nitroaniline	26	0.22	NC	25
	2,6-Dinitrotoluene	10	3.7	NC	10
	2,4-Dinitrophenol	26	7.3	NC	26
	2,4-Dinitrotoluene	10	7.3	NC	10
	4,6-Dinitro-2-methylphenol	26	0.37	NC	26
	Hexachlorobenzene	10	0.042	NC	10
	Pentachlorophenol	26	0.56	NC	26
	3-3'Dichlorobenzidine	10	0.15	NC	20
	Benzo(a)anthracene	10	0.092	NC	10
	Chrysene	10	9.2	NC	10
	Benzo(b)fluoranthene	10	0.092	NC	10
	Benzo(k)fluoranthene	10	0.92	NC	10
	Benzo(a)pyrene	10	0.0092	NC	10
	Indeno(1,2,3-cd)pyrene	10	0.092	NC	10
	Dibenz(a,h)anthracene	10	0.0092	NC	10

[a]Maximum detection limit from the Himco Construction Debris Area soils, and ground water monitoring locations.

[b]Soil Risk-Based Screening Levels (RBSLs) are EPA Region 9 residential soil Preliminary Remediation Goals (PRGs) (Oct 1, 1999), for carc compounds, and RBSLs divided by a factor of 10 for noncarc compounds. Likewise, ground water RBSLs are EPA Region 9 tap water PRGs (Oct 1, 1999), for carc compounds, and RBSLs divided by a factor of 10 for noncarc compounds.

[c]NC - compound was not observed in the background samples, therefore no background mean or UTL was calculated for the compound.

[d]QAPP Quantitation Limit given *WorkPlan for the Supplemental Field Investigation at the Himco Dump Superfund Site, Elkhart, Indiana*, (USACE, October 1998).

Table 5-2
Potentially Complete Human Health Exposure Pathways Selected for Evaluation at Himco Dump/CDA

Current & Future Land Use	Surrounding Land Use	Potentially Contaminated Media	Potentially Exposed Populations	Exposure Route Evaluated Based on Available Data	Rationale
Residential	The Himco site is a closed landfill. Land use in the vicinity of site is agricultural, residential, and light industrial.	Surface Soil Subsurface Soil Ground Water Air[a]	Residents - adult and child	ADULTS Surface Soil *Ingestion *Dermal Contact Ground Water *Ingestion *Dermal Contact (showering) * Inhalation CHILDREN Surface Soil *Ingestion *Dermal Contact Ground Water *Ingestion *Dermal Contact (bathing) * Inhalation **Inhalation of soils/ dust not evaluated, inhalation of soils/ VOCs was to be considered only if "volatile" COPCs were identified.	The residential scenario is intended to address the event of a homeowner coming into contact with off-site surface soils (0 to 0.5 ft.) either by incidental ingestion or dermal contact. The COPC surface soil maximum concentration was used to obtain exposure point concentrations from each individual residence. For ground water, the residential scenario is intended to address the event of a homeowner installing a well and using the ground water underlying the site as a source of household water. The exposure point concentration was derived by using the arithmetic average of 1995/1998 shallow aquifer data from specific well-pair monitoring locations for proposed exposure locations.

Table 5-2
Potentially Complete Human Health Exposure Pathways Selected for Evaluation at Himco Dump/CDA (continued)

Current & Future Land Use	Surrounding Land Use	Potentially Contaminated Media	Potentially Exposed Populations	Exposure Route Evaluated Based on Available Data	Rationale
Residential	The Himco site is a closed landfill. Land use in the vicinity of site is agricultural, residential, and light industrial.	Surface Soil Subsurface Soil Ground Water Air[a]	Residents involved in gardening/digging activities - adult and child	ADULTS Mixed Soils 0-2 ft. *Ingestion *Dermal Contact CHILDREN Mixed Soils 0-2 ft. *Ingestion *Dermal Contact **Neither receptor is expected to encounter ground water **Inhalation of soils/ dust not evaluated, inhalation of soils/ VOCs was to be considered only if "volatile" COPCs were identified.	The residential"gardening" scenario is intended to address the event of a homeowner coming into contact with off-site mixed soils to 2 ft. either by incidental ingestion or dermal contact while gardening or performing landscaping activities. The COPC maximum concentration using mixed soils data to 2 ft. was used to obtain exposure point concentrations from each individual residence.
			Construction Worker (involved in resident home improvement projects).	Mixed Soils 0-6 ft. *Ingestion *Dermal Contact **Inhalation **Not expected to encounter ground water **Inhalation of soils/ VOCs was to be considered only if "volatile" COPCs were identified.	Exposure to off-site related contaminants may occur during potential excavation activities. The COPC maximum concentration using mixed soils data to 6 ft. was used to obtain exposure point concentrations from each individual residence.

[a]The inhalation exposure route was quantified using modeling to address potential risk via the air pathway.

Table 5-3
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Himco Dump Superfund Site/Construction Debris Area, Mixed Soil Data

Scenario Timeframe: Current/Future
Medium: Total Soil
Exposure Medium: Soil/Dust-Volatilization
Exposure Point: Ingestion/Dermal Contact/Inhalation

Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Quantitation Limits	Concentration Used for Screening (max)	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
Inorganics															
Aluminum	1360		8860		mg/kg	SB16-6	47/47	10.0	8860		7600 N			yes	ASL
Anitmony	9.2	J	13.1	J	mg/kg	SB07-0.5	2/47	8.6-13.8	13.1		3.1 N			yes	ASL
Arsenic	0.55	J	12.5	J	mg/kg	SB11-0.5	47/47	0.5	12.5		0.039 C			yes	ASL
Banum	7.8		444		mg/kg	SB19-2	47/47	1.0	444		540 N			no	BSL
Beryllium	0.10	J	0.9	J	mg/kg	SB16-6	23/47	0.10-0.70	0.9		15 N			no	BSL
Cadmium	1.0		2.0		mg/kg	SB15-6	13/47	0.90-1.2	2.0		3.7 N			no	BSL
Calcium	361	J	85900	J	mg/kg	SB16-6	47/47	20.0	85,900		4,000,000			no	NUT
Chromium	3.3		25.1		mg/kg	SB20-0.5	47/47	1.0	25.1		210 C			no	BSL
Cobalt	1.9	J	10.8		mg/kg	SB15-6	40/47	1.7-3.4	10.8		470 N			no	BSL
Copper	3.1	J	2,220		mg/kg	SB15-6	47/47	2.0	2,220		290 N			yes	ASL
Iron	1330		26000		mg/kg	SB15-0.5	47/47	10.0	26,000		50,000			no	NUT
Lead	5.2		695	J	mg/kg	SB15-0.5	47/47	0.5	695		400			yes	ASL
Magnesium	333	J	22600		mg/kg	SB15-6	47/47	20.0	22,600		85,000			no	NUT
Manganese	14.8		1410		mg/kg	SB15-6	47/47	1.0	1410		180 N			yes	ASL
Mercury	0.05	J	27.9		mg/kg	SB20-0.5	28/47	0.05-0.06	27.9		2.3 N			yes	ASL
Nickel	6.0		298		mg/kg	SB15-6	28/47	5.8-16.5	298		160 N			yes	ASL

(1) Minimum/maximum detected concentration from '98 Construction Debris Area soil data (all depths).
(2) '92 Himco Dump RI/FS background surface soil (0-2') data (SEC Donohue Inc., 1992) not used.
(3) Preliminary Remediation Goals Table, Oct 1, 1999, U.S. EPA Region 9, (Cancer benchmark value = 1E-06, HQ=0.1), or chemical-specific Recommended Daily Allowances (RDAs) or Daily Dietary Intakes.
(4) Rationale Codes

Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Frequent Detection (FD)
- Toxicity Information Available (TX)
- Above Screening Levels (ASL)
- Quantitation Limit is greater than Risk-Based Screening Level (QL>RBSL)

Deletion Reason:
- Infrequent Detection (IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Essential Nutrient (NUT)
- Below Screening Level (BSL)

Definitions:
- N/A = Not Applicable
- SQL = Sample Quantitation Limit
- COPC = Chemical of Potential Concern
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
- ND = Not Detected
- MCL = Federal Maximum Contaminant Level
- SMCL = Secondary Maximum Contaminant Level
- J = Estimated Value
- C = Carcinogenic
- N = Non-Carcinogenic
- RBSL = Risk-Based Screening Level

Table 5-3
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Himco Dump Superfund Site/Construction Debris Area, Mixed Soil Data

Scenario Timeframe: Current/Future
Medium: Total Soil
Exposure Medium: Soil/Dust-Volatilization
Exposure Point: Ingestion/Dermal Contact/Inhalation

Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Quantitation Limits	Concentration Used for Screening (Max)	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
Potassium	210	J	586	J	mg/kg	SB19-6	35/47	125-198	586		29,250,000			no	NUT
Selenium	0 6	J	1.6	J	mg/kg	SB19-2	12/47	0.10-0.60	1.6		39 N			no	BSL
Silver	1		3.1		mg/kg	SB20-2	6/47	0.80-1.40	3.1		39 N			no	BSL
Sodium	20.4	J	525		mg/kg	SB04-2	46/47	16.8	525		50,000,000			no	BSL
Thallium	0.1	J	0 5		mg/kg	multiple	6/47	0.08-0.40	0.5		0.51 N			no	BSL
Vanadium	3.7	J	18		mg/kg	SB18-2	47/47	1	18		55 N			no	BSL
Zinc	10		1120		mg/kg	SB15-6	47/47	2	1120		2300 N			no	BSL
Cyanide	0.05	J	4.9		mg/kg	SB10-2	42/47	0.10-0.11	4.9		120 N			no	BSL
Volatile Organics															
Methylene Chloride	0.034		0.075		mg/kg	SB19-2	3/47	0.010-0.024	0.075		8.9 C			no	BSL
Acetone	0.002	J	0 022		mg/kg	SB15-2	10/47	0 010-0.013	0.022		160 N			no	BSL
Carbon Disulfide	0 002	J	0.002	J	mg/kg	SB16-6	1/47	0.010-0.015	0.002		36 N			no	BSL
1,1-Dichloroethane	0.002	J	0.002	J	mg/kg	SB16-6	1/47	0.010-0.015	0.002		59 N			no	BSL
Benzene	0.004	J	0.004	J	mg/kg	SB16-6	1/47	0.010-0.015	0.004		0.67 C			no	BSL
Ethylbenzene	0.014		0.014		mg/kg	SB16-6	1/46	0.010-0.015	0.014		230 Sat			no	BSL
Xylene	0.009	J	0.009	J	mg/kg	SB16-6	1/46	0.010-0.015	0.009		210 Sat			no	BSL

(1) Minimum/maximum detected concentration from '98 Construction Debris Area soil data (all depths).
(2) '92 Himco Dump RI/FS background surface soil (0-2') data (SEC Donohue Inc., 1992) not used.
(3) Preliminary Remediation Goals Table, Oct 1, 1999, U.S. EPA Region 9, (Cancer benchmark value = 1E-06, HQ=0.1), or chemical-specific Recommended Daily Allowances (RDAs) or Daily Dietary Intakes.
(4) Rationale Codes

Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Frequent Detection (FD)
- Toxicity Information Available (TX)
- Above Screening Levels (ASL)
- Quantitation Limit is greater than Risk-Based Screening Level (QL>RBSL)

Deletion Reason:
- Infrequent Detection (IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Essential Nutrient (NUT)
- Below Screening Level (BSL)

Definitions:
- N/A = Not Applicable
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- COPC = Chemical of Potential Concern
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
- ND = Not Detected
- MCL = Federal Maximum Contaminant Level
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- J = Estimated Value
- C = Carcinogenic
- N = Non-Carcinogenic
- Sat = Soil Saturation
- RBSL = Risk-Based Screening Level

Table 5-3
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Himco Dump Superfund Site/Construction Debris Area, Mixed Soil Data

Scenario Timeframe: Current/Future
Medium: Total Soil
Exposure Medium: Soil/Dust-Volatilization
Exposure Point: Ingestion/Dermal Contact/Inhalation

Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Quantitation Limits	Concentration Used for Screening (max)	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
Semivolatile Organics															
bis(2-Chloroethyl)ether	ND		ND		mg/kg		0/47	0.330-0.690	ND		0.21 C			yes	QL>RBSL
1,2-Dichlorobenzene	0.098	J	0.098	J	mg/kg	SB16-6	1/47	0.330-0.690	0.098		370 Sat			no	BSL
4-Methylphenol	0.050	J	0.050	J	mg/kg	SB20-2	1/47	0.330-0.690	0.050		31 N			no	BSL
N-Nitroso-di-n-propylamine	ND		ND		mg/kg		0/47	0.330-0.690	ND		0.069 C			yes	QL>RBSL
2-Nitrophenol	ND		ND		mg/kg		0/47	0.330-0.870	ND		none			no	NTX
bis(2-Chloroethoxy)methane	ND		ND		mg/kg		0/47	0.330-0.690	ND		none			no	NTX
Naphthalene	0.038	J	2.2		mg/kg	SB20-6	6/47	0.330-0.690	2.2		5.6 N			no	BSL
4-Chloro-3-methylphenol	ND		ND		mg/kg		0/47	0.330-0.690	ND		none			no	NTX
2-Methylnaphthalene	0.048	J	1.0		mg/kg	SB20-6	3/47	0.330-0.690	1.0		none			no	NTX
2-Nitroaniline	ND		ND		mg/kg		0/47	0.340-1.7	ND		0.35 N			yes	QL>RBSL
Acenaphthylene	0.067	J	2.3		mg/kg	SB20-6	6/47	0.330-0.690	2.3		none			no	NTX
3-Nitroaniline	ND		ND		mg/kg		0/47	0.390-1.7	ND		none			no	NTX
Acenaphthene	0.037	J	0.890		mg/kg	SB20-6	6/47	0.330-0.690	0.890		370 N			no	BSL
Dibenzofuran	0.078	J	1.5		mg/kg	SB20-6	3/47	0.330-0.690	1.5		29 N			no	BSL

(1) Minimum/maximum detected concentration from '98 Construction Debris Area soil data (all depths).
(2) '92 Himco Dump RI/FS background surface soil (0-2') data (SEC Donohue, Inc., 1992) not used.
(3) Preliminary Remediation Goals Table, Oct 1, 1999, U.S. EPA Region 9, (Cancer benchmark value = 1E-06, HQ=0.1).
(4) Rationale Codes

Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Frequent Detection (FD)
- Toxicity Information Available (TX)
- Above Screening Levels (ASL)
- Quantitation Limit is greater than Risk-Based Screening Level (QL>RBSL)

Deletion Reason:
- Infrequent Detection (IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Essential Nutrient (NUT)
- Below Screening Level (BSL)

Definitions:
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Table 5-3
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Himco Dump Superfund Site/Construction Debris Area, Mixed Soil Data

Scenario Timeframe: Current/Future
Medium: Total Soil
Exposure Medium: Soil/Dust-Volatilization
Exposure Point: Ingestion/Dermal Contact/Inhalation

Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Quantitation Limits	Concentration Used for Screening (max)	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
Diethylphthalate	0.064	J	0.064	J	mg/kg	SB-16-6	1/47	0.330-0.690	0.064		4900 N			no	BSL
4-Chlorophenyl-phenylether	ND		ND		mg/kg		0/47	0.330-0.690	ND		none			no	NTX
Fluorene	0.044	J	2.5		mg/kg	SB20-6	5/47	0.330-0.690	2.5		260 N			no	BSL
4-Nitroaniline	ND		ND		mg/kg		0/47	0.830-1.7	ND		none			no	NTX
4,6-Dinitro-2-methylphenol	ND		ND		mg/kg		0/47	0.830-1.7	ND		none			yes	NTX
4-Bromophenyl-phenylether	ND		ND		mg/kg		0/47	0.330-0.690	ND		none			no	NTX
Hexachlorobenzene	ND		ND		mg/kg		0/47	0.330-0.690	ND		0.30 C			yes	QL>RBSL
Phenanthrene	0.037	J	18.0		mg/kg	SB20-6	20/47	0.340-0.690	18.0		none			no	NTX
Anthracene	0.041	J	4.9	J	mg/kg	SB20-6	13/47	0.340-0.690	4.9		2200 C			no	BSL
Carbazole	0.037	J	1.5		mg/kg	SB20-6	9/47	0.330-0.690	1.5		24 C			no	BSL
Di-n-butylphthalate	0.037	J	0.095	J	mg/kg	SB19-0.5	3/47	0.330-0.690	0.095		610 N			no	BSL
Fluoranthene	0.043	J	29.0		mg/kg	SB20-6	26/47	0.350-0.690	29.0		230 N			no	BSL
Pyrene	0.040	J	21.0		mg/kg	SB20-6	26/47	0.340-0.690	21.0		230 N			no	BSL
Butylbenzylphthalate	0.054	J	0.06	J	mg/kg	SB16-6	2/47	0.330-0.690	0.06		1200 N			no	BSL
Benzo(a)anthracene	0.039	J	9.7		mg/kg	SB20-6	23/47	0.340-0.690	9.7		0.62 C			yes	ASL
Chrysene	0.047	J	9.7		mg/kg	SB20-6	23/47	0.340-0.690	9.7		62 C			no	BSL

(1) *Minimum/maximum detected concentration from '98 Construction Debris Area soil data (all depths).*
(2) '92 Himco Dump RI/FS background surface soil (0-2') data (SEC Donohue Inc., 1992) not used.
(3) Preliminary Remediation Goals Table, Oct 1, 1999, U.S. EPA Region 9, (Cancer benchmark value = 1E-06, HQ=0.1).
(4) Rationale Codes

Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Frequent Detection (FD)
- Toxicity Information Available (TX)
- Above Screening Levels (ASL)
- Quantitation Limit is greater than Risk-Based Screening Level (QL>RBSL)

Deletion Reason:
- Infrequent Detection (IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Essential Nutrient (NUT)
- Below Screening Level (BSL)

Definitions:
- N/A = Not Applicable
- SQL = Sample Quantitation Limit
- COPC = Chemical of Potential Concern
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
- *ND = Not Detected*
- MCL = Federal Maximum Contaminant Level
- SMCL = Secondary Maximum Contaminant Level
- J = Estimated Value
- C = Carcinogenic
- N = Non-Carcinogenic
- Sat = Soil Saturation
- RBSL = Risk-Based Screening Level

Table 5-3
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Himco Dump Superfund Site/Construction Debris Area, Mixed Soil Data

Scenario Timeframe: Current/Future
Medium. Total Soil
Exposure Medium: Soil/Dust-Volatilization
Exposure Point: Ingestion/Dermal Contact/Inhalation

Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Quantitation Limits	Concentration Used for Screening (max)	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
bis(2-Ethylhexyl)phthalate	0.036	J	30.0		mg/kg	SB14-6	32/47	0.330-1.5	30 0		35 C			no	BSL
Di-n-octylphthalate	0.056	J	0.130	J	mg/kg	SB19-6	3/47	0.330-0.690	0.130		120 N			no	BSL
Benzo(b)fluoranthene	0.038	J	9 7		mg/kg	SB20-6	26/47	0.340-0 690	9.7		0.062 C			yes	ASL
Benzo(k)fluoranthene	0.038	J	10.0		mg/kg	SB20-6	22/47	0.340-0.690	10.0		6.2 C			yes	ASL
Benzo(a)pyrene	0.053	J	11.0		mg/kg	SB20-6	24/47	0.340-0.690	11.0		0.062 C			yes	ASL
Indeno(1,2,3-cd)pyrene	0.041	J	6.4		mg/kg	SB20-6	24/47	0 340-0.690	6.4		0.62 C			yes	ASL
Dibenz(a,h)anthracene	0.043	J	2.0		mg/kg	SB20-6	21/47	0.340-0.690	2.0		0.062 C			yes	ASL
Benzo(g,h,I)perylene	0.038	J	7.1		mg/kg	SB20-6	29/47	0.340-0.690	7.1		none			no	NTX

(1) Minimum/maximum detected concentration from '98 Construction Debris Area soil data (all depths).
(2) '92 Himco Dump RI/FS background surface soil (0-2') data (SEC Donohue, Inc., 1992) not used.
(3) Preliminary Remediation Goals Table, Oct 1, 1999, U.S. EPA Region 9, (Cancer benchmark value = 1E-06, HQ=0.1).
(4) Rationale Codes

Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Frequent Detection (FD)
- Toxicity Information Available (TX)
- *Above Screening Levels (ASL)*
- Quantitation Limit is greater than Risk-Based Screening Level (QL>RBSL)

Deletion Reason:
- Infrequent Detection (IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Essential Nutrient (NUT)
- Below Screening Level (BSL)

Definitions:
- N/A = Not Applicable
- SQL = Sample Quantitation Limit
- COPC = Chemical of Potential Concern
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
- ND = Not Detected
- MCL = Federal Maximum Contaminant Level
- SMCL = Secondary Maximum Contaminant Level
- J = Estimated Value
- C = Carcinogenic
- N = Non-Carcinogenic
- RBSL = Risk-Based Screening Level

Table 5-4
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Himco Dump Superfund Site, '95 and '98 Combined Downgradient Shallow Aquifer Data Set for Ground Water

Scenario Timeframe: Current/Future
Medium: Ground Water
Exposure Medium: Ground Water
Exposure Point: Tap Water/Water Vapor

Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Quantitation Limits	Concentration Used for Screening (max)	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
Inorganics															
Aluminum	58	J	393		ug/L	WT116A95	7/9	26 0-200	393	119.4	3600 N	50	SMCL	no	BSL
Anitmony	20.4	J	43.2	J	ug/L	WT119A98	2/9	12.8-42.2	43.2	17.6	1.5 N	6	MCL	yes	ASL
Arsenic	1.0	J	24.3	J	ug/L	WT114A98	6/9	0 90-3.8	24.3	1.2	0.045 C	50	MCL	yes	ASL
Barium	33 5	J	238	J	ug/L	WT114A98	9/9	200?	238	43.1	260 N	2000	MCL	no	BSL
Beryllium	0.4		0.6	J	ug/L	WT114A98	2/9	0.40-0.60	0.6	0.5	7.3 N	4	MCL	no	BKG/BSL
Cadmium	1.1		1.7	J	ug/L	WT114A95	3/9	1.1-4 6	1.7	1.5	1.8 N	5	MCL	no	BKG/BSL
Calcium	27000	J	546000		ug/L	WT116A95	9/9	5000	546,000	93,025	400,000			yes	>NUT
Chromium	7.1	J	13.1		ug/L	WT101A98	5/9	4 0-7.0	13.1	13 4	11 N	100	MCL	no	BKG
Cobalt	10.9	J	13.8	J	ug/L	WT114A95	3/9	5.9-7.8	13.8	6	220 N			no	BSL
Copper	1.7		5.4		ug/L	WT119A98	2/9	1.7-4.1	5.4	5.8	140 N	1300	MCL	no	BKG/BSL
Iron	1360		28100		ug/L	WT101A98	9/9	11.7-100	28,100	39.2	5000	300	SMCL	yes	>NUT
Lead	3 4	J	3.4	J	ug/L	WT119A98	1/9	0.5-1.7	3.4	0.6	15	15	MCL	no	BSL
Magnesium	14700		55400		ug/L	WT116A95	9/9	5000	55,400	15,425	85,000			no	NUT
Manganese	279		3080		ug/L	WT101A98	9/9	15	3080	25.6	88 N			yes	ASL
Mercury	0.1	J	0.1	J	ug/L	multiple	1/9	0.10-0.20	0.1	0.1	1.1 N	2	MCL	no	BKG/BSL
Nickel	9.7	J	23.8	J	ug/L	WT101A95	3/9	28.3	23.8	33.9	73 N	100	MCL	no	BKG/BSL

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Toxicity Information Available (TX)
Above Screening Levels (ASL)
Quantitation Limit is greater than Risk-Based Screening Level (QL>RBSL)

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Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
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Medium: Ground Water
Exposure Medium: Ground Water
Exposure Point: Tap Water/Water Vapor

Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Quantitation Limits	Concentration Used for Screening (Max)	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
Potassium	3580	J	38000		ug/L	WT116A95	9/9	5000	38,000	1752.5	2,925,000			no	NUT
Selenium	6.0	J	6.0	J	ug/L	WT119A98	1/6	3.6-6.0	6.0	2	18 N	50	MCL	no	BSL
Silver	2.5		2.5		ug/L	WT116A95	1/9	2.5-5.3	2.5	7.4	18 N	100	SMCL	no	BKG/BSL
Sodium	12100		201000	J	ug/L	WT116A95	9/9	5000	201,000	31475	5,000,000			no	NUT
Thallium	5.3	J	6.7	J	ug/L	WT114A95	3/9	0.40-4.7	6.7	2.5	0.29 N	2	MCL	yes	ASL
Vanadium	10.4	J	20 9	J	ug/L	WT101A95	3/9	4.5-12.3	20.9	12.1	26 N			no	BSL
Zinc	1.8	J	45.4		ug/L	WT116A95	6/9	0.90-3.2	45.4	3 8	1100 N	5000	SMCL	no	BSL
Cyanide	7.8		31.9		ug/L	WT116A98	5/9	10.0-10.0	31.9	6.5	73 N			no	BSL
Volatile Organics															
Chloromethane	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	1.5 C			yes	QL>RBSL
Bromomethane	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.87 N			yes	QL>RBSL
Vinyl Chloride	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.02C	2	MCL	yes	QL>RBSL
Methylene Chloride	0.7	J	1 0	J	ug/L	WT115A95	2/9	10.0-10.0	1 0	ND	4.3 C			no	BSL
Carbon Disulfide	0.7	J	0.7	J	ug/L	WT114A95	1/9	10.0-10.0	0.7	ND	100 N			no	BSL
1,1-Dichloroethene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.046 C	7	MCL	yes	QL>RBSL
1,1-Dichloroethane	4 0	J	7.0	J	ug/L	WT116A95	5/9	10.0-10.0	7.0	ND	81 N			no	BSL
total 1,2-Dichloroethene	1.0	J	1.0	J	ug/L	WT116A95	1/9	10.0-10.0	1.0	ND	6.1 N	100	MCL	no	BSL

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Chloroform	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.16 C	100	MCL	yes	QL>RBSL
1,2-Dichloroethane	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.12 C	5	MCL	yes	QL>RBSL
Carbon Tetrachloride	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.17 C	5	MCL	yes	QL>RBSL
Bromodichloromethane	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.18 C	100	MCL	yes	QL>RBSL
1,2-Dichloropropane	4.0	J	4.0	J	ug/L	WT116A95	1/9	10.0-10.0	4.0	ND	0.16 C	5	MCL	yes	ASL
cis-1,3-Dichloropropene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.081 C			yes	QL>RBSL
Trichloroethene	0.9	J	0.9	J	ug/L	WT116A95	1/9	10.0-10.0	0.9	ND	1.6 C	5	MCL	no	BSL
Dibromochloromethane	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	1.0 C			yes	QL>RBSL
1,1,2-Trichloroethane	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.20 C	5	MCL	yes	QL>RBSL
Benzene	1.0	J	15		ug/L	WT116A95	3/9	10.0-10.0	15	ND	0.39 C	5	MCL	yes	ASL
trans-1,3-Dichloropropene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.081 C			yes	QL>RBSL
Bromoform	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	8.5 C	100	MCL	yes	QL>RBSL
Tetrachloroethene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	1.1 C	5	MCL	yes	QL>RBSL
1,1,2,2-Tetrachloroethane	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.055 C			yes	QL>RBSL
Ethylbenzene	0.7	J	0.7	J	ug/L	WT116A95	1/9	10.0-10.0	0.7	ND	130 N	700	MCL	no	BSL

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Semivolatile Organics															
bis(2-Chloroethyl)ether	ND		ND		ug/l		0/9	10 0-10.0	ND	ND	0.0098 C			yes	QL>RBSL
2-Chlorophenol	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	3.8 N			yes	QL>RBSL
1,3-Dichlorobenzene	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	0.55 N	600	MCL	yes	QL>RBSL
1,4-Dichlorobenzene	ND		ND		ug/l		0/9	10 0-10.0	ND	ND	0.050 C	600	MCL	yes	QL>RBSL
2,2'-Oxybis(1-chloropropane)	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	0.27 C			yes	QL>RBSL
N-Nitroso-di-n-propylamine	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	0.0096 C			yes	QL>RBSL
Hexachloroethane	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	4.8 C			yes	QL>RBSL
Nitrobenzene	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	0.34 N			yes	QL>RBSL
2-Nitrophenol	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	none			no	NTX
bis(2-Chloroethoxy)methane	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	none			no	NTX
Naphthalene	0.4	J	0.4	J	ug/l	WT116A95	1/9	10.0-10.0	0.4	ND	0.62 N			no	BSL
Hexachlorobutadiene	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	0.86 C			yes	QL>RBSL
4-Chloro-3-methylphenol	ND		ND		ug/l		0/9	10.0-10.0	ND	ND	none			no	NTX
2-Methylnaphthalene	0.5	J	0 5	J	ug/L	WT116A95	1/9	10.0-10.0	0.5	ND	none			no	NTX
2,4,6-Trichlorophenol	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	6.1 C			yes	QL>RBSL
2-Nitroaniline	ND		ND		ug/L		0/9	25.0-26.0	ND	ND	0.22 N			yes	QL>RBSL

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Dimethylphthalate	7.0	J	7.0	J	ug/L	WT101A98	1/9	10.0-10.0	7.0	ND	37000 N			no	BSL
Acenaphthylene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	none			no	NTX
2,6-Dinitrotoluene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	3.7 C			yes	QL>RBSL
3-Nitroaniline	ND		ND		ug/L		0/9	25.0-26.0	ND	ND	none			no	NTX
Acenaphthene	3.0	J	3.0	J	ug/L	WT116A95	1/9	10.0-10.0	3.0	ND	37 N			no	BSL
2,4-Dinitrophenol	ND		ND		ug/L		0/9	25.0-26.0	ND	ND	7.3 N			yes	QL>RBSL
Dibenzofuran	2.0	J	2.0	J	ug/L	WT116A95	1/9	10.0-10.0	2.0	ND	2.4 N			no	BSL
2,4-Dinitrotoluene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	7.3 N			yes	QL>RBSL
Diethylphthalate	0.2	J	19	J	ug/L	WT101A98	4/9	10.0-10.0	19	3.9	29000 N			no	BSL
4-Chlorophenyl-phenylether	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	none			no	NTX
Fluorene	3.0	J	3.0	J	ug/L	WT116A95	1/9	10.0-10.0	3.0	ND	24 N			no	BSL
4-Nitroaniline	ND		ND		ug/L		0/9	25.0-26.0	ND	ND	none			no	NTX
4,6-Dinitro-2-methylphenol	ND		ND		ug/L		0/9	25.0-26.0	ND	ND	none			no	NTX
4-Bromophenyl-phenylether	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	none			no	NTX
Hexachlorobenzene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.042 C			yes	QL>RBSL
Pentachlorophenol	ND		ND		ug/L		0/9	25.0-26.0	ND	ND	0.56 C	1	MCL	yes	QL>RBSL
Phenanthrene	0.2	J	0.2	J	ug/L	WT116A95	1/9	10.0-10.0	0.2	ND	none	1	MCL	no	NTX

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Anthracene	0.3	J	0.3	J	ug/L	WT116A95	1/9	10.0-10.0	0.3	ND	180 C			no	BSL
Carbazole	6.0	J	6.0	J	ug/L	WT116A95	1/9	10.0-10.0	6.0	ND	3.4 C			yes	ASL
3-3'-Dichlorobenzidine	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.15 C			yes	QL>RBSL
Benzo(a)anthracene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.092 C			yes	QL>RBSL
Chrysene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	9.2 C			yes	QL>RBSL
bis(2-Ethylhexyl)phthalate	0.4	J	15.0	J	ug/L	WT116A95	5/9	10.0-10.0	15.0	2.3	4.8 C			yes	ASL
Benzo(b)fluoranthene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.092 C			yes	QL>RBSL
Benzo(k)fluoranthene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.92			yes	QL>RBSL
Benzo(a)pyrene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.0092 C	0.2	MCL	yes	QL>RBSL
Indeno(1,2,3-cd)pyrene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.092 C			yes	QL>RBSL
Dibenz(a,h)anthracene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	0.0092 C			yes	QL>RBSL
Benzo(g,h,I)perylene	ND		ND		ug/L		0/9	10.0-10.0	ND	ND	none			no	NTX

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Table 5-5
Exposure Point Concentrations for COPCs in Himco CDA Soils

Chemical	Land Parcel M						Land Parcel O					
	0 - 0.5 ft.		0 - 2 ft.		0 - 6 ft.		0 - 0.5 ft.		0 - 2 ft.		0 - 6 ft.	
	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum
Aluminum	4080	detection	4080	detection	4080	detection	4220	detection	5130	detection	5130	detection
Antimony	5.75	non-detect	5.75	non-detect	5.75	non-detect	4.7	non-detect	4.7	non-detect	5.15	non-detect
Arsenic	1.6	detection	1.6	detection	1.6	detection	2.1J	detection	2.1J	detection	2.1J	detection
Copper	15.9J	detection	15.9J	detection	15.9 J	detection	20.4	detection	22.6	detection	22.6	detection
Manganese	58.7	detection	58.7	detection	58.7	detection	337	detection	337	detection	337	detection
Mercury	0.03	non-detect	0.03	non-detect	0.03	non-detect	0.08J	detection	0.08J	detection	0.08J	detection
Nickel	4.2	non-detect	4.2	non-detect	4.2	non-detect	9.6J	detection	12.3J	detection	12.3J	detection
Benzo(a)anthracene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.210	non-detect
Benzo(b)fluoranthene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.210	non-detect
Benzo(k)fluoranthene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.210	non-detect
Benzo(a)pyrene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.210	non-detect
Indeno(1,2,3-cd)pyrene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.210	non-detect
Dibenz(a,h)anthracene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.210	non-detect

[a]in mg/kg

Table 5-5
Exposure Point Concentrations for COPCs in Himco CDA Soils

Chemical	Land Parcel P						Land Parcel S					
	0 - 0.5 ft.		0 -2 ft.		0 - 6 ft.		0 - 0.5 ft.		0 - 2 ft.		0 - 6 ft.	
	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum
Aluminum	5670	detection	5670	detection	5670	detection	4740	detection	4740	detection	4740	detection
Antimony	4.6	non-detect	4.6	non-detect	4.6	non-detect	13.1J	detection	13.1J	detection	13.1J	detection
Arsenic	1.5J	detection	1.5J	detection	1.5J	detection	12.5J	detection	12.5J	detection	12.5J	detection
Copper	37.2	detection	38.1	detection	38.1	detection	2110	detection	2110	detection	2110	detection
Manganese	319	detection	319	detection	319	detection	539	detection	539	detection	539	detection
Mercury	0.07J	detection	0.07J	detection	0.07J	detection	0.25J	detection	0.25J	detection	0.25J	detection
Nickel	8.1J	detection	8.1J	detection	8.1J	detection	12	detection	12	detection	15.4J	detection
Benzo(a)anthracene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.280J	detection	1.5	detection	1.5	detection
Benzo(b)fluoranthene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.560	detection	1.9	detection	1.9	detection
Benzo(k)fluoranthene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.200	non-detect	0.560	detection	0.560	detection
Benzo(a)pyrene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.430	detection	1.5	detection	1.5	detection
Indeno(1,2,3-cd)pyrene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.540	detection	0.540	detection	0.540	detection
Dibenz(a,h)anthracene	0.180	non-detect	0.180	non-detect	0.180	non-detect	0.200	non-detect	0.200	non-detect	0.345	non-detect

[a]in mg/kg

Table 5-5
Exposure Point Concentrations for COPCs in Himco CDA Soils

Chemical	Land Parcel F						Land Parcel D					
	0 - 0.5 ft.		0 - 2 ft.		0 - 6 ft.		0 - 0.5 ft.		0 - 2 ft.		0 - 6 ft.	
	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum	EPC[a]	Selection Maximum
Aluminum	4320	detection	6200	detection	8860	detection	4120	detection	4120	detection	5210	detection
Antimony	5.55	non-detect	5.55	non-detect	6.65	non-detect	5.6	non-detect	5.7	non-detect	6.9	non-detect
Arsenic	6J	detection	10.8	detection	10.8	detection	3.4	detection	6.1	detection	6.1	detection
Copper	242	detection	664	detection	2220	detection	50.6	detection	113	detection	113	detection
Manganese	592	detection	592	detection	1410	detection	373	detection	373	detection	373	detection
Mercury	27.9	detection	27.9	detection	27.9	detection	0.06	detection	0.2	detection	0.2	detection
Nickel	21J	detection	23.7J	detection	298	detection	13.5	detection	14.7	detection	14.7	detection
Benzo(a)anthracene	0.780	detection	1.7	detection	9.7	detection	0.310J	detection	1.1	detection	1.1	detection
Benzo(b)fluoranthene	1.6	detection	2.8	detection	9.7	detection	0.380	detection	1.7	detection	1.7	detection
Benzo(k)fluoranthene	1.2	detection	1.2	detection	10	detection	0.360	detection	2.1	detection	2.1	detection
Benzo(a)pyrene	1.3	detection	1.7	detection	11	detection	0.430	detection	1.4	detection	1.4	detection
Indeno(1,2,3-cd)pyrene	1.2	detection	1.2	detection	6.4	detection	0.370	detection	1.1	detection	1.1	detection
Dibenz(a,h)anthracene	0.450	detection	0.450	detection	2	detection	0.130J	detection	0.360J	detection	0.360J	detection

[a]in mg/kg

Table 5-6
Exposure Point Concentrations for COPCs in Himco Shallow Aquifer Downgradient Ground Water

Chemical	Himco Shallow Aquifer Downgradient Ground Water		
	WT101A/WT114A EPC[a] in ug/L	WT115A EPC[a] in ug/L	WT116A/WT119A EPC[a] in ug/L
Antimony	13.8	13.8	32.0
Arsenic	14.8	1.2	3.6
Manganese	1209.8	463	479.0
Thallium	2.4	2.8	1.5
1,2-Dichloropropane	5.0	5.0	4.8
Benzene	4.3	3.0	7.5
Carbazole	5.0	5.0	5.3
bis(2-Ethylhexyl)pthalate	4.0	2.7	6.8

[a]The arithmetic mean from '95 and 98 well or well-pair exposure locations.
Chemicals of potential concern (COPCs) were selected from the entire dataset based on least a single detection. Once COPCs were selected, non-detects were replaced by one-half the quantitation limit. The data were then segregated into exposure locations and the arithmetic mean was determined.

Table 5-7
(Soil)
Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors at Himco
(see text for variable descriptions)

Pathway Variable	Construction Worker	Gardener (age-adjusted)	Child Gardener	Resident (age-adjusted)	Child Resident
Inhalation of VOCs and Resuspended Dust from Soil					
IR_a (m^3/hour)	2.5[a]	NA	NA	NA	NA
ET_a (hours/day)	8[b]	NA	NA	NA	NA
EF (days/year)	188[b]	NA	NA	NA	NA
ED (years)	1[b]	NA	NA	NA	NA
BW (kg)	70[a]	NA	NA	NA	NA
AT Non-cancer (days)[c]	1095	NA	NA	NA	NA
AT Cancer (days)[d]	25550	NA	NA	NA	NA
Incidental Ingestion of Soil					
IR_s (mg/day)	480[e]	480[e]	200[a]	100[a]	200[a]
IFS_{adj} (mg-yrs/kg-day)	NA	245	NA	114	NA
FI_s (unitless)	1[b]	1[b]	1[b]	1[b]	1[b]
EF (days/year)	180[b]	40[e]	40[e]	350[a]	350[a]
ED (years)	3[b]	30[a]	6[a]	30[a]	6[a]
BW (kg)	70[a]	70[a]	15[a]	70[a]	15[a]
AT Non-cancer (days)[c]	1095	NA	2190	NA	2190
AT Cancer (days)[d]	25550	25550	25550	25550	NA
Dermal Contact with Soil					
SA (cm^2)	2000[f]	5800[f]	1825[f]	5800[f]	1825[f]
SFS_{adj} (cm^2-yr/kg)	NA	2720	NA	2720	NA
EF (events/year)	180[b]	40[e]	40[e]	350[a]	350[a]
ED (years)	3[b]	30[a]	6[a]	30[a]	6[a]
BW (kg)	70[a]	70[a]	15[a]	70[a]	15[a]
AF (mg/cm^2-event)	1[f]	1[f]	1[f]	1[f]	1[f]
ABS (unitless)	csv	csv	csv	csv	csv
AT Non-cancer (days)[c]	1095	NA	2190	NA	2190
AT Cancer (days)[d]	25550	25550	NA	25550	NA

NA=not applicable

csv=chemical-specific value

[a]EPA, 1991, *Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors,* Interim Final, Office of Solid Waste and Emergency Response, OSWER Directive: 9285.6-03.

[b]Assumed; see text

[c]Calculated as the product of ED (years) x 365 days/year.

[d]Calculated as the product of 70 years (assumed human lifetime [EPA, 1989, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual {Part A}]*, Interim Final, Office of Emergency and Remedial Response, Washington D.C., EPA/540/1-8/002, 1989) X 365 days/year.

[e]EPA, 1989,*Exposure Factors Handbook.* EPA/600/8-89/043.

[f]EPA, 1992, *Dermal Exposure Assessment: Principles and Applications,* Interim Report, Office of Research and Development, Washington D.C., EPA/600/8-91/001B, including Supplemental Guidance dated August 18, 1992.

Table 5-8
(Groundwater)
Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors at Himco
(see text for variable descriptions)

Pathway Variable	Construction Worker	Gardener (age-adjusted)	Child Gardener	Resident (age-adjusted)	Child Resident
Inhalation of VOCs from Groundwater (shower/bath)					
$InhF_{adj}$ (m^3-year/kg-hr)	NA	NA	NA		NA
IR_{av} (m^3/hour)	NA	NA	NA	0.6[a]	0.6[a]
ETs (hrs/day)	NA	NA	NA	0.2[a]	0.75[a]
EF (days/year)	NA	NA	NA	350[b]	350[b]
ED (years)	NA	NA	NA	30[b]	6[b]
BW (kg)	NA	NA	NA	70[b]	15[b]
AT Non-cancer (days)[c]	NA	NA	NA	NA	2190
AT Cancer (days)[d]	NA	NA	NA	25550	NA
f_s (unitless)	NA	NA	NA	0.75[e]	0.75[e]
F_{w-s} (L/hour)	NA	NA	NA	600[e]	600[e]
t1 (hour)	NA	NA	NA	0.2[a]	0.75[a]
V (m^3)	NA	NA	NA	9[e]	9[e]
Inhalation of VOCs from Groundwater (house)					
$InhF_{adj}$ (m^3-year/kg-day)	NA	NA	NA		NA
IR_{av} (m^3/day)	NA	NA	NA	30[a]	20[a]
EF (days/year)	NA	NA	NA	350[b]	350[b]
ED (years)	NA	NA	NA	30[b]	6[b]
BW (kg)	NA	NA	NA	70[b]	15[b]
AT Non-cancer (days)[c]	NA	NA	NA	NA	2,190
AT Cancer (days)[d]	NA	NA	NA	25550	NA
f_h (unitless)	NA	NA	NA	0.5[e]	0.5[e]
F_{w-h} (L/day)	NA	NA	NA	723[e]	723[e]
HV (m^3)	NA	NA	NA	177.7[e]	177.7[e]
k (unitless)	NA	NA	NA	0.15[e]	0.15[e]
ER (exchanges/day)	NA	NA	NA	13.7[e]	13.7[e]
Ingestion of Drinking Water					
IFW_{adj} (L-year/kg-day)	NA	NA	NA	1.09	NA
IR_w (L-day)	NA	NA	NA	2[a]	1[a]
EF (days/year)	NA	NA	NA	350[b]	350[b]
ED (years)	NA	NA	NA	30[b]	6[b]
BW (kg)	NA	NA	NA	70[b]	15[b]
AT Non-cancer (days)[c]	NA	NA	NA	NA	2,190
AT Cancer (days)[d]	NA	NA	NA	25550	NA
Dermal Contact with Groundwater					
SFW_{adj} (cm^2-year/kg)	NA	NA	NA	9777	NA
SA (cm^2)	NA	NA	NA	20000[a]	7300[f]
ET_d (hours/event)	NA	NA	NA	0.2[a]	0.75[a]
EF (events/year)	NA	NA	NA	350[b]	350[b]
ED (years)	NA	NA	NA	30[b]	6[b]
BW (kg)	NA	NA	NA	70[b]	15[b]
Kp (cm/hour)	NA	NA	NA	csv	csv
AT Non-cancer (days)[c]	NA	NA	NA	NA	2,190
AT Cancer (days)[d]	NA	NA	NA	25550	NA

NA=not applicable

csv=chemical-specific value

[a]EPA, 1989, *Exposure Factors Handbook.* EPA/600/8-89/043., the 1997 Exposure Factors Handbook (EPA/600/P-95002Fa) was used for child bathing time.

[b]EPA, 1991, *Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors,* Interim Final, Office of Solid Waste and Emergency Response, OSWER Directive: 9285.6-03.

[c]Calculated as the product of ED (years) x 365 days/year.

Table 5-8
(Groundwater)
Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors at Himco
(see text for variable descriptions)

[d]Calculated as the product of 70 years (assumed human lifetime [EPA, 1989, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual {Part A}]*, Interim Final, Office of Emergency and Remedial Response, Washington D.C., EPA/540/1-8/002, 1989) X 365 days/year.

[e]RISK*ASSISTANT software. Thistle Publishing.

[f]EPA, 1992, *Dermal Exposure Assessment: Principles and Applications,* Interim Report, Office of Research and Development, Washington D.C., EPA/600/8-91/001B, including Supplemental Guidance dated August 18, 1992.

Table 5-9
Chemical-Specific Values for Detected Chemicals of Potential Concern

COPC	Reference Dose - RfD[a] (mg/kg-day) Oral	Inh.	Dermal	Cancer Slope Factor -CSF[a] $(mg/kg\text{-}day)^{-1}$ Oral	Inh.	Dermal	ABS[b]	GAF	(source)	Kp[c] (cm/hr)	tau[d] (hr)	t*[e] (hr)	VF/PEF[f] (m^3/kg)
Metals													
Aluminum	1.00E+00	1.00E-03	2.70E-01				0.01	0.27	ATSDR '92	0.001			g
Antimony	4.00E-04		4.00E-05				0.01	0.1	ATSDR '92	0.001			g
Arsenic[h]	3.00E-04		2.85E-04	1.50E+00	1.51E+01	1.58E+00	0.032	0.95	ATSDR '99	0.001			g
Calcium							0.01	0.05	EPA 1989	0.001			g
Copper	4.00E-02		2.40E-02				0.01	0.6	NCEA 6-24-92	0.001			g
Iron	3.00E-01		1.50E-02				0.01	0.05	EPA 1989	0.001			g
Manganese-nonfood	4.70E-02	1.43E-05	2.35E-03				0.01	0.05	EPA 1989	0.001			g
Mercury	3.00E-04	8.60E-05					0.01	0.05	EPA 1989	0.001			g
Nickel	2.00E-02		1.00E-03				0.01	0.05	EPA 1989	0.001			g
Thallium (sulfate)	8.00E-05		8.00E-05				0.01	1	ATSDR '92	0.001			g
Volatile/Semivolatile Organics													
Benzene[i]	3.00E-03	1.70E-03	3.00E-03	1.50E-02	7.70E-03	1.50E-02	0.1	1	IRIS	2.10E-02	2.60E-01	6.30E-01	2.80E+03
Dichloropropane,1,2-		1.14E-03		6.80E-02		7.56E-02	0.1	0.9	Jones/Owen '89	1.00E-02	4.30E-01	1.00E+00	3.70E+03
Benzo(a)anthracene				7.30E-01			0.1	NA	NCEA 2-9-93	NA	NA	NA	g
Benzo(a)pyrene				7.30E+00			0.1	NA	NCEA 7-24-91	NA	NA	NA	g
Benzo(b)fluoranthene				7.30E-01			0.1	NA	NCEA 2-11-92	NA	NA	NA	g
benzo(k)fluoranthene				7.30E-02			0.1	NA		NA	NA	NA	g
Bis(2-Ethylhexyl)phthalate	2.00E-02		1.80E-02	1.40E-02	1.40E-02	1.56E-02	0.1	0.9	Jones/Owen '89	3.30E-02	2.10E+01	1.00E+02	g
Carbazole				2.00E-02		2.22E-02	0.1	0.9	Jones/Owen '89	6.55E-02	9.20E-01	5.50E+00	g
Dibenz(a,h)anthracene				7.30E+00			0.1	NA	NCEA 12-29-92	NA	NA	NA	g
Indeno(1,2,3-c,d)pyrene				7.30E-01			0.1	NA	NCEA 2-11-92	NA	NA	NA	g

[a]Values are from either IRIS 2000, HEAST 1997, or NCEA values
[b]EPA 1992 Dermal Exposure Assessment Principles and Applications. In general, the ABS for inorganics is 1% and organics is 10%; exceptions are noted.
[c]EPA 1992 Dermal Exposure Assessment Principles and Applications
[d]EPA 1992 Dermal Exposure Assessment Principles and Applications
[e]EPA 1992 Dermal Exposure Assessment Principles and Applications
[f]VF/PEF values are from EPA Region IX PRG Table Oct, 1999
[g]The construction worker scenario uses the PEF value 1.42E+09
[h]ABS from Wester, R.C., H.I. Maibach, et al., 1993.
[i]IRIS now presents a range of slope factors for benzene. The lowest values are presented here because "any value (within the range) will have equal scientific plausibility (EPA 2000b)

ABS = Absorption Factor (dermal)
COPC = Chemical of Potential Concern
GAF = Gastrointestinal absorption factor

Kp = Permeability coefficient
t* =time to reach steady state absorption
VF/PEF = Volatilization factor/particulate emission factor
Blank space = Indicates no published value available

source acronyms:
I = IRIS =Integrated Risk Information System, 2000
E = NCEA = National Center for Environmental Assessment
H = HEAST = Health Effects Assessment Summary Tables, 1997
ATSDR = Agency for Toxic Substances and Disease Registry