APPENDIX J

RISK ASSESSMENT

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ReTeC Project No. E30-489-200

JUNE 1991

ORIGINAL (Red)

TABLE OF CONTENTS

TABLE OF CONTENTS

ORIGINAL (Red)

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF FIGURES

1.0 INTRODUCTION

1.1 OVERVIEW

This report presents a risk assessment for the Westinghouse Elevator Plant Site (Plant site) located in Gettysburg, Pennsylvania. This site is the location of an elevator and escalator components manufacturing plant. Subsequent site investigations have examined potential contamination of soils, groundwater, surface water and sediments either on-site or in the immediate vicinity of the site.

A risk assessment is an important part of the Remedial Investigation and Feasibility Study (RI/FS) process. The objective of the risk assessment is to identify potential human health and ecological effects that would be associated with the site if no remedial action were taken. This assessment will justify the selection of the "no action" alternative as a remedial action, if the potential human health and ecological effects associated with the Plant site in its current state are judged to be acceptable. If remedial action is judged to be necessary, then the risk assessment will help identify media requiring remedial action. In addition, the risk assessment provides the baseline for evaluating the risk reduction that can be achieved from different remedial actions (or remedial alternatives). The risk assessment can also be used to help identify residual levels (or concentrations) of compounds in different media that are protective of human health and the environment. These residual levels can be used to set clean-up levels in a specific medium where remedial action would be required if the residual level is exceeded.

1.2 SITE BACKGROUND

This section presents background information on the Plant site. First, the history of the Plant site is briefly reviewed. Next, past site investigations are summarized.

Site History

The Westinghouse Elevator Plant was constructed in 1968 as an elevator and escalator component manufacturing operation. Westinghouse operated the plant until 1988 when operations were sold to Schindler Holdings, A. G., the current operator. The Plant site is located approximately 1.5 miles from Gettysburg, in Cumberland Township, Adams County, Pennsylvania. The plant setting relative to Gettysburg is provided in Figure 1-1. The site is approximately 90 acres in size and is located in a semirural area with some

residential and light industrial development. Figure 1-2 provides the layout and physical features for the site. The operations at the site have remained essentially unchanged since startup in 1968 until the present except for a change from trichloroethene (TCE) to 1,1,1-trichloroethane (TCA) in 1975 as the primary solvent used in degreasing. These operations include parts receiving, parts preparation, and final assembly into products. The preparation processes at the site include degreasing, priming and painting, the application of an acoustical coating to components, and the application of adhesives and insulation board to elevators. The raw materials for these processes include various solvents, paints, cutting and lubricating oils, and insulating material. The waste materials generated at the plant include spent solvents, paint sludges, spent oils and grease, and insulation pieces. As stated above, prior to 1975 the degreasing operations utilized a TCE based solvent. After 1975, the process changed and a 1,1,1-TCA based solvent was used. The spent solvent was containerized and shipped off-site for disposal.

The Plant site also used TCE in its Triclene phosphatizing process. This process was used for producing a crystalline iron phosphate layer on steel for corrosion protection. This coating process preceded paint-booth operations. Spent compounds resulting from this process were containerized and shipped off-site for disposal. The Triclene process was also discontinued in 1975. Painting was with a lead chromate primer. Excess paint was collected using a wet scrubber system. Prior to 1984, the scrubber waste was discharged directly to the municipal sewer system. After 1984, the scrubber waste water was treated to remove heavy metals prior to discharge to the sewer. The treatment involved the addition of emulsion breakers, reducing agents, caustic soda, and flocculants in the waste stream. This treatment resulted in the formation of a sludge containing zinc, lead, chromium, and other heavy metals. This sludge was containerized and shipped off-site for disposal.

The sound deadening or acoustical coating process utilized a polymer (hydroxystyrene) matrix that contained copper and was sold under the trade name of Spraylat. The process generated waste waters and excess Spraylat that was containerized and shipped off-site for disposal. The final process involved the application of adhesives and insulation. The insulation used prior to 1972 contained asbestos, but its use was discontinued thereafter. Excess adhesives and insulation generated from this process were containerized and shipped off-site for disposal.

Prior to 1981, drummed spent waste materials were stored in an area located in the southern portion of the plant, presently referred to as the Old Waste Drum Storage Area, prior to off-site shipment for disposal. Currently waste materials are stored in drums near the shipping docks on a covered, diked, concrete pad referred to as the Hazardous Waste Drum Storage Area.

Environmental concern began in 1983 when local residents, near the Plant site, complained to the Pennsylvania Department of Environmental Resources (PADER). Site investigations began in 1983 when the PADER sampled groundwater at the plant and in nearby residential wells. Volatile organic compounds were detected in groundwater near the plant. Afterwards, samples of surface water, soils, and groundwater were obtained that confirmed the presence of volatile organics in these media. Surface water and sediment sampling was performed in 1984 by Westinghouse. In addition, ten bedrock groundwater wells were constructed by R.E. Wright, Associates, on behalf of Westinghouse, for monitoring groundwater at the site. In 1987, Westinghouse entered into a consent agreement with the U.S. EPA to perform a remedial investigation/feasibility study (RI/FS) of the site. Investigative activities associated with the RI/FS began in December, 1988. As stated previously, Westinghouse sold the operations and leased the property to Schindler Holdings, A.G.

Three voluntary remedial actions have been implemented. In 1983, a soil removal operation was implemented that involved removal of soil from the railroad dock and pumphouse areas. This action was halted by the PADER shortly thereafter until a formal investigation was approved. Between 1984 and 1987, Westinghouse installed water mains along Boyd's School Road, Table Rock Road, Biglerville Road, Cedar Avenue, Maple Avenue, and Apple Avenue. In 1984, a groundwater pump and treat system was installed and operated that utilized an air stripping unit to remove volatiles. The effluent from this system is released, via a National Pollution Discharge Elimination System (NPDES) permit, to the Northern Tributary.

Site Investigations

A number of investigations have been performed at the Plant site. The investigations from which data have been generated for the Plant site include the historical investigations conducted at the site (briefly discussed above), the RI/FS Phase I investigation, and the RI/FS Phase II investigation. The historical investigations at the Plant site include all sampling efforts prior to the RI/FS Phase I investigation. These sampling efforts were conducted by Pennsylvania Department of Environmental Resources (PADER), U.S. EPA Region III, Westinghouse, and Westinghouse consultants (i.e., R.E. Wright Associates). On March 10, 1987, Westinghouse entered into a Consent Agreement with the EPA to perform an RI/FS of the site. Phase I sampling efforts at the Plant site were initiated in November 1988 by Paul C. Rizzo Associates, consultant for Westinghouse. Phase II sampling efforts began in August, 1990 by Rizzo Associates and were completed in the fall of 1990.

These site investigations have generated an extensive amount of site data. Samples have been collected from on-site soil, groundwater, and off-site groundwater, surface water and sediments. A number of potential source areas were identified prior to the Phase I investigation. These potential source areas include:

- Remote Tank Fill Line Area;
- Degreasing Fluid Storage Tank Area;
- Pumphouse Area;
- Railroad Dock Area; and
- Old Waste Drum Storage Area.

The source areas are presented in Figure 1-2. Data from both the Phase I and II investigations indicates that, overall, the concentrations of compounds-of-interest in these areas are low. With regard to on-site groundwater contamination, this suggests that an alternative source area exists that is contributing to groundwater contamination. The results of the Phase I and II investigations show that groundwater beneath the site contained detectable concentrations of compounds-of-interest. Potentially, the affected off-site media include off-site groundwater and surface water in the Eastern Tributary of Rock Creek. Based on the Phase II Sampling and Analysis Plan for the Plant site (Rizzo, 1990), the following compounds-of-interest have been identified for the Plant site:

- target compound list (TCL) volatiles;
- bis(2-ethylhexyl)phthalate; and
- polychlorinated biphenyls (in pumphouse area soils only).

1.3 BASELINE SITE SITUATIONS

For the purpose of the risk assessment, the Plant site is evaluated based on existing site conditions and as if no further remedial actions have been implemented or are intended to be implemented. In other words, this risk assessment assumes that no remedial action has been implemented, with the exception of the soil removal actions and the groundwater pump and treatment system that has been designed and installed on-site as an interim remedial measure. In addition, the installed water mains and water treatment filters that have been supplied and installed for local residents as an interim remedial measure will also be considered in this risk assessment with regard to current off-site potential residential groundwater uses.

1.4 SCOPE OF THE RISK ASSESSMENT

As identified above, previous investigations at the Plant site have resulted in an extensive data set. Analytical data exists for several soil, groundwater surface water and sediment samples that have been obtained during the historical site investigation, and the RI/FS Phase I and Phase II investigations. Overall, the data set for the Plant site provides an adequate basis for performing the risk assessment.

A comprehensive quantitative risk assessment is required as part of the RI/FS at the Plant site to characterize potential on-site and off-site human health risks and ecological effects both now and in the future. Data from site investigations indicate that compounds have been detected in both on-site and off-site media. Therefore, this risk assessment is intended to provide a comprehensive assessment of the potential existing and future human health and ecological effects resulting from constituents detected in on-site and off-site media.

This risk assessment is presented in two parts: a human health effects evaluation and an ecological effects evaluation. The elements of the human health effects evaluation include:

- identification of compounds-of-interest;
- human health exposure assessment;
- human health toxicity assessment; and
- characterization of potential human health risks.

This study design conforms with current U.S. EPA guidance for conducting a human health evaluation (EPA, 1989). Determination of the compounds-of-interest is based on a detailed data validation and evaluation exercise using current EPA guidance (EPA, 1989). The human health exposure assessment includes:

- characterization of the exposure setting;
- identification of potential sources and migration pathways;
- identification of potential receptors and exposure pathways; and
- quantification of potential intakes.

The toxicity assessment consists of two steps: hazard identification; and dose-response evaluation. Hazard identification is the determination of potential adverse health effects from exposure to a compound. Dose-response evaluation is the determination of the relationship between the dose of a compound and the incidence of a health effect from that

dose. Dose-response evaluation results in a numerical index of toxicity, such as a cancer slope factor or reference dose (see Section 4 for a definition of cancer slope factor and reference dose).

Risk characterization combines the estimates of intake with the numerical indices of toxicity to develop numerical estimates of risk. Risk characterization also requires the consideration of uncertainty in the analysis. Uncertainty is important for qualifying and interpreting the results.

The elements of the ecological effects evaluation are similar to those identified for the human health evaluation (identification of compounds of environmental interest, assessment of ecological exposure, assessment of ecological toxicity, and characterization of potential ecological risks). Differences arise in the methodologies used to determine ecologically relevant exposures and risk. The ecological toxicity assessment has a similar structure as the human health toxicity assessment but its content includes potential effects of the compounds-of-interest to ecological receptors rather than to human receptors.

1.5 ORGANIZATION OF THE REPORT

Section 2.0 of this report presents the compounds-of-interest in different media resulting from the data validation and evaluation exercise. Section 3.0 is the human health exposure assessment and Section 4.0 is the human health toxicity assessment. Section 5.0 discusses the results of the human health risk characterization. Section 6.0 is the ecological exposure and toxicity assessment and Section 7.0 presents the results of the ecological risk characterization. Section 8.0 presents a summary of the human health and ecological risk assessment.

2.0 IDENTIFICATION OF COMPOUNDS-OF-INTEREST

2.1 APPROACH FOR IDENTIFICATION OF COMPOUNDS-OF-INTEREST

This section involves a review of analytical data, obtained from site investigations, to 1) Identify the compounds that are likely to be site related; and 2) Determine whether reported concentrations for the analytical data are of acceptable quality for use in the quantitative risk assessment (EPA, 1989a). This evaluation involves a review of analytical methods, detection limits, blank samples and background samples. The result of this evaluation is a list of compounds-of-interest for quantitative risk assessment. This data evaluation is conducted in accordance with current EPA guidance on data evaluation (EPA, 1989a). The data evaluation procedure includes:

- Information was segregated into data sets by medium. The data were considered separately for each medium since different analytical procedures were used for each medium.
- For each data set, the analytical methods were evaluated for their suitability for risk assessment.
- For each data set, the quantitation limits were evaluated for their suitability for risk assessment.
- For each data set, qualified or coded data were evaluated.
- For each data set, data from field samples were compared with field and laboratory blanks.
- For each data set, tentatively identified compounds, if they were reported, were evaluated.
- For each data set, field samples were compared with background samples, when available.

The outcome of this procedure is a list of compounds-of-interest for each medium that is used for quantitative risk assessment. Figure 2-1 presents a schematic of the data evaluation process.

At the conclusion of the formal evaluation procedure, the data was subjected to a final screening, based on current EPA guidance (EPA, 1989a), to eliminate compounds that may have been detected in one medium but, because they were detected at low concentrations and in only one or a few samples, were not considered to be relevant for estimating potential risks at the Plant site. A final list of compounds-of-interest for quantitative risk assessment was then assembled by medium. A master list of compounds-of-interest was assembled that includes all compounds-of-interest by medium. This master list of compounds-of-interest formed the basis for assembling quantitative indices of toxicity in the toxicity assessment presented in Section 4.

2.2 GENERAL SITE-SPECIFIC DATA EVALUATION CONSIDERATIONS

The data from the Phase I and Phase II site investigation was combined, grouped by media and subjected to the data evaluation. Analytical data from only the Phase I and II investigations were used for the following reasons: 1) The analytical data from the historical investigations were obtained six to seven years ago; 2) Data obtained prior to the Phase I investigation was taken prior to the implementation of interim remedial response actions and is not considered representative of existing site conditions (conditions following the interim remedial measures taken at the site); and 3) The historical data was not subjected to a standard laboratory QA/QC procedure which is necessary to validate the data for risk assessment.

2.3 SUMMARY OF MEDIA-OF-INTEREST

The analytical data collected in the Phase I and Phase II site investigations were combined and grouped by environmental media to provide an overall understanding of the presence of compounds-of-interest at the Plant site. The environmental media include:

- soils;
- groundwater,;
- surface water; and
- sediment.

Short physical descriptions of the data evaluation procedure used to summarize each medium are presented below.

Soils

All soil samples were taken on-site and are summarized by depth. Surface soils, (i.e., samples taken from the surface or from a composite sample from 0 to a two foot depth) and subsurface soil (i.e., samples taken from two feet to fifteen feet) were summarized separately.

Groundwater

Groundwater samples were summarized separately for on-site and off-site locations and at two depths, shallow and deep.

Surface Water and Sediment

Surface water and sediment samples were collected from two off-site intermittent streams in the vicinity of the Plant site.

2.3.1 Surface Soils

Surface soil samples were taken during the Phase I and Phase II investigations. The analytical data has been combined for data evaluation. Phase I surface soil samples consisted of composite samples taken throughout the source areas. Soil samples were taken from the surface at three to six locations within a source area, then combined and homogenized. From this mixture, a sample was collected and submitted for chemical analysis. Phase II soil samples were taken from soil borings or test pits. These samples consisted of composited material from a two feet depth interval. Surface soils were assumed to be those samples which comprise the 0 to 2 foot interval. Samples taken below two foot were considered subsurface samples. Figure 2-2 shows the on-site locations of the Phase I and Phase II samples. The samples are summarized both as a group and also by distinct areas to focus the identification of compounds-of-interest by source area. This "focused" evaluation of compounds-of-interest by area is discussed at the end of this section. Analytical data for the Phase I and Phase II investigations can be found in Appendix A.

Evaluation of On-Site Surface Soil Samples as a Group

As identified above, the data evaluation procedure for surface soil samples considered the following:

- evaluation of analytical methods;
- evaluation of quantitation limits;
- evaluation of qualified or coded data;
- comparison of field and laboratory blanks with field samples;
- evaluation of tentatively identified compounds (TICs); and
- comparison of samples with background.

The first step in the data validation process is the evaluation of analytical methods. As identified in the Phase II Sampling and Analysis Plan (Rizzo, 1990), the chemicals of interest for the Phase II investigation are the target compound list (TCL) volatile organics, bis(2-ethylhexyl)phthalate and PCBs. Soil sample analyses were conducted using EPA analytical methods, including analysis by GC/MS for the volatile and semi-volatile organics and GC for the PCBs. The data included QA/QC support (lab blanks, trip blanks, matrix spikes, etc.) and one background soil sample. The analytical methods and techniques used for both the Phase I and Phase II investigations are adequate for risk assessment purposes.

Table 2-1 provides a summary table of the analytical data from Phase I and Phase II for on-site surface soil samples. The summary includes the number of samples, the number of positive hits per compound in the samples, the minimum and maximum detection limits and the minimum and maximum concentrations detected in the sample. The compounds detected in at least one surface soil sample include:

- methylene chloride;
- acetone;
- 1,1-dichloroethane;
- 1,1,1-trichloroethane
- xylenes;
- bis(2-ethylhexyl)phthalate; and
- PCB-1254.

The second data evaluation step involves evaluation of sample analytical detection limits. Sample analytical detection limits refer to the specific detection limits reported by the laboratory for a specific compound for a specific sample. Practical quantitation limits refer to the limit of detection for a particular analytical method based on the limits for the extraction procedures and equipment limitations. Sample analytical detection limits represent the accuracy of a particular test on a sample, whereas, practical quantitation limits represent goals for a test based on the limitations of the equipment. The analytical detection limits for the on-site surface soil samples ranged from:

- 5.61 to 1333 ppb (dry weight) for the individual TCL volatile compounds,
- 0.4 ppm for bis (2-ethylhexyl)phthalate, and
- 96.39 to 201.01 ppb for the PCB's.

Based on the sample matrix, practical quantitation limits for low concentration soil and sediment volatile organics range from 5 to 100 ppb (EPA SW-846, 1986). The soil samples, for the most part, are within this range, although one soil sample, PTB-11 (0 - 1 foot), had detection limits for some volatiles that exceeded this recommended range. The sample analytical detection limits for these compounds exceeded the recommended range due to the levels of xylene in this sample which required dilution of the sample extract. Detection limits for bis(2-ethylhexyl)phthalate and PCB's were within acceptable ranges. Overall the detection limits are considered acceptable for the risk assessment.

The third validation step included evaluation of qualified or coded data. The Phase I and Phase II surface soil samples were not qualified with standard EPA qualifiers in the reports obtained from the laboratory. Samples that were below the detection limit were signified with a less than (<) sign.

The fourth validation step involves comparison with field and laboratory blanks. Comparison of concentrations detected in the blanks with concentrations detected in the samples was done to exclude any non-site related contaminants. One method blank was analyzed during the Phase II investigation, however, all compounds were below the sample analytical detection limit in this sample.

The fifth step of the data evaluation procedure includes evaluation of tentatively identified compounds (TICs). TICs were not reported for any media at the Plant site.

The sixth step of the data evaluation procedure involves a comparison of samples with background concentrations. One background sample was taken during the Phase I investigation. Methylene chloride was detected in the background sample at a concentration of 32.79 ppb, tetrachloroethene was detected at a concentration of 10.09 ppb and toluene was detected at a concentration of 6.31 ppb. Based on the above evaluation, a preliminary list of compounds-of-interest for on-site surface soil samples for quantitative risk assessment is presented in Table 2-2.

Evaluation of Surface Soil Samples by Potential Source Area

As stated above, surface soil analytical data was also evaluated for each potential source area. This focused evaluation was performed because the potential source areas are

physically separated from each other and the list of compounds-of-interest for each area is also likely to differ (i.e., the Sampling and Analysis Plan identified PCB as a compound of interest only for the Pump House Area soils). The surface soil samples were separated into five areas to further focus the risk assessment showing contaminated versus uncontaminated areas. These areas include:

- Remote Tank Fill Line Area;
- Degreasing Fluid Storage Tank Area;
- Pumphouse Area;
- Railroad Dock Area; and
- Old Waste Drum Storage Area.

Each area was then summarized to include the number of samples, the number of positive hits per compound in the samples, the minimum and maximum detection limits and the minimum and maximum concentrations detected in the sample. Tables 2-3 through 2-7 present a summary of data for each source area. Table 2-8 identifies the compounds-of-interest associated with each area. As seen in the data summary tables (2-3 through 2-7), no compounds-of-interest are associated with the Degreasing Fluid Storage Tank Area surface soils. Only methylene chloride (i.e., a common lab contaminant) is associated with the Remote Tank Fill Line Area surface soil and the Old Waste Drum Storage Area surface soil. The Railroad Dock Area surface soils had only acetone and xylenes. The compounds-of-interest for Pump House Area surface soils include methylene chloride, 1,1-dichloroethane, 1,1,1-trichloroethane, bis(2-ethylhexyl)phthalate and PCB Arochlor 1254. Risks calculated for on-site surface soils will address each of these areas individually.

2.3.2 Subsurface Soils

Subsurface soil samples (from 2-15') were taken during the Phase II investigation. The analytical data from these samples has been combined for data evaluation. Figure 2-2 shows the on-site locations of these samples. As can be seen in the figure, the areas of interest include the source areas identified in Section 2.4, as well as the former pond area in the front of the plant building. The analytical data for the Phase II investigation is found in Appendix A.

Unlike the data evaluation for surface soils, a focused evaluation was not performed for subsurface soil samples. The reasons for not performing a focused evaluation of subsurface soils are; 1) The likelihood of direct contact exposures to subsurface soils at this site is low, and 2) A preliminary review of the data indicates that concentrations of compounds-of-interest in subsurface soil are low and are not indicative of a potential source

area for groundwater contamination. The evaluation of subsurface soil analytical data included the following:

- evaluation of analytical methods;
- evaluation of quantitation limits;
- evaluation of qualified or coded data;
- comparison of blank data with samples;
- evaluation of tentatively identified compounds (TICs); and
- comparison of samples with background.

The subsurface soil samples were submitted for chemical analysis for TCL volatile organics, bis(2-ethylhexyl)phthalate and PCBs. Sample analyses were conducted using EPA analytical methods, including analysis by GC/MS for the volatile and semi-volatile organics and GC for the PCBs and extensive QA/QC support. These analytical methods and techniques are adequate for risk assessment purposes.

Table 2-9 provides a summary of the Phase II on-site subsurface data. The summary includes the number of samples, the number of positive hits per compound in the samples, the minimum and maximum detection limits and the minimum and maximum concentrations detected in the sample. The compounds detected in at least one subsurface soil sample include:

- methylene chloride;
- acetone;
- 1,1-dichloroethene;
- 1,1-dichloroethane;
- 1,2-dichloroethene;
- 1,1,1-trichloroethene; and
- trichloroethene.

The sample analytical detection limits for the on-site subsurface soil samples ranged from:

- 5.13 to 12.11 ppb for the individual TCL volatile compounds,
- 0.4 ppm for bis (2-ethylhexyl)phthalate, and
- 86.58 to 174.42 ppb for the PCB's.

These sample analytical detection limits are well within the EPA recommended range of precision and are considered acceptable for the risk assessment.

The Phase II subsurface soil samples were not qualified with standard EPA qualifiers by the laboratory. Samples that were below the detection limit were designated with a less than (<) sign.

A comparison of concentrations detected in the blanks with concentrations detected in the samples was done to exclude any non-site related contaminants (i.e., lab contaminants). One method blank was analyzed during the Phase II investigation, all compounds were below the detection limit in the blank.

TICs were not evaluated in any media at the Plant site. One background sample was taken during the Phase I investigation. Methylene chloride was detected in the background sample at a concentration of 32.79 ppb, tetrachloroethane was detected at a concentration of 10.09 ppb and toluene was detected at a concentration of 6.31 ppb. Based on the above evaluation, a preliminary list of compounds-of-interest in on-site subsurface soil samples for quantitative risk assessment is presented in Table 2-10.

2.3.3 Groundwater

Groundwater samples were analyzed during the Phase I and Phase II investigations. These data sets were combined for data evaluation. Figure 2-3 presents the groundwater sampling locations for the Phase I and Phase II investigations. As can be seen in the figure, areas both on-site and off-site are included. Evaluation of the analytical data from the groundwater samples considered the following:

- evaluation of analytical methods;
- evaluation of quantitation limits;
- evaluation of qualified or coded data;
- comparison of blank data with samples;
- evaluation of tentatively identified compounds (TICs); and
- comparison of samples with background.

Data evaluation was initially done on all groundwater samples combined. A separate evaluation was then done for on-site and off-site locations by depth, i.e., shallow and deep. The evaluation of groundwater data by location and depth was done to further identify the nature and extent of contamination.

<u>Evaluation of Groundwater Data</u>

Groundwater samples were submitted for chemical analysis for TCL volatile organics

and bis(2-ethylhexyl)phthalate. Sample analyses were conducted using EPA analytical methods, including analysis by GC/MS with QA/QC support. These analytical methods and techniques are adequate for risk assessment purposes.

Table 2-11 provides a summary of groundwater data from both the Phase I and Phase II investigations. The summary includes the number of samples, the number of positive hits per compound in the samples, the minimum and maximum detection limits and the minimum and maximum concentrations detected in the sample. The compounds detected in one or more groundwater samples include:

- acetone;
- carbon disulfide;
- 1,1-dichloroethene;
- 1,1-dichloroethane;
- 1,2-dichloroethene;
- 1,2-dichloroethane;
- 2-butanone;
- 1,1,1-trichloroethane;
- trichloroethene;
- toluene; and
- bis(2-ethylhexyl)phthalate.

The sample analytical detection limits for the on-site shallow groundwater samples ranged from:

- 5 to 1000 ppb for the individual TCL volatile compounds, and
- 10 to 20 ppb for bis (2-ethylhexyl)phthalate.

Based on the sample matrix, practical quantitation limits for low concentration groundwater volatile organics range from 5 to 100 ppb (EPA SW-846, 1986). Volatile organic compounds in the groundwater samples, for the most part, are within this range. However, one sample, PMW-9A, had sample analytical detection limits which exceed the practical quantitation limits for some compounds. The detection limits were higher due to the levels of volatiles in this sample. Detection limits for bis(2-ethylhexyl)phthalate were well within EPA acceptable ranges. Overall the detection limits are considered acceptable for the risk assessment.

The Phase I and Phase II groundwater samples were not qualified with standard EPA qualifiers by the laboratory. Samples that were below the detection limit were signified with

a less than (<) sign.

Comparison of concentrations detected in the blanks with concentrations detected in the samples was done to exclude any non-site related contaminants. Thirteen equipment, trip or method blanks were analyzed during the Phase I and Phase II investigations. Three equipment blanks were analyzed. No compounds were detected in the equipment blanks. Five trip blanks were also analyzed. No compounds were detected in two of these trip blanks. Three trip blanks identified methylene chloride at concentrations of 25 ppb, 11 ppb and 10 ppb. Five method blanks were analyzed. No compounds were detected in four of these method blanks. One method blank identified methylene chloride at a concentration of 14 ppb.

Methylene chloride in the blank samples was attributed to laboratory contamination as it is a common lab contaminant.

TICs were not reported for any media at the Plant site. Groundwater wells PMW-3A and PMW-7A could be considered as shallow background monitoring wells while monitoring wells PMW-4, PMW-5, and PMW-6 could be considered deep background monitoring wells, although all of these wells are located on-site and in the vicinity of the plant. No background groundwater wells were placed in off-site locations.

The analytical results from these shallow on-site wells show only detectable levels of methylene chloride at 23 ppb in PMW-3A during the Phase II investigation. A review of data for the on-site deep background groundwater wells shows low levels of acetone in wells PMW-4 (14 ppb) and PMW-5 (13 ppb) during the Phase II investigation. It should be noted that, although acetone and methylene chloride were found in numerous blank samples and background samples, both of these compounds are common laboratory contaminants and these compounds are not believed to be compounds-of-interest from plant operations or to actually be present in blank samples or background groundwater. Based on the above evaluation, a preliminary list of potential compounds-of-interest for groundwater samples for quantitative risks assessment is presented in Table 2-12.

Evaluation of On-Site Groundwater Data

On-site shallow and deep groundwater data were collected during the Phase I and Phase II investigations. A summary of the shallow and deep on-site groundwater data is presented below.

Shallow Groundwater Data. Table 2-13 provides a summary of on-site shallow groundwater

data from both the Phase I and Phase II investigations. The compounds detected in one or more shallow samples include:

- acetone;
- carbon disulfide;
- 1,1-dichloroethene;
- 1,1-dichloroethane;
- 1,2-dichloroethene;
- 1,2-dichloroethane;
- 1,1,1-trichloroethane;
- trichloroethene; and
- bis(2-ethylhexyl)phthalate.

The compounds found at the highest concentrations were trichloroethene at 54,000 ppb, 1,1,1-trichloroethane at 3200 ppb, 1,1-dichloroethane at 3200 ppb, and 1,2-dichloroethene (total) at 800 ppb. It should be noted that these concentrations were observed during the Phase I investigation when the groundwater treatment system had not been operating for a period of 18 months. Lower concentrations were observed for all of these compounds during the Phase II investigation.

Deep Groundwater Data. Table 2-14 provides a summary table of the Phase I and Phase II investigation on-site deep groundwater samples. The compounds that were detected in at least one deep groundwater sample include:

- acetone;
- carbon disulfide;
- 1,1-dichloroethene;
- 1,1-dichloroethane;
- 1,2-dichloroethene;
- 1,2-dichloroethane;
- 2-butanone;
- 1,1,1-trichloroethane;
- trichloroethene;
- toluene; and

- bis(2-ethylhexyl)phthalate.

The compounds found at the highest concentrations were trichloroethene at 45,000 ppb (note this was from monitoring well PMW-1 that, during the Phase I investigation, was screened over both the shallow and deep zones), 1,1,1-trichloroethane at 6000 ppb, 1,1-dichloroethane at 3200 ppb, and 1,2-dichloroethene (total) at 330 ppb. It should be noted that, as identified above for the on-site shallow groundwater, these concentrations were observed during the Phase I investigation when the groundwater treatment system had not been operating for a period of 18 months.

Evaluation of Off-Site Groundwater Data

Off-site groundwater data was obtained during the Phase II investigations. A summary of shallow and deep groundwater is presented below.

Shallow Groundwater Data. Table 2-15 provides a summary of the Phase II investigation results for off-site shallow groundwater samples. The only compound detected in off-site shallow groundwater was acetone at 15 ppb at monitoring well PMW-11A.

Deep Groundwater Data. Table 2-16 provides a summary of the Phase II investigation for off-site deep groundwater samples. The compounds detected in at least one sample in off-site groundwater include:

- acetone;
- 1,1-dichloroethene;
- 1,1,1-trichloroethane; and
- trichloroethene.

The maximum concentrations observed for these compounds were 230 ppb for trichloroethene, 7 ppb for 1,1,1-trichloroethane, and 6 ppb for 1,1-dichloroethene.

2.3.4 Surface Water and Sediment

Surface water and sediment samples were analyzed during both Phase I and Phase II investigations. Figure 2-4 present the surface water and sediment sampling locations during the Phase I and II investigations. Evaluation of the analytical data from the surface water and sediment samples included the following:

- evaluation of analytical methods;

- evaluation of quantitation limits;
- evaluation of qualified or coded data;
- comparison of blank data with samples;
- evaluation of tentatively identified compounds (TICs); and
- comparison of samples with background.

Surface water and sediment data are evaluated separately below.

Surface Water

Surface water samples were submitted for analysis for TCL volatile organics and bis(2-ethylhexyl)phthalate. Sample analyses were conducted using EPA analytical methods, including analysis by GC/MS and extensive QA/QC support. These analytical methods and techniques are adequate for risk assessment purposes.

Table 2-17 provides a summary table of the Phase I and Phase II investigation of off-site surface water samples. The summary includes the number of samples, the number of positive hits per compound in the samples, the minimum and maximum detection limits and the minimum and maximum concentrations detected in the sample. The compounds detected in at least one off-site surface water sample include:

- acetone; and
- trichloroethene.

The analytical detection limits for the off-site surface water samples ranged from:

- 5 to 10 ppb for TCL volatile compounds, and
- 10 to 20 ppb for bis (2-ethylhexyl)phthalate.

The detection limits are well within EPA recommended practical quantitation limits and are acceptable for risk assessment.

Phase I and Phase II surface water samples were not qualified with standard EPA qualifiers from the laboratory. Samples that were below the detection limit were signified with a less than (<) sign.

A comparison of concentrations detected in the blanks with concentrations detected in the samples was done to exclude any non-site related contaminants. One method blank and two equipment blanks were analyzed for comparison with surface water samples. One

equipment blank had a concentration of bis(2-ethylhexyl)phthalate of 3,000 µg/L. The second equipment blank had detectable levels of acetone at 10 µg/L and carbon disulfide at 5 µg/L. As discussed above, additional method blanks and QA/QC samples were taken during the groundwater investigations that are appropriate for evaluating the quality of surface water sample data.

TICs were not reported for any media at the Plant site. Background samples were taken at SW-5 during the Phase II investigation. Acetone was detected at 17 ppb in the background sample. Based on the above evaluation, a list of compounds-of-interest for off-site surface water samples for qualitative risk assessment is presented in Table 2-18.

Sediment

Off-site sediment samples were submitted for analysis of TCL volatile organics and bis(2-ethylhexyl)phthalate. Sample analyses were conducted using EPA analytical methods, including analysis by GC/MS. These analytical methods and techniques are adequate for risk assessment purposes.

Table 2-19 provides a summary table of the Phase I and Phase II investigation off-site sediment samples. The summary includes the number of samples, the number of positive hits per compound in the samples, the minimum and maximum detection limits and the minimum and maximum concentrations detected in the sample. The chemicals that were detected in at least one sediment sample include:

- methylene chloride;
- acetone; and
- bis(2-ethylhexyl)phthalate.

The analytical detection limits for the on-site surface soil samples ranged from:

- 6.18 to 22.08 ppb for TCL volatile compounds, and
- 0.41 to 0.52 ppm for bis (2-ethylhexyl)phthalate.

Detection limits for TCL volatile bis(2-ethylhexyl)phthalate were within acceptable ranges.

The Phase I and Phase II sediment samples were not qualified with standard EPA qualifiers. Samples that were below the detection limit were signified with a less than (<) sign.

Comparison of concentrations detected in the blanks with concentrations detected in the samples was done to exclude any non-site related contaminants. Two method blanks were analyzed during the Phase I investigation. No compounds were detected in these method blanks. As discussed above, additional QA/QC sampling was done for the soil investigation that are appropriate for evaluating the quality of sediment data.

TICs were not evaluated in any media at the Plant site. A background sample was analyzed at SED-5. Acetone was detected in the background sample at 34 ppb. Based on the above evaluation, a preliminary list of compounds-of-interest for sediment samples for quantitative risk assessment is presented in Table 2-20.

2.4 FURTHER REDUCTION OF COMPOUNDS-OF-INTEREST

The Risk Assessment Guidance document (EPA, 1989a) allows for reduction of the list of compounds-of-interest once the data evaluation process has taken place. Reduction in the list of compounds-of-interest was performed in order to conduct the risk assessment with the most precise and realistic set of compounds-of-interest for the site. The Risk Assessment Guidance (EPA, 1989a) suggests elimination of a compound from the quantitative risk assessment if: 1) It is detected infrequently, i.e., detected in one or perhaps two of the environmental media sampled; 2) It is not detected in any other sampled media or at high concentrations; and 3) There is no reason to believe that the compound may be present. Based on this guidance, the following compounds were eliminated from the list of compounds-of-interest.

TCL Volatiles

The list of 34 volatile organics on the target compound list were subjected to the data evaluation procedure. Twelve of the compounds were detected in at least one media. Several of the compounds detected were found infrequently in the various media sampled at the Plant site.

Methylene Chloride — Detected in on-site surface and subsurface soils and off-site sediments. Methylene chloride is a common laboratory contaminant and was detected in several blanks. It was detected in the background soil sample (SS-BACK) and the concentrations in these samples were less than 10 times the practical quantitation limit.

Acetone	Detected in on-site soils, on-site and off-site groundwater, surface water and sediments. Acetone is a common lab contaminant. It was detected in various background samples and lab blanks and the concentrations were less than 10 times the practical quantitation limit.
Carbon Disulfide	Detected in only two of forty three groundwater samples. Carbon disulfide is not associated with the plant operations and was detected at a concentration less than 5 times the practical quantitation limit. One equipment blank sample had a carbon disulfide concentration of 5 µg/L (surface water QA/QC).
Toluene	Detected in only one of forty three groundwater samples at a concentration of 6 ppb which is less than 5 times the practical quantitation limit.
2-Butanone	Detected in only one of forty three groundwater samples. 2-Butanone was not associated with plant operations and was detected at a concentration of 55 ppb.

The volatile compounds that will be included in the list of compounds-of-interest are 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, and xylenes.

Semi-Volatile Compounds

Bis(2-ethylhexyl)phthalate is the only semi-volatile compound that was subjected to the data evaluation process. The compound was detected in one sample from several media; including surface soils, shallow groundwater (on and off-site), deep groundwater (on-site only), and sediments. The concentrations ranged from 0.73 to 90 ppb. Bis (2-ethylhexyl)phthalate was eliminated as a compound of interest in all of these media as it is not a compound of interest for plant operations, it was only detected in one or a few samples from each medium, it was found at or near the detection limit in all samples, and because it is a common laboratory contaminant (as a plasticizer, it can be associated with various pieces of laboratory and field equipment). One surface water equipment blank had a detectable concentration of bis(2-ethylhexyl)phthalate of 3,000 µg/L which suggests a potential source as the laboratory.

(Red)

PCBs

PCBs were only considered potential compounds-of-interest in Pump House area soils. Arochlor 1254 was the only PCB isomer identified in any surface soil samples. It was found in one surface soil sample (SS-3) at a concentration of 518 ppb. Therefore, this PCB isomer will be included as a compound of interest.

2.5 COMPOUNDS-OF-INTEREST

The compounds-of-interest at the Plant site are compounds that are associated with past industrial operations at the site, have been detected in at least one environmental media during previous site investigations and have the data evaluation and screening process described above. These compounds are listed in Table 2-21.

3.0 EXPOSURE ASSESSMENT FOR PUBLIC HEALTH EVALUATION

3.1 ELEMENTS OF AN EXPOSURE ASSESSMENT

This section presents an exposure assessment for persons potentially exposed, both now and in the future, to compounds-of-interest associated with the Plant site. This discussion assumes the site remains essentially as it is, or in other words, discusses potential exposures associated with the "no action alternative." The exposure assessment identifies pathways by which humans are potentially exposed to compounds at a site and estimates the magnitude, frequency and duration of actual or potential human exposures. In the exposure assessment, reasonable maximum estimates of exposure are developed for both current and future land use scenarios. Estimates of current exposures are used to determine whether health effects could arise based on the current land use scenario at the site. Estimates of future exposures are used to evaluate the potential for future effects and include a qualitative estimate of the likelihood that such exposures would actually occur. This exposure assessment has the following elements as per current EPA guidance (EPA, 1989a):

- discussion of potential sources and migration pathways;
- identification of potential human receptors;
- delineation of potential receptor-specific exposure pathways;
- development of intake assumptions associated with each exposure pathway;
- estimation of exposure point concentrations; and
- estimation of pathway and receptor-specific intakes and doses of compounds-of-interest.

Two things should be noted about the exposure assessment presented in this section. First, the exposure assessment characterizes potential receptor exposures to compounds-of-interest at the Plant site. Second, intakes estimated in this section are intended to approximate reasonable maximum exposures (RMEs) as suggested by the Risk Assessment Guidance for Superfund (EPA, 1989a). Exposure assumptions based on RME are based on conservative assumptions so that the risk assessment is protective of even the most exposed or sensitive sub-populations. Thus, while these intakes were estimated with methodologies consistent with EPA procedures, it is important to emphasize that these are not estimates of actual intakes or potential typical intakes, but rather, they are estimates of intakes that are intended to approximate maximum exposures to be protective of these more exposed or sensitive sub-populations. Intakes to the population on the average would likely be lower.

3.2 POTENTIAL SOURCES AND MIGRATION PATHWAYS

A number of media were identified in Section 2.3 that can serve as potential sources of compounds-of-interest: soils, groundwater, surface water, and sediment. Potential routes whereby compounds-of-interest can migrate from these source areas to other environmental media are discussed in the following paragraphs.

3.2.1 Surface and Shallow Subsurface Soils

From a risk assessment standpoint, soils are classified into two types (i.e., surface and subsurface) according to their location and based on the potential for exposure. Soils from 0 - 24 inches in depth are considered surface soils (i.e., soils with the potential for direct contact exposures). Soils below 24 inches are considered subsurface soils (i.e., soils that would be contacted during construction/excavation related activities). Therefore, further discussion of surface soils will be for soil in the upper 24 inches while reference to subsurface soils will be for those soils greater than 24 inches in depth.

Surface and subsurface soils of interest at the site are from the following potential source areas:

- Remote Tank Fill Line Area;
- Degreasing Fluid Storage Tank Area;
- Pumphouse Area;
- Railroad Dock Area; and
- Old Waste Drum Storage Area.

The approximate location of these potential source areas are shown in Figure 3-1. A summary of surface and subsurface soil data is provided below.

Surface Soil Data

During the Phase I investigation, composite surface soil samples were taken from each potential source area and submitted for chemical analysis. Each surface soil sample consisted of composited material from three to six samples taken from various points within the potential source area. The exact locations of these sampling points for each potential source area were presented in Figure 2-2 of the Phase I Remedial Investigation / Feasibility Study Report for the Plant site (Rizzo, 1989). The compounds detected in at least one sample were methylene chloride (potentially introduced at the laboratory since it is a common laboratory contaminant), 1,1-dichloroethane, 1,1,1-trichloroethane, bis(2-

above for surface soils, these relatively low levels of compounds-of-interest in subsurface soils indicate that the subsurface soils in these areas are not significant source areas contributing to groundwater contamination.

3.2.2 Groundwater

This section discusses patterns of groundwater flow beneath the Plant site and reviews the results of the chemical analysis of groundwater samples. In subsequent discussions, groundwater is described in relation to two locations: on-site and off-site. Groundwater flow at the site is largely influenced by the subsurface geology. Beneath the site is a thin layer of soil or fill that varies in thickness from 5 to 15 feet and is called the surficial layer. Beneath this is bedrock that has been designated as shallow and deep for the purpose of reporting Phase I and Phase II groundwater data. Bedrock lies in bedding planes that are tilted along a northwest-dipping homocline at an angle from 10° to 35°, with a median of about 20°. Groundwater flow is intermittent in the surficial layer and it is largely unsaturated. In general, groundwater flows in the bedrock in an easterly direction from the Plant site toward Rock Creek (see Figure 3-1).

The most significant potential migration pathways are likely to be the transport of constituents with groundwater to off-site groundwater and possible discharge to surface water in the Northern and Eastern Tributaries of Rock Creek. Groundwater monitoring wells were installed on and near the site and sampled to collect data for shallow groundwater (i.e., at a depth of 40 to 50 feet below the surface) and deep groundwater (i.e., at a depth of approximately 120 feet below the surface). These wells were installed to identify the extent of compounds-of-interest in groundwater and to identify groundwater flow patterns and chemical migration. The migration of compounds in groundwater appears to follow groundwater flows with some lateral dispersion, from southwest to northeast, along the bedding planes. From the Phase II results, there appears to be preferential flow along bedrock fractures oriented east to west and located just north of the Plant site.

The compounds-of-interest identified in the Phase II Sampling and Analysis Plan for the Plant site (Rizzo, 1990) for groundwater include the TCL volatiles and bis(2-ethylhexyl)phthalate. However, following the data evaluation process the compounds-of-interest retained for quantitative risk assessment for groundwater are:

- 1,1-dichlorethene;
- 1,1-dichloroethane;
- 1,2-dichloroethene;

- 1,2-dichloroethane;
- 1,1,1-trichloroethane; and
- trichloroethene.

The extent of the contaminant plume has been identified to the north by monitoring well PMW-17 (see Figure SAP-3 - Rizzo, 1990), and, to the south by PMW-15, PMW-11A, and PMW-11B. However, the extent of the contaminant plume to the east of the site has not fully been identified as TCE was detected at 230 ppb at PMW-16B and 7 ppb at PMW-14. These wells are the eastern-most wells from the site and are both screened as deep groundwater wells. Some general observations can be drawn regarding the presence of compounds-of-interest in groundwater at the site.

- The highest concentrations of compounds-of-interest in on-site groundwater are limited to a relatively small area in front of the Plant site near the former pond area (see Figure 3-1).

- Compounds-of-interest in shallow groundwater appear to be limited to just a few wells near the pond which indicates that compounds are migrating downward as they disperse away from the pond.

- Compounds-of-interest in off-site groundwater have only been detected in the deep groundwater wells in the Phase II investigation.

Total VOC concentrations in on-site groundwater have been detected as high as 60,000 ppb in the shallow aquifer at well PMW-9A and as high as 54,000 ppb in the monitoring well PMW-1, based on the Phase I sampling data. However, additional sampling from the Phase II investigation shows much lower concentrations of total VOCs in these areas. This may be an indication of the effect of the groundwater pump and treat system currently in use at the Plant site. Also, some differences may be due to the reconstruction of monitoring well PMW-1 during the Phase II investigation. It is worth noting that the current groundwater pump and treat system should prevent significant additional off-site migration of compounds-of-interest from the vicinity of the former pond area. Therefore, it is not anticipated that these high concentrations of compounds-of-interest on-site will eventually be found at off-site locations as long as the pump and treat system is operating.

3.2.3 Surface Water and Sediment

Figure 3-1 shows the surface water features of the Plant site and surrounding area. There are two intermittent streams in the immediate vicinity of the site. One stream is located north of the site (i.e., Northern Tributary) and one to the east (i.e., Eastern Tributary) both of which converge and discharges into Rock Creek. Run-off from the plant is primarily directed either to storm sewers or directly to the Northern and Eastern Tributaries of Rock Creek. Water from these tributaries eventually discharge into Rock Creek approximately 1 mile southeast of the plant. It is also believed that some surficial groundwater discharges into these tributaries. However, since these tributaries are intermittent and are dry most of the year, it is believed that these streams serve to recharge groundwater during periods of precipitation, although flow of groundwater to these streams occurs from time to time. Compounds-of-interest could enter these surface water bodies either with on-site run-off or, occasionally, by discharging from the surficial groundwater. In addition, effluent from the groundwater pump and treat system is discharged at an NPDES discharge point in the Northern Tributary. Once compounds-of-interest enter the surface water they could either sorb onto sediments or migrate with surface water.

A review of data for surface water and sediments shows detectable levels of acetone and TCE in surface water and methylene chloride, acetone and bis(2-ethylhexyl)phthalate in sediments. However, of the compounds detected, only TCE was considered a compound of interest in surface water for the risk assessment since methylene chloride, acetone and bis(2-ethylhexyl)phthalate are common laboratory contaminants. No compounds-of-interest were identified for sediments for the quantitative risk assessment. Two conclusions can be drawn from the analytical data for surface water and sediments. First, sediments are not currently acting as a source of compounds-of-interest to surface water. Second, the absorption to sediments of compounds-of-interest is not considered a significant fate mechanism. Based on the results from the Phase I and Phase II investigations, it appears that the streams are not currently acting as a significant migration pathway for compounds-of-interest from the Plant site.

3.3 POTENTIAL HUMAN RECEPTORS AND EXPOSURE PATHWAYS

Exposure pathways are routes whereby compounds-of-interest could be assimilated by a potential receptor. Exposure pathways require the existence of a receptor, the presence of compounds-of-interest in a medium that the receptor contacts, and an intake route associated with the receptor.

Since exposure pathways require the presence of a receptor, these pathways depend upon uses of the site. both current and in the future. Table 3-1 identifies potential human receptors for the current and future land use scenarios. These potential receptors include individuals both on-site and off-site. The on-site area is defined as the area within the Plant property boundaries. Receptors in the off-site areas are those individuals in the residences and businesses near the site. The Plant site is currently used for commercial/industrial purposes and the intended future uses of the site are also for commercial/industrial purposes. Thus, current and future uses of the site will be considered industrial in nature and all exposure pathways will be based on an industrial scenario. The off-site areas immediately adjacent to the Plant site are primarily residential. Although some light industry is associated with this area, the predominant surrounding properties are residential. Therefore, the human health effects evaluation will consider residential receptors as the primary off-site receptors. Evaluating off-site receptors based on a residential scenario is considered conservative and appropriate since residential exposures are typically greater (based on exposure frequency and duration) than exposure to other receptors.

The following paragraphs discuss potential exposure pathways for each of the receptors listed in Table 3-1.

3.3.1 Current Land Use Scenario

On-Site

The only potential on-site receptors identified for the current land use scenario are on-site workers. Currently there are three types of workers at the plant: office workers, plant workers and maintenance workers. Office workers are primarily administrative people that work in the offices on-site. Plant workers are those individuals involved with current plant manufacturing operations (i.e., manufacture and assembly of elevators and escalators and their components) located primarily in the process areas of the plant. Maintenance workers are those individuals involved in landscaping, repair and light construction of the buildings and grounds at the site. Both office workers and plant workers are individuals whom are primarily indoors and are expected to have little to no exposure to compounds-of-interest in soils from potential source areas. Maintenance workers are anticipated to be both indoors and seasonally outdoors with a greater exposure to compounds-of-interest in soils from the potential source areas. Therefore, the risk assessment for the Plant site will consider potential health effects to the maintenance workers.

Maintenance workers, in theory, could be subjected to only one type of potential exposure: those associated with surface soils. Although high concentrations of volatiles were

detected in on-site groundwater, it is currently not used. Therefore, no exposure pathways were identified that involved compounds-of-interest in on-site groundwater. Potential exposure pathways associated with compounds-of-interest in surface soil include incidental ingestion and dermal contact. Table 3-2 summarizes the exposure pathways for on-site maintenance workers.

Off-Site

The off-site receptors of interest are off-site residents who could, in theory, be exposed to compounds-of-interest in off-site groundwater. However, Westinghouse has implemented an interim remedial action at the site that involved the installation of water mains to residences near the site to provide them with an alternative potable water source. These water mains have been provided for residents along Biglerville Road, Boyd's School Road, Table Rock Road, Cedar Avenue, Maple Avenue, and Apple Avenue. The off-site residents in these areas are assumed to have no current risk. Off-site residents that potentially use groundwater as a potable water source are those individuals living along Boyd's School Road. However, as a part of this interim remedial action plan, Westinghouse has provided residences along Boyd's School Road with a water filtration system that utilizes three in-line carbon filters to treat groundwater prior to use. The integrity of this filtration system is determined by monthly water samples of the effluent from these carbon filters.

Although interim remedial actions have been implemented to eliminate potential off-site groundwater exposures, it is believed that some residents along Table Rock Road, north of Boyd's School Road, may still currently be using groundwater as a potable water source. If this is true, then a distant off-site residence in this area is potentially at risk to compounds-of-interest in off-site groundwater. In addition, while nearby residents (i.e., residents that live adjacent to the Plant site) may have municipal water lines available, it is possible that a nearby resident may use groundwater for a potable water source and for irrigation. Therefore, two off-site groundwater users will be evaluated: nearby residents and distant off-site residents. Both the nearby residents and distant off-site residents are assumed to use off-site groundwater as a potable water source (i.e., for household uses) and for irrigation.

Nearby residents are assumed to potentially be exposed to compounds-of-interest in near-site groundwater and soils irrigated with near-site groundwater. The most likely scenario is that groundwater would be used for potable water and for irrigation of a garden. The primary exposure pathways for potable water uses would include ingestion, dermal contact while showering (or bathing), and inhalation of volatiles in showerroom air. Exposures to compounds-of-interest in groundwater in an irrigation scenario would occur while individuals were working (or playing if children) in or near the garden. It is believed

that the Gettysburg area receives sufficient annual and seasonal rainfall to minimize the need for irrigating lawns. The primary exposure pathways for nearby residents in an irrigation scenario include inhalation of volatiles from groundwater during irrigation, inhalation of volatiles and fugitive dusts from irrigated soils and dermal contact with irrigated soils from a garden. Table 3-2 summarizes the exposure pathways for nearby residents. Note, off-site groundwater users consist of three receptor groups: adults; children aged 2 to 18 years (referred to as "children"); and young children aged 2 to 6 years (referred to as "young children"). Although all three receptors are assumed to be exposed to compounds-of-interest in groundwater, the specific intake assumptions associated with the exposure for each group are assumed to vary.

The distant off-site resident (similar to the nearby residents) could potentially be subjected to two types of exposures: exposures associated with potable use of distant off-site groundwater; and exposures associated with groundwater used for irrigation. The exposure pathways associated with distant off-site residents include ingestion of groundwater as drinking water, dermal contact while showering, inhalation of volatiles while showering, inhalation of volatiles from groundwater during irrigation, inhalation of volatiles and fugitive dusts from irrigated soils and dermal contact with irrigated soils from a garden. Table 3-2 summarizes the exposure pathways for distant off-site residents. As described above for nearby residents, distant off-site residents consist of three different receptor groups: adults; children aged 2 to 18 years (referred to as "children"); and young children aged 2 to 6 years (referred to as "young children").

3.3.2 Future Land Use Scenario

On-Site

For the future land use scenario, the on-site receptors are assumed to be maintenance workers. This is based on the presumption that future use of the site is anticipated to be similar to existing uses (i.e., for industrial purposes). The exposure assumptions used for the future maintenance worker are the same as discussed above in Section 3.3.1 for the current land use scenario.

Off-Site

Potential off-site receptors for the future land use scenario include both nearby residents and distant off-site residents. The exposure assumptions for nearby residents and distant off-site residents include exposure to compounds-of-interest in groundwater from potable water uses and from groundwater used for irrigation, as described above in Section

3.3.1. The nearby residents and distant off-site residents are assumed to have the same exposure scenarios as described in Section 3.3.1 for the current land use scenario, i.e., exposure to compounds-of-interest in groundwater by ingestion of groundwater as drinking water, inhalation of volatiles while showering, inhalation of volatiles from groundwater during irrigation, inhalation of volatiles and fugitive dusts from irrigated soils and dermal contact with irrigated soils from a garden.

The exposure assumptions for receptors in the future land use scenario are presented in Table 3-3. Please note that the exposure assumptions for both future distant off-site residents and future nearby residents are assumed to be identical. The difference between exposures to nearby residents and distant off-site residents in the future land use scenario is the location of the off-site groundwater well potentially used by these receptors.

3.4 INTAKE ASSUMPTIONS

This section describes the intake assumptions used for calculating the intake by potential receptors at the Plant site. This discussion is divided into two parts: the first part provides a general overview of various intake equations and assumptions; and the second part discusses assumptions used for specific receptors at the Plant site. The intake assumptions presented are based on the Risk Assessment Guidance for Superfund (EPA, 1989a) and are intended to estimate reasonable maximum exposures. These intake assumptions are not intended to estimate actual or expected future intakes but, rather, reasonable maximum intakes. Thus, the intakes calculated based on these assumptions are likely to be higher than actual intakes and, for some compounds and intake routes, may be much higher than actual intakes.

3.4.1 Overview of Intake Assumptions

This section provides a general discussion of the assumptions used to calculate the intake from various exposure pathways. Exposure pathways are defined as a direct contact route between a receptor and a contaminated medium. Exposure pathways are determined for receptors based on the receptors' expected activities at the site. In order to translate exposures to potentially media containing compounds-of-interest into intakes or doses, intake assumptions must be specified. These intake assumptions consider the number of times a receptor is expected to contact a particular medium, the duration of the contact and the mechanisms that enable the compound to be potentially assimilated by the receptor.

Generally, the intake or dose of a particular compound by a receptor is calculated

with the equation:

$$I = \frac{C \cdot CR \cdot EFD}{BW} \cdot \frac{1}{AT}$$

where:

I	=	the compound intake (mg/Kg BW-day);
C	=	the compound concentration (e.g., mg/Kg or mg/L);
CR	=	contact rate or the amount of contaminated medium contacted per event (e.g., liters/day);
EFD	=	the frequency (days/year) and duration (number of years) of exposure days;
BW	=	the average body weight of the receptor (Kg); and
AT	=	averaging time of the exposure (days).

This equation calculates an intake that is normalized over the body weight of the individual and the time of the exposure. Body weight is typically defined as 70 Kg for an adult. For children, body weight is highly dependent on age. For exposures estimated using the Superfund guidance document (EPA, 1989a), the intake variables are selected for a reasonable maximum exposure (RME) for all pathways.

Since the intake or dose is combined with chemical-specific dose-response information to give a measure of potential risk, the intake or dose must be calculated in a manner compatible with the quantitative dose-response information for potential carcinogenic or non-carcinogenic chemical constituents used in the analysis. Two different types of health effects are considered in this analysis: carcinogenic effects and chronic non-carcinogenic effects.

For carcinogenic effects, the relevant intake is the total cumulative intake averaged over a lifetime because the quantitative dose-response function for carcinogens is based on the assumption that cancer results from chronic, lifetime exposures to carcinogenic agents. This intake or dose is then averaged over a lifetime to provide an estimate of intake or dose to carcinogens as (mg/Kg-day). Thus, for potentially carcinogenic compounds, the averaging time (AT) is equal to 70 years (EPA, 1989b).

In this analysis, non-carcinogenic effects will be evaluated for chronic exposures. For chronic, non-carcinogenic effects, the relevant intake or dose is based on the chronic daily intake averaged over the exposure period. The quantitative dose-response function for non-carcinogenic effects is based on the assumption that effects occur once a threshold dose

resulting from chronic exposure is attained. For non-carcinogenic compounds, the averaging time (AT) is equal to the exposure duration for the receptor (e.g., 30 years or 10,950 days for the on-site worker or near-site resident adult).

3.4.2 Generalized Assumptions for Exposure Analysis

In this section, the calculated intake or dose per event is discussed for five types of exposure: inhalation of volatiles and fugitive dusts, dermal contact with soil, incidental ingestion of soil, ingestion of water, and dermal contact with water.

Inhalation. For inhalation, the dose per event is estimated using the formula:

$$Iinhal = \frac{CA \cdot IR \cdot ABS \cdot ET \cdot EF \cdot ED}{BW \cdot AT}$$

where:

CA	=	compound concentration in the air (mg/m^3);
IR	=	inhalation rate (m^3/hr);
ABS	=	inhalation absorption factor (fraction absorbed/hr);
ET	=	exposure time (hours/day);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight (Kg); and
AT	=	averaging time (days).

Air concentrations of compounds-of-interest (CA) are discussed in Section 3.5. The concentrations of compounds-of-interest in the air are the ambient air concentrations of volatilized compounds and fugitive dust emissions from various source media. The inhalation rate (IR) is the average rate of respiration for individuals per hour (or per day for daily exposures). This rate is dependent on the age and the average activity level of the individual. Table 3-4 provides a listing of typical inhalation rates for individuals over a range of activity levels. The daily rate for adults used in this analysis was 30 m^3/day (or 1.25 m^3/hr) which is the reasonable maximum exposure rate for adults (EPA, 1989b). For children (aged 2 to 18), the inhalation rate was assumed to be equal to the adult value. For young children, the inhalation rate was assumed to be 24 m^3/day (or 1 m^3/hr). The shower inhalation rate used for adults and children was 0.89 m^3/hr which corresponds to a reasonable worst case indoor inhalation rate in the EPA Exposure Factors Handbook (EPA, 1989b). The duration of exposure (ED) is assumed to be the average length of the exposure per event. The exposure frequency (EF) for exposures to volatiles and fugitive dusts from garden soils and volatiles from groundwater during showers was assumed to be 365 days per

year. For inhalation exposures from irrigation water, the EF was assumed to be equal to 1 day per week, 24 weeks per year (the time for irrigation). Exposure frequency and duration are defined in the exposure pathway descriptions outlined for each receptor. The inhalation absorption factor (ABS) is assumed to be 1.0 for all receptors, implying that all of the inhaled compound is assimilated into the body. This is a conservative and, consequently, health protective assumption. The exposure time (ET) of the event is described in the exposure pathway descriptions for specific receptors.

Dermal Contact with Soils. The intake or dose per event from dermal contact with soil is estimated using the equation:

$$\text{Ider-s} = \frac{CS \cdot CF \cdot SA \cdot AF \cdot ABS \cdot ET \cdot EF \cdot ED}{BW \cdot AT}$$

where:

CS	=	compound concentration in the soil (mg/Kg);
CF	=	conversion factor (10^{-6} Kg/mg);
SA	=	exposed skin surface area (cm^2);
AF	=	soil adherence factor (mg/cm^2);
ABS	=	skin absorption factor (fraction absorbed/hr);
ET	=	Exposure time (hours/day);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight (Kg); and
AT	=	averaging time (days).

Soil concentrations (CS) are discussed in Section 3.5. The exposed skin surface area is based on two variables, the total body surface area (TBS) and fraction of body exposed (FBE). The product of TBS and FBE results in the surface area exposed to soil contaminants (SA). For this analysis, the value used for total body surface area for adults is 1.94 m^2 which corresponds to the 50th percentile for TBS for adults males (EPA, 1989b). The 50th percentile values are recommended by the Superfund guidance document (EPA, 1989a) because the surface area is strongly correlated to the average body weight. For children, the value used for body surface area is 1.21 m^2, which corresponds to the average for a child from age 3 to 18 (EPA, 1989b). The body surface area used for young children is 0.73 m^2 which corresponds to a child aged 3 to 6 years (EPA, 1989b).

The fraction of body exposed (FBE) is dependent on the nature of the activity being conducted and the age and type of individuals involved. Exposures via dermal contact are

generally limited to certain parts of the body (i.e., hands, forearms, head, neck, etc.). Table 3-5 provides the percent surface area of different parts of the body typically used in defining dermal exposures. The fraction of body exposed to dermal contact to soils are further defined in the individual exposure scenarios discussed later in this chapter. The soil adherence factor (AF) is the density of soil adhering to the exposed fraction of the body. Reported values for this variable range from 0.5 to 2.8 mg/cm^2 (Harger, 1979). A conservative estimate of 1.5 mg/cm^2 was used in this analysis that corresponds to the adherence of potting soil. This value is assumed to be conservative because the organic carbon content highly influences soil adherence and potting soil typically has an organic carbon fraction which greatly exceeds typical soils. The skin absorption factor (ABS) is the rate of compound uptake from dermal contact to soil multiplied by a soil-compound matrix effect (Hawley, 1985). Reported values for a pure compound uptake range from 1 to 12% for exposures as long as 12 hours (Hawley, 1985). A conservative estimate of 1.5% per hour was used for this analysis. The matrix effect is based on the assumption that a compound adsorbed to soil particles results in less absorption through the skin (Hawley, 1985). Hawley sites a value of 15% for the matrix effect. The exposure time (ET), frequency (EF) and duration (ED) of the event is the length of exposure to soil contaminants and is defined in the exposure pathway descriptions for each receptor.

Incidental Ingestion of Soil. The intake or dose from the incidental ingestion pathway is calculated based on the equation:

$$\text{Ing-s} = \frac{CS \cdot IR \cdot CF \cdot FI \cdot ABS \cdot EF \cdot ED}{BW \cdot AT}$$

where:

CS	=	compound concentration in the soil (mg/Kg);
IR	=	ingestion rate (mg soil/day);
CF	=	conversion factor (10^{-6} Kg/mg);
FI	=	fraction ingested (unitless);
ABS	=	ingestion absorption factor (unitless);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight (Kg); and
AT	=	averaging time (days).

The concentration in the soil (CS) is the concentration of compounds-of-interest which is based on their respective media exposure point concentration and is discussed later in this section. The ingestion rate (IR) is the amount of contaminated soil incidentally ingested per

day or event. For soil, the incidental intake values are based on established EPA guidelines using the Interim Final Guidance for Soil Ingestion Rates (EPA, 1989c). This guidance document specifies intake rates of 200 mg/day for children aged six and under, and 100 mg/day for older age groups in the absence of site specific data. The fraction ingested is the percent of the daily intake from the exposure medium and is based on the hours spent on site. The absorption factor used in this calculation is 1.0 implying that all the ingested compound is assimilated into the body. This is a conservative and health protective assumption. The exposure frequency (EF) and duration (ED) of the event is described in the exposure pathway descriptions for specific receptors.

Water Ingestion. The equation used to estimate the intake or dose per event from water ingestion is:

$$Iing\text{-}w = \frac{CW \cdot IR \cdot ABS \cdot EF \cdot ED}{BW \cdot AT}$$

where:

CW	=	compound concentration in the water (mg/L);
IR	=	ingestion rate (L/day);
ABS	=	absorption factor (unitless);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight (Kg); and
AT	=	averaging time (days).

The concentration of compounds-of-interest in water (CW) are discussed in Section 3.5. The quantity of water ingested is the daily intake of water per day. A value of 2 L/day was used for adults and 1.5 L/day for children and young children for ingestion of groundwater as drinking water (EPA, 1989b). The absorption factor (ABS) used in this analysis is assigned a value of 1 (or 100%), which implies that all of the compound ingested is assimilated into the body. Use of this value is conservative and health protective. The exposure frequency (EF) and duration (ED) of the event is described in the exposure pathway descriptions for specific receptors.

Dermal Contact to Water. The intake or dose per event for dermal contact with water was estimated using the equation:

$$Ider\text{-}w = \frac{CW \cdot SA \cdot PC \cdot ET \cdot EF \cdot ED \cdot CF}{BW \cdot AT}$$

where:

CW	=	compound concentration in the water (mg/L);
SA	=	exposed skin surface area (cm^2);
PC	=	compound permeability constant (cm/hr);
ET	=	exposure time (hrs/day);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
CF	=	volumetric conversion factor - water (L/1000 cm^3);
BW	=	body weight (Kg); and
AT	=	averaging time (days).

The concentration of compounds-of-interest in water (CW) are discussed in Section 3.5. The exposed skin surface area (SA) is determined in a manner analogous to that described above for dermal contact with soils. The area of the body exposed (i.e., hands, feet, neck, head, etc.) used for specific receptors is provided below in the discussion of exposures for each receptor. The compound permeability constant (PC) for compounds in water is the rate of compound absorption through the skin. No values were available for this variable for specific compounds. Therefore, the a value of 0.008 L/m^2-hr (or 0.0008 cm/hr) was used which corresponds to the permeability constant for water (EPA, 1988). This assumes that the compounds-of-interest are carried through the skin as a solute in water as the water is absorbed through the skin. Thus, the compound permeation rate through the skin is a function of water absorption. The exposure time (ET), frequency (EF) and duration (ED) of the event is described in the exposure pathway descriptions for specific receptors.

3.4.3 Intake Assumptions for Receptors Associated with the Current Land Use Scenario

Potential receptors associated with the current land use scenario include:

- on-site maintenance workers;
- nearby residents; and
- distant off-site residents.

A detailed discussion of receptor-exposure information is provided below.

<u>On-Site Maintenance Worker</u>

As stated above, the on-site maintenance worker was assumed to be exposed to compounds-of-interest in on-site surface soils via dermal contact and incidental ingestion.

Table 3-6 provides a summary of the equations for calculating the dose to the on-site maintenance worker. Table 3-7 provide a list of the specific intake assumptions for the on-site maintenance worker. As identified in Section 1, the Phase I investigation identified five potential source areas associated with surface soil contamination. It was assumed that the on-site maintenance worker would be exposed to compounds-of-interest in each potential source area 20 percent of the time. Thus, the exposure frequency was assumed to be 1 day per week at each potential source area (i.e., one day per week at each potential source location or 5 exposures per week or 20% of the total at each area), for 30 weeks per year. The exposure duration was assumed to be 30 years. The incidental ingestion rate was assumed to be 100 mg/day, which corresponds to the average daily dose for an adult (EPA, 1989c). However, the fraction ingested from the contaminated source was assumed to be 0.5 or 50%, which yields an ingestion rate of 50 mg/day from the contaminated source areas. The 50% value (i.e., which yields 50 mg/day) was assumed because soils would be incidentally ingested from the entire site and not just from the contaminated source areas that comprise only a small fraction of the overall area of the site. For dermal contact exposures, the exposure time was assumed to be 4 hours per day which corresponds to the 50% exposure to the contaminated source identified above for incidental ingestion pathway. The area of the body exposed for dermal contact was assumed to be 11.1% which corresponds to the area of the hands and forearms (EPA, 1989b).

Nearby Residents

Nearby residents include adults, children and young children. Nearby residents, in the current (and future) land use scenario, are assumed to be potentially exposed to compounds-of-interest through the use of near-site groundwater as a potable water source and for irrigation. Exposures to compounds-of-interest in near-site groundwater are assumed to occur via ingestion, dermal contact while showering (adults and children) or bathing (young children), inhalation of volatiles while showering (adults and children only), inhalation of volatiles from groundwater during irrigation, dermal contact to irrigated soils and inhalation of volatiles and fugitive dusts from irrigated soils. The exposures to near-site groundwater as a potable water source were assumed to occur daily. For exposures to irrigated soils, it was assumed that exposure would occur while adults worked in the garden and children and young children worked or played near the garden. Table 3-8 presents the equations for calculating exposure to nearby residents for the current and future land use scenarios. Tables 3-9, 3-10, and 3-11 present the intake assumptions used for nearby resident adults, children and young children, respectively, for the future land use scenario. The exposure frequency for all nearby residents to groundwater ingestion, dermal contact and inhalation of volatiles while showering, and inhalation of volatiles and fugitive dusts from irrigated soils was assumed to be 7 days per week, 52 weeks per year. Exposures to volatiles

from groundwater during irrigation were assumed to occur 1 day per week, for 24 weeks per year. The exposure frequency for dermal contact with irrigated soils was assumed to be 2 days per week for 24 weeks (or 6 months which corresponds to a maximum period for irrigation) for adults, and 4 days per week, 24 weeks per year for children and young children. Irrigation was assumed to occur every other day during this period with a total irrigation rate of approximately 32 inches per year. The actual period for irrigating a garden would be much less because there typically is sufficient rainfall in spring and fall in the Gettysburg area. The exposure time was assumed to be 24 hours for inhalation of volatiles and fugitive dusts from irrigated soils, 4 hours for dermal contact with irrigated soils, 1 hour for inhalation of volatiles from groundwater during irrigation and 15 minutes for a shower and bath. The exposure duration for off-site residents exposed to groundwater was 30 years for adults, 16 years for children, and 5 years for young children.

Distant Off-Site Residents

Distant off-site residents include adults, children and young children. Distant off-site residents in both the current and future land use scenarios are assumed to be potentially exposed to compounds-of-interest through the use of distant off-site groundwater as a potable water source and for irrigation. Exposures to compounds-of-interest in distant off-site groundwater are assumed to occur via ingestion, dermal contact while showering (adults and children) or bathing (young children), inhalation while showering (adults and children only), inhalation of volatiles from groundwater while irrigating, dermal contact to irrigated soils and inhalation of volatiles and fugitive dusts from irrigated soils. The exposures to groundwater as a potable water source were assumed to occur daily. For exposures to irrigated soils, it was assumed that exposure would occur while adults worked in the garden and children and young children worked or played near the garden. Table 3-12 presents the equations for calculating exposure to distant off-site residents. Tables 3-13, 3-14, and 3-15 present the intake assumptions used for distant off-site resident adults, children and young children, respectively. The exposure frequency for distant off-site residents to ingestion of groundwater, inhalation and dermal exposure during showering, and inhalation of volatiles and fugitive dusts from irrigated soils was assumed to be 7 days per week, 52 weeks per year. The exposure frequency to volatiles from groundwater during irrigation were assumed to occur 1 day per week, for 24 weeks per year. The exposure frequency for dermal contact with irrigated soils was assumed to be 2 days per week for 24 weeks (or 6 months which corresponds to a maximum period for irrigation) for adults, and 4 days per week, 24 weeks per year for children and young children. As identified above for nearby residents, the actual period for irrigating a garden would probably be much less. The exposure time was assumed to be 24 hours for inhalation of volatiles and fugitive dusts from irrigated soils, 4

hours for dermal contact with irrigated soils, 1 hour for inhalation of volatiles from groundwater during irrigation and 15 minutes for a shower and bath. The exposure duration for off-site residents exposed to groundwater was 30 years for adults, 16 years for children, and 5 years for young children.

3.4.4 Intake Assumptions for Receptors Associated with the Future Land Use Scenario

Seven different receptors have been identified in three major receptor groups for the future land use scenario. These receptors include on-site maintenance worker, nearby residents (adults, children and young children) and distant off-site residents (adults, children and young children). For the on-site maintenance workers, the exposure scenario is the same as for the current land use conditions. Therefore, the discussion provided in Section 3.4.3 is appropriate. Similarly, for the nearby residents and distant off-site residents, the discussion provided in Section 3.4.3 is appropriate. While intake assumptions are the same for the current and future pathways for these receptors, the calculated risks may be different for future pathways due to differences in the exposure point concentrations between the current and future land use scenarios.

3.5 ESTIMATION OF POTENTIAL EXPOSURE POINT CONCENTRATIONS

Section 3.3 identified potential current and future receptors and described potential intake pathways for each receptor. Each intake pathway involves the receptor in contact with a particular contaminated medium (e.g., soil, air or water). The source of chemical contact in the exposure medium may be:

- compounds in the medium at the point of exposure;
- compounds that are initially in the medium at another location and are subsequently transported through that medium to the point of exposure; or
- compounds that are initially in a source medium, are then transported from the source medium to the exposure medium and finally transported through the exposure medium to the point of exposure.

As compounds move from medium to medium and location to location within a particular medium, concentrations can change over time as one medium in one location loses compounds and another medium in another location gains compounds. In addition, overall

available mass of a compound may change as the compound is lost through transformation or degradation processes such as hydrolysis, photolysis, and biodegradation. Consequently, knowing the concentration of the compound in a particular medium at the current time is not necessarily enough, since the concentration of the compound may change over time. To help estimate the potential change of compound concentrations over time in a medium from transport or transformation processes, mathematical models are typically employed and were employed in this exposure assessment.

Table 3-16 list potential exposure media, potential source media, and potential routes of intake for receptors in the current and hypothetical future use scenarios. This table also present a methodology for estimating each exposure point concentration. The potential source media listed in these tables are:

- on-site surface soils; and
- on-site groundwater.

The on-site exposure medium is:

- on-site surface soils.

The off-site exposure media are:

- near-site groundwater (via transport from on-site groundwater);
- near-site indoor shower air (volatiles from near-site groundwater);
- near-site irrigated soil (irrigated with near-site groundwater);
- near-site air (volatiles from groundwater during irrigation);
- near-site air (volatiles and dust from near-site irrigated soils);
- distant off-site groundwater (via transport from on-site groundwater);
- distant off-site indoor shower air (volatiles from distant off-site groundwater);
- distant off-site irrigated soils (irrigated with distant off-site groundwater);
- distant off-site air (volatiles from groundwater during irrigation); and
- distant off-site air (volatiles and dust from distant off-site irrigated soils).

The exposure point concentrations were estimated for these exposure media based on:

- the Phase I and Phase II analytical data summarized in Section 2;
- shower room volatilization model;
- volatilization from groundwater during irrigation model;
- soil accumulation from irrigation model; and
- soil to air model.

A summary of exposure point concentrations and the fate and transport models used to estimate exposure point concentrations is provided in Appendix B.

On-Site Surface Soils

For on-site surface soils, samples from the Phase I and II investigations were combined from each potential source area. Since data are limited in each area (only one or two samples per potential source area), the maximum concentration detected was assumed to be the exposure point concentration. Although biodegradation is an obvious potential fate mechanism associated with the compounds-of-interest in surface soils, especially for long-term exposures, exposure point concentrations for the future land use scenario were assumed to be the same as presented for the current land use scenario. This assumption is considered conservative and health-protective for the risk assessment.

Off-Site Groundwater

For off-site groundwater, the exposure point concentrations were estimated for two locations: near-site groundwater and distant off-site groundwater. Near-site groundwater is groundwater immediately adjacent to the site. Since the wells identified as deep wells are located in a more permeable zone, deep groundwater analytical data from wells PMW-13B, PMW-8B, and PMW-12B were statistically evaluated to estimate exposure point concentrations for near-site groundwater in the current land use scenario. Only data from the Phase II investigation will be used since data only exists for PMW-13B and PMW-12B from the Phase II investigation and because this data represents existing site conditions. The lower of either the maximum concentration or the upper 95% confidence level on the mean concentration was used as the exposure point concentration for a particular compound from these wells.

The exposure point concentrations for distant off-site groundwater in the current land use scenario were estimated based upon analytical data from PMW-16B. This is conservative since this well is approximately 2,400 ft from Table Rock Road. The location of monitoring well PMW-16B and the location of potential distant off-site residents is provided in Figure 3-1. Although the assumption was made that groundwater concentrations

near Table Rock Road were equal to the groundwater concentrations detected at well PMW-16B in the Phase II investigation, no evidence suggests that any compounds-of-interest have actually migrated that far. This assumption was made because of the complexity of the subsurface aquifer, a lack of information regarding the extent of the contaminant plume to the east of the site and a lack of groundwater flow information to enable modelling this concentration. This assumption was made to be conservative and health protective so that actual risks would not be underestimated. The resulting health risks that were calculated for distant off-site residents can be considered maximum potential health risks.

Uncertainty exists regarding the estimation of exposure point concentrations for the future land use scenario. If the on-site groundwater pump and treatment system as an interim remedial measure is not considered, the assumption could be made that future near-site and, eventually, distant off-site groundwater concentrations of compounds-of-interest would increase over time. However, a review of on-site groundwater data between the historical sampling periods and the Phase I investigation indicates groundwater concentrations have been reduced (from a maximum concentration of over 81,000 ppb total VOA in 1984 at PMW-1 to approximately 54,000 ppb total VOA in 1988 at the same location) with the operation of the pump and treat system. Further reductions have been observed between the Phase I and Phase II investigations. Preliminary indications from the Phase II investigation shows that the wells with the highest concentrations of compounds-of-interest fall within the estimated capture zone. For near-site groundwater, two of the three wells that were used to estimate exposure point concentrations fall within this estimated capture zone. Therefore, exposure point concentrations in the near-site groundwater should decrease with operation of the pump and treat system. However, due to a lack of sufficient data to estimate this, future exposure point concentrations for near-site groundwater are assumed to be the same as for the current land use scenario. This assumption is considered conservative and health protective for the risk assessment.

For distant off-site groundwater (i.e., groundwater near Table Rock Road), future groundwater concentrations may increase slightly due to transport of compounds from areas not believed to be within the capture zone of the pump and treat system. However, sufficient data does not exist to accurately characterize this change. It is expected that future concentrations in distant off-site groundwater will not exceed the current near-site groundwater concentrations. Therefore, distant off-site groundwater concentrations for the future land use scenario are assumed to be equal to near-site groundwater concentrations for the current land use scenario. This is a conservative assumption since the effect of the groundwater pump and treat system is anticipated to reduce concentrations of compounds-of-interest in the near-site groundwater and since on-site groundwater data was used to estimate near-site groundwater concentrations.

Shower Air Concentrations

To estimate the average shower room air concentrations of volatiles, the model of Foster and Chrostowski (1987) was used. This model is based on a simple box model of air exchange in the shower room with constant emission of volatiles during the shower. The average concentration in the shower room is the time weighted sum of the average concentration in the shower room air during the shower and the average concentration in the shower room air after the shower. A more detailed discussion of the shower volatilization model is provided in Appendix B.

Air Concentrations from Groundwater During Irrigation

Air concentrations of compounds-of-interest in groundwater that volatilize during irrigation was estimated using two models: the volatile emission rate was estimated using the shower volatilization model of Foster and Chrostowski (1987); and, volatile dispersion was estimated using the box dispersion model of Pasquill (1975). A more detailed discussion of the volatilization from groundwater during irrigation model is provided in Appendix B.

Irrigated Soil Concentrations

Concentrations of compounds-of-interest in irrigated soils were estimated by a soil accumulation from irrigation model which considers the fate of compounds when introduced to soils including adsorption, biodegradation, leaching and volatilization. A detailed discussion of the soil accumulation from irrigation model is provided in Appendix B.

Air Concentrations from Irrigated Soils

Compounds-of-interest in irrigated soils can be released to the air via volatilization and fugitive dust emissions. These emissions, that are areal in nature, will mix with the air immediately above the soil surface to give concentrations of compounds-of-interest in the air. The estimation of air concentrations from volatilization and fugitive dust is actually based on three different models: a fugitive dust emission model; a volatilization emission from surface soils model; and a dispersion model. The fugitive dust emission model used was based on Cowherd (1984) as described in GRI (1988). The volatilization from soil emission model used was EPA (1989d). The dispersion model used was the nearfield box dispersion model of Pasquill (1975). A more detailed discussion of these models is provided in Appendix B.

Summary of Exposure Point Concentrations

Table 3-17 presents a summary of the exposure point concentrations for the media-of-interest at the Plant site. For on-site surface soils, exposure point concentrations are provided by potential source area. The compounds-of-interest for the quantitative risk assessment for Pump House Area surface soils and the exposure point concentrations are:

- 1,1-dichloroethane at 0.088 mg/Kg;
- 1,1,1-trichloroethane at 0.432 mg/Kg; and
- PCB Arochlor 1254 at 0.518 mg/Kg.

The compounds-of-interest for the quantitative risk assessment for Railroad Dock Area surface soils and the exposure point concentrations are:

- xylenes at 5.128 mg/Kg.

No exposure point concentrations were applicable for the Remote Fill Spout area, Degreasing Fluid Storage Tank area, or the Old Waste Drum Storage area soil. The exposure point concentrations for the remaining areas (e.g., the Pump House and Railroad Dock areas) were assumed to remain the same for both the current and future land use scenarios. Since only a few samples were taken from each potential source area, the exposure point concentrations for these areas were assumed to be equal to the maximum concentration.

The compounds-of-interest for the quantitative risk assessment for near-site groundwater in the current and future land use scenarios, and for distant off-site groundwater in the future land use scenario, and their exposure point concentrations are:

- 1,1-dichloroethene at 0.012 mg/L;
- 1,1-dichloroethane at 0.0025 mg/L;
- 1,2-dichloroethene at 0.0025 mg/L;
- 1,2-dichloroethane at 0.0025 mg/L;
- 1,1,1-trichloroethane at 0.038 mg/L; and
- trichloroethene at 0.45 mg/L.

The compounds-of-interest for the quantitative risk assessment for distant off-site groundwater in the current land use scenario, and their exposure point concentrations are:

- 1,1-dichloroethene at 0.006 mg/L;

- 1,1-dichloroethane at 0.0025 mg/L;
- 1,2-dichloroethene at 0.0025 mg/L;
- 1,2-dichloroethane at 0.0025 mg/L;
- 1,1,1-trichloroethane at 0.007 mg/L; and
- trichloroethene at 0.23 mg/L.

It should be noted that not all of these compounds were detected in the monitoring wells used to calculate the exposure point concentrations. When a compound was not detected in a particular well, half the detection limit was used to estimate the exposure point concentration according to EPA guidance (EPA, 1989a).

3.6 ESTIMATED INTAKES AND DOSES

Intake assumptions, described in detail in Section 3.4, were combined with the exposure point concentrations described in Section 3.5, to calculate intakes and doses. These calculated chemical intakes are presented in Appendix C. Potential intakes or doses are presented for each receptor for each compound of interest. Two intakes or doses are estimated for each receptor. An average lifetime intake was estimated that can be combined with an appropriate cancer slope factor to estimate a cancer risk. A chronic intake was also estimated that can be combined with an appropriate RfD to generate a chronic hazard index. The estimation of these potential health effects is discussed in Section 5.0.

3.7 UNCERTAINTIES IN THE PUBLIC HEALTH EXPOSURE ASSESSMENT

The sources of uncertainty associated with the estimates of exposure were evaluated by investigating the assumptions used in the exposure assessment. Uncertainties associated with the exposure assessment for the Plant site include those associated with the environmental sampling, analysis, and data evaluation; and those associated with the parameters used to estimate intakes.

Environmental Sampling, Analysis and Data Evaluation

In this category, uncertainties may arise from the following:

- the number of samples collected;
- the choice of parameters to be analyzed;
- the actual chemical analysis performed on each sample;

- the detection limits; and
- combining data generated from different investigations.

The uncertainties associated with each item in this list are discussed in more detail below.

First, for each medium and each location within a medium, there is the possibility that not enough samples were taken to characterize that medium and location. As the number of samples increases, the uncertainty, presumably, decreases. For the Plant site, there have been three different investigations (Historical, Phase I, and Phase II). However, only data for the Phase I and Phase II investigations were used since the historical data is outdated (data was collected in 1983 and 1984), it does not represent existing site conditions because of implementation of interim remedial measures (i.e., the interim soil removal actions from the Pump House and Railroad Dock area and the installation and operation of the groundwater pump and treat system), and because the data was not validated in accordance with standard laboratory procedures. These investigations have generated information about the on-site surface and subsurface soils; on-site and off-site groundwater in both the shallow and deep aquifers; and off-site surface water and sediments. It appears that sufficient data has been collected to adequately characterize on-site soils and groundwater, and off-site surface water and sediments. However, data is lacking regarding the extent of contamination in off-site groundwater. The uncertainty associated with the number of samples collected is anticipated to be low (may affect estimates of exposure by less than one order-of-magnitude).

Second, not all parameters were analyzed in every media during every sampling investigation. However, with regard to the compounds identified from the Phase I as relevant for sampling in the Phase II investigation (e.g., TCL volatiles, bis(2-ethylhexyl)phthalate; and PCBs - in Pump House area soils only), the compounds analyzed were consistent for each media for both the Phase I and Phase II investigations. Therefore, the uncertainty associated with the analysis of all parameters is low.

Third, the actual chemical analyses performed on each sample could lead to erroneous data. However, the same laboratory and analytical methods were used in both the Phase I and Phase II sampling efforts, Also, the QA/QC documentation was supportive of accurate data. Therefore, the uncertainty associated with this assumption is low.

Fourth, analytical detection limits varied somewhat within and between media. However, the relatively low concentrations observed for most compounds in most media prevented substantial matrix effects on the sample analytical results for the compounds-of-interest at the site. It was assumed that the compound was present at half the analytical

detection limit for all compounds detected below detection limits. This is a conservative assumption and likely to overestimate the actual concentrations of the compounds since many of the compounds were only detected in one or a few samples, often at or near the detection limit. This indicates that the presence of the chemical constituent is slight or may not occur at all in some areas. However, with regard to the estimation of exposure point concentrations in groundwater, the use of half the detection limit may lead to estimates of risk that are artificially inflated. The uncertainty associated with this assumption is low to moderate (may affect the estimated exposure by less than one to two orders-of-magnitude).

Finally, combining site investigation data from several investigations typically results in much uncertainty. Combining data where analytical methods and detection limits differ can bias the risk assessment. However, as stated above, the same laboratory and analytical methods were used in both instances and the analytical data compared well in both phases. Therefore, the uncertainty introduced by this procedure is low.

Fate and Transport Analysis

The objective of the fate and transport analysis is to estimate exposure point concentrations. For this analysis, exposure point concentrations were estimated either from site analytical data or from a model. For exposure point concentrations estimated from site analytical data (e.g., on-site soils and groundwater), uncertainties associated with modeling are not relevant. However, uncertainties do arise from assumptions used for determination of the exposure media and exposure point concentration. In this effort, uncertainties can arise from the following sources:

- the use of the upper 95 percent confidence limit or the maximum concentration in groundwater to estimate the exposure point concentration according to EPA guidance (EPA, 1989a);
- the use of on-site monitoring well data to estimate near-site groundwater concentrations;
- the use of monitoring data from PMW-16B to estimate distant off-site groundwater exposure point concentrations for the current land use scenario; and
- the use of the maximum concentrations for samples from on-site soil as the exposure point concentration.

The uncertainties associated with each item in this list are discussed below.

First, the use of the upper 95 percent confidence limit or the maximum concentration (whichever is lower) to define the concentration of each compound in groundwater adds uncertainty to the analysis. The use of this value is conservative and it is likely to overstate the actual concentration of a compound in a particular medium. It should be noted that the use of the upper 95 percent confidence limit or the maximum concentration as the source concentration for a given media is recommended in the Superfund Risk Assessment Guidance (EPA, 1989a). The uncertainty associated with this assumption is considered moderate (may affect the estimated of exposure by two orders-of-magnitude).

Second, the use of the on-site groundwater data as the database for off-site groundwater provides a high level of uncertainty. As pointed out earlier in Section 3, the influence of the on-site groundwater pump and treat system is anticipated to prevent significant migration of compounds from on-site groundwater to off-site locations. It appears that this pumping system has contained the majority of contamination on-site based on the observation that off-site concentrations of compounds-of-interest currently are 1% or less than the concentrations observed on-site. This is noteworthy because, the compounds-of-interest are considered very soluble and mobile. Also, the concentrations for some compounds in monitoring well PMW-8B have decreased between the Phase I and Phase II investigations which reflects the effectiveness of the pump and treat system to contain and remove the compounds-of-interest in groundwater along the property boundary. The use of on-site groundwater concentrations to estimate off-site exposure estimates is likely to overestimate near-site groundwater concentrations by one order-of-magnitude. Therefore, the uncertainty associated with this assumption is considered low to moderate.

Third, the use of groundwater data from monitoring well PMW-16B to estimate distant off-site groundwater concentrations can be considered very conservative and health protective. This well is approximately 2400 feet hydraulically up-gradient from Table Rock Road. The anticipated groundwater concentrations at Table Rock Road would most likely be much less than at monitoring well PMW-16B.

Finally, the use of the maximum concentration as the exposure point concentration is a very conservative assumption. Risk assessment guidance (EPA, 1989a) specifies that the upper 95% confidence level is to be used as the exposure point concentration. However, insufficient data exists to allow a statistical evaluation in each of these areas. Also, this assumption does not allow for source depletion due to biodegradation, photolysis or volatilization.

Uncertainty also exists in the assumptions used for each fate and transport model. The volatilization models chosen for estimating volatile emissions from surface soils, while based on state-of-the-art scientific understanding, could either over or underestimate actual emissions. However, the models chosen are recommended by the EPA and the parameters utilized in the analyses were conservatively chosen. Thus, it is likely that the models overestimate actual volatile emissions from irrigated surface soils, leading to a moderate uncertainty to overestimate actual concentrations.

Second, the fugitive dust emission model chosen for this analysis could either under of overestimate actual fugitive dust emissions. However, the ambient air concentrations predicted with this model in conjunction with the box dispersion model are consistent with typical PM10 dust concentrations measured in Region III. Thus, the uncertainty associated with these estimates is likely to be low.

Third, the shower volatilization model, used in this analysis to estimate the shower room air concentrations of volatiles and volatile emissions from groundwater during irrigation, while based on state-of-the-art scientific understanding of this process, could either over or underestimate actual volatile emissions. However, as defined above for the soil volatilization model, the model chosen was recommended by EPA and has been used in other Superfund risk assessments. Also, the parameters used in the models were conservatively chosen. It is more likely that volatile emissions are overestimated rather than underestimated. The uncertainty associated with these assumptions is assumed to be moderate.

Fourth, uncertainty is associated with the irrigation model used to estimate potential concentrations of compounds-of-interest in irrigated soils. This model does not consider biodegradation of compounds which leads to an over-estimate of actual soil concentrations, especially for long term exposures. Since compounds applied in irrigation water are solubilized and, consequently, already in a form amenable to microbial action, biodegradation is believed to be a significant fate mechanism. This scenario does not consider loss to volatilization from groundwater during irrigation. This was estimated to be as high as 40%, on the average, for the compounds-of-interest in groundwater based on the fraction volatilized from the shower model. Additionally, the parameters used in this model were conservatively chosen, so overestimation is more likely, leading to a moderate level of uncertainty.

Exposure Parameter Estimation

In this category, uncertainties may arise from the following:

- the standard assumptions regarding ingestion rates, period exposed, life expectancy, etc.;
- the use of body surface area and body weight assumptions;
- the assumption that the amount of media intake is constant and representative;
- the use of an absorption factor of 1.0 (or 100%); and
- the assumptions associated with daily lifetime exposure.

The uncertainties associated with each item in this list are discussed in more detail below.

First, the standard assumptions regarding ingestion rate, period exposed, life expectancy, population characteristics and lifestyle may not be representative of the actual situation. This assumption can lead to an overestimation of risk due to the conservative assumptions used when calculating exposures. The risk assessment used EPA recommended values which are intended to be very conservative. The uncertainty associated with these assumptions are moderate to high but are conservative and should overestimate exposure.

Second, the use of body surface area and body weight may not be representative of the actual situation. However, the assumptions used correlate to the 50 percentile value, as recommended by the EPA Risk Assessment Guidance (EPA, 1989a). Therefore, uncertainty associated with this assumption is anticipated to be low.

Third, the assumption that the amount of media intake is constant and representative of the exposed population is a very conservative assumption resulting in a moderate potential for over estimation of exposure.

Fourth, use of an absorption factor of 1.0 for ingestion and inhalation of compounds-of-interest may not represent actual intakes. The absorption of 100% of a compound through ingestion and inhalation is unlikely. This assumption is likely to overestimate the intake or doses by perhaps an order-of-magnitude or more (i.e., low to moderate for over-estimation of risk).

Finally, the assumptions for daily lifetime exposure of receptors may not be representative of the actual situation. For example, the off-site residents (e.g., nearby residents and distant off-site residents) are assumed to be exposed to the compounds-of-

interest in groundwater 7 days per week, 52 weeks per year, for 18 (for children) or 30 years (for adults). This leads to a moderate to high level of uncertainty since the likelihood that this scenario would occur is very small.

Summary

Taken together, the uncertainties associated with environmental sampling, analysis and data evaluation; fate and transport analysis; and parameters used to estimate intakes can be considerable. The approach employed in this analysis tends toward high estimates of exposure to ensure protection of the more exposed or sensitive sub-populations. Although there is considerable uncertainty associated with the exposures estimated in this analysis, it is much more likely that the values estimated will overestimate actual or potential exposures rather than under estimating them.

3.8 SUMMARY OF THE PUBLIC HEALTH EXPOSURE ASSESSMENT

This section presented the public health exposure assessment portion of the risk assessment for the Plant site. First, potential sources of compounds-of-interest and migration pathways for these compounds were discussed. Second, the basis for the exposure assessment was established by identifying potential receptors and exposure pathways. Third, intake assumptions were specified for each potential receptor. Fourth, a fate and transport analysis was utilized to estimate exposure point concentrations of compounds-of-interest under current and future land use scenarios. Fifth, intakes and doses were calculated by combining the intake assumptions and exposure point concentrations. Finally, uncertainties in the public health exposure assessment were identified and discussed.

4.0 TOXICITY ASSESSMENT FOR HUMAN HEALTH EVALUATION

4.1 ELEMENTS OF A TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to weigh available evidence regarding the potential for compounds-of-interest to cause adverse health effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a compound and the increased likelihood or severity of the adverse effect. A toxicity assessment considers:

- the types of adverse health effects associated with exposures to compounds-of-interest;
- the relationship between the magnitude of exposure and the adverse effects; and
- related uncertainties such as the weight of evidence of a particular compound's carcinogenicity in humans.

The toxicity assessment for the Plant site was accomplished in two steps: hazard identification and dose-response assessment. The first step, hazard identification, is the process of determining whether exposure to an agent can cause an increase in the incidence of an adverse health effect. Hazard identification also involves characterizing the nature and strength of the evidence of causation. The second step, dose-response evaluation, is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values are derived that can be used to estimate the incidence of adverse effects occurring in humans at different exposure levels.

It should be emphasized that the dose-response values discussed in this section are based on methodology that is consistent with EPA risk assessment guidelines (EPA,1989a) and is intended to be conservative and, therefore, health protective. However, because these dose-response values are conservative, they are likely to overstate the actual relationship between an actual dose and the manifestation of an adverse health effect.

Based on the screening of analytical data from previous site investigations using the

data evaluation procedure, a list of compounds-of-interest was prepared. This list is presented in Table 4-1 and provides the focus for discussions in this section.

4.2 OVERVIEW OF CHEMICAL PROFILES

Chemical profiles are included for each compound of interest where adequate data is available. Printouts from the Integrated Risk Information System (IRIS) database are used as chemical profiles. IRIS is an EPA database which provides up to date health risk and EPA regulatory information for numerous chemicals. IRIS contains only those RfDs and slope factors that have been verified by the RfD or Carcinogen Risk Assessment Verification Endeavor (CRAVE) Workgroups and consequently, is considered to be the preferred source of toxicity information. The information contained in the IRIS database includes:

- a summary of the status of the data contained in the file;
- chronic human health hazard assessment for non-carcinogenic effects of the compounds-of-interest including reference doses and uncertainty factors;
- carcinogenicity assessment for lifetime exposure data;
- health hazard assessments for varied exposure durations;
- supplemental data including acute human health hazard information and physical/ chemical properties of the compound; and
- references and synonyms.

Chemical profiles for compounds-of-interest are provided in Appendix D.

4.3 TOXICITY INFORMATION FOR NON-CARCINOGENIC EFFECTS

The degree of toxicity of non-carcinogenic compounds is based on the ability of organisms to repair and detoxify after exposure to a compound. This mechanism of repair must be exceeded by some critical concentration (threshold) before the health effect is manifested. For example, an organ can have a large number of cells performing the same

or similar functions that must be significantly depleted before the effect on the organ is seen. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without an appreciable risk of adverse effects.

A reference dose (RfD) is the value assigned to a compound whereby a daily exposure of the compound at or below the reference dose will not cause any appreciable adverse health effects. The RfD is derived using conservative safety factors to adjust from animals to humans, to protect sensitive sub-populations and to ensure that the RfD is unlikely to underestimate the potential for adverse non-carcinogenic effects to occur. The purpose of the RfD is to provide a benchmark against which the sum of doses (those projected from human exposure to various environmental conditions) might be compared. RfDs are expressed in various ways but primarily according to the length of exposure being evaluated. A chronic RfD is an estimate of a daily exposure level for the human population, including sensitive sub-populations, that is likely to be without an appreciable risk of damaging effects during a lifetime. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound.

The EPA has developed RfDs for some of the compounds-of-interest selected for the Plant site. RfDs were obtained from the IRIS database. Another EPA document that is used for RfDs when they were not available in the IRIS database is the EPA Fourth Quarter 1990 Health Effects Assessment Summary Tables (EPA, September 1990). The RfDs are summarized in Table 4-2.

In addition to RfDs, the EPA (through its office of Drinking Water), develops Health Advisories (HAs) for individual compounds representing less-than-lifetime exposures. The HAs are developed from data describing non-carcinogenic endpoints of toxicity. The HAs represent guidance levels for drinking water exposures based on the length of potential exposure. The values for the One-day and Ten-day exposure periods do not consider other sources of exposure such as food or air. For each, the resulting value, in mg/L, assumes that 100% of an individual's exposure comes from drinking water. HAs are derived to protect sensitive members of the population. For the One-day and Ten-day HAs, the protected individual is assumed to be a child. The child is assumed to weigh 10 kg unless otherwise noted. It is also assumed that the child consumes 1 L of water/day. Table 4-3 is a summary of the health advisories for the compounds-of-interest at the Plant site as derived from the IRIS database.

4.4 TOXICITY INFORMATION FOR CARCINOGENIC EFFECTS

For compounds that exhibit carcinogenic effects, many authorities believe that one or more molecular events can evoke changes in a single cell or a small number of cells that can lead to tumor formation. This non-threshold theory of carcinogenesis suggests that any level of exposure to a carcinogen can result in some finite possibility of generating the disease. In the absence of information concerning the mechanisms of action for the chemical, the EPA assumes that a non-threshold mechanism is operable for carcinogens.

The weight-of-evidence classification and cancer slope factor are the toxicity data most commonly used to evaluate potential human carcinogenic risks. The carcinogenic potential of a compound is classified into one of the following groups, according to the weight of evidence from epidemiological and animal studies:

- Group A Human Carcinogen
- Group B Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
- Group C Possible Human Carcinogen (limited evidence of carcinogenicity in animals or lack of human data)
- Group D Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
- Group E Evidence of Non-carcinogenicity for Humans (no evidence of carcinogenicity in adequate studies).

The classifications for the compounds-of-interest at the Plant site are shown in Table 4-4.

At low doses, the probability of contracting cancer in a lifetime is assumed to be proportional to the cumulative lifetime dose. The coefficient relating dose to risk is called the cancer slope factor (CSF). Thus, if the dose or intake is represented by I and the cancer slope factor by q_1^*, then the risk, R, is given by the equation:

$$R = q_1^* \cdot I$$

The intake has units of mg/kg-day and represents the average daily intake over the lifetime of the exposed individual. The cancer slope factor is actually the upper bound value based on fitting a mathematical model to experimental dose response data. The cancer slope factor is used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular compound. Cancer slope factors for the compounds-of-interest at the Plant site are provided in Table 4-4.

4.5 UNCERTAINTIES RELATED TO TOXICITY INFORMATION

A large source of the uncertainty associated with a risk assessment are the quantitative indices of toxicity (RfDs and CSFs). To compensate for these uncertainties, these quantitative indices for evaluating long term exposures are based on concepts and assumptions that bias an evaluation in the direction of overestimation of health risk. The degree of uncertainty associated with quantitative indices of toxicity is dependent on both the strength of evidence and confidence.

As stated earlier, an RfD is an estimate of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. An uncertainty factor is used in calculating the RfD and reflects scientific judgement regarding the various types of data used to estimate RfD values. An uncertainty factor of 10 is generally used to account for variations in human sensitivity when extrapolating from valid human studies involving long term exposure of average healthy subjects. An additional 10-fold factor is generally used for each of the following extrapolations: from long-term animal studies to humans, from a LOAEL (the lowest observed adverse effect level) to a NOAEL (the no observed adverse effect level) and from subchronic studies to a chronic RfD. In order to reflect professional assessment of the uncertainties of the study and data base not explicitly addressed by the above uncertainty factors, an additional uncertainty factor or modifying factor ranging from greater than 0 to less than or equal to ten is applied. The default value for this modifying factor is 1 (HEAST, 1990).

For carcinogens, uncertainties are compensated for by using upper bounds for cancer slope factors. Cancer slope factors are estimated through the use of mathematical models for estimating the largest possible linear slope (within the 95% confidence limit) at low extrapolated doses that is consistent with the data. The slope factor is characterized as an upper-bound estimate, where, at best, the dose-response assumptions used in a risk assessment provide a rough but plausible estimate of the upper limit of risk. That is, it is not likely that the true risk would be much more than the estimated risk, but it could very

well be considerably lower, even approaching zero (HEAST, 1990).

In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given compound. EPA's weight of evidence classification provides information that can indicate the level of confidence or uncertainty in the carcinogenicity data obtained from studies in humans or experimental animals. Some of the uncertainties in the hazard evaluation are further compensated for by assuming that animal carcinogens behave as human carcinogens. The summation of the risks associated with all potential carcinogens, which is done for each evaluated exposure pathway, tends to overestimate risk by including probable human carcinogens (Group B) with demonstrated human carcinogens (Class A).

It is important to emphasize that the methodology typically employed to estimate cancer slope factors (i.e., extrapolating from risks generated at high doses in animal studies to risks at low doses) has considerable uncertainty associated with it, uncertainty suggesting that risks estimated with this methodology could overestimate actual risks. First, the carcinogenic effect is assumed to not exhibit a threshold effect. However, the human body has mechanisms to detoxify compounds, particularly at low doses.

Second, there is considerable uncertainty regarding the appropriateness of extrapolating from carcinogenic effects at high doses in animals to low doses in either animals or humans. The high doses are often near the maximum tolerated dose for a test animal species and these high doses are believed to cause cell proliferation which will result in increased cancer risk because the odds of mutation increase (Cohen, 1990; Ames, B.N. and L.S. Gold, 1990). These findings call into question the animal test protocol used as the basis for developing dose-response relationships for carcinogenic effects.

These two items suggest that the current practice of assuming that carcinogenic effects do not exhibit threshold behavior and assuming that carcinogenic effects observed at high doses in test animals can be used to predict cancer effects at lower doses are likely to be incorrect, at least for some compounds. Thus, while the current practice is conservative and, therefore, health protective, it is likely to be overconservative and is likely to overstate the actual risk from exposure to compounds at low doses.

4.6 SUMMARY OF QUANTITATIVE INDICES OF TOXICITY

The toxicity assessment provides information that is used in conjunction with the exposure assessment to estimate potential risks posed to human receptors. This section

presents a brief summary of health effects and discusses quantitative indices of toxicity for each compound of interest.

4.6.1 Volatile Organics

1,1-Dichloroethane

Summary of Health Effects. The EPA has classified 1,1-dichloroethane as a Class C - Possible Human Carcinogen. At one time 1,1-dichloroethane was used as an anesthetic, but it induces cardiac arrhythmias and its use was discontinued. It is probable that human exposure to high levels of 1,1-dichloroethane may cause central nervous system depression, respiratory tract, and skin irritation, since many of the chlorinated aliphatics cause these effects (Parker at al, 1979). However, no dose response data concerning these effects are available.

Quantitative Indices of Toxicity. The EPA has derived both an oral and an inhalation RfD for 1,1-dichloroethane of 0.1 mg/kg/day. The uncertainty factor associated with these RfDs is 1000. Cancer slope factors have not been determined.

1,2-Dichloroethane

Summary of Health Effects. The EPA has classified 1,2-dichloroethane as a Class B2 - Probable Human Carcinogen- based on inadequate evidence of carcinogenicity from human studies and sufficient evidence from animal studies. Data on the toxicokinetics of 1,2-dichloroethane in humans are limited. Data from animal studies suggest that the compound is rapidly absorbed following oral and inhalation exposure and after dermal contact with the liquid form of the compound (EPA, 1985). Effects of acute inhalation exposure in humans include irritation of mucous membranes in the respiratory tract and central nervous system depression (EPA, 1985). Death may occur as a result of respiratory and circulatory failure. Chronic studies in animals also have revealed toxic effects following inhalation exposure including degeneration of the liver (EPA, 1985).

Quantitative Indices of Toxicity. EPA has derived both an oral and an inhalation CSF for 1,2-dichloroethane of 0.091 $(mg/kg/day)^{-1}$.

1,1-Dichloroethene

Summary of Health Effects. The EPA has classified 1,1-dichloroethene as a Class C - Possible Human Carcinogen. The compound is rapidly absorbed after oral and inhalation

exposures (EPA, 1984,1987). Humans acutely exposed to 1,1-dichloroethene vapors exhibit central nervous system depression (CH2M Hill, 1989). In animals, the liver is the principal target of toxicity (CH2M Hill, 1989). Workers chronically exposed to 1,1-dichloroethene in combination with other vinyl compounds exhibit liver dysfunction, headaches, vision problems, weakness, fatigue and neurological sensory disturbances (EPA, 1987a). Chronic oral administration to experimental animals results in both hepatic and renal toxicity (EPA, 1984).

Quantitative Indices of Toxicity. The EPA has derived an oral CSF for 1,1-dichloroethene of 1.2 $(mg/kg/day)^{-1}$. The inhalation CSF is 0.6 $(mg/kg/day)^{-1}$. Additionally, an oral RfD has been derived, it is 0.009 mg/kg/day. There is an uncertainty factor of 1000 associated with the RfD.

1,2-Dichloroethene

Summary of Health Effects. An IRIS chemical profile is only available for trans-1,2-dichloroethene. With regard to carcinogenic classification, the EPA states that trans-1,2-dichloroethene has not been evaluated as a possible substance/agent for evidence of human carcinogenic potential. It is expected to be absorbed by any route of exposure. Information on the health effects of trans-1,2-dichloroethene is limited. Inhalation exposure to 200 ppm was associated with pneumonic infiltration to the lungs and progressive fatty degeneration of the liver in rats (Freundt et al, 1977). High concentrations have anaesthetic properties in humans (Irish, 1963).

Quantitative Indices of Toxicity. EPA has derived an oral RfD for t-1,2-dichloroethene of 0.02 mg/kg/day. The uncertainty factor associated with this RfD is 1000. Neither an inhalation RfD nor CSF has been determined.

1,1,1-Trichloroethane

Summary of Health Effects. The EPA has classified 1,1,1-trichloroethane as a Class D carcinogen. It is rapidly absorbed following oral and inhalation exposures. Pulmonary absorption is initially large and gradually decrease to a steady state condition. Absorption through the skin is slow. 1,1,1-Trichloroethane distributes throughout the body and readily crosses the blood brain barrier (EPA,1984). The most notable toxic effects of the compound in humans and animals are central nervous system depression, including anesthesia at very high concentrations, and impairment of coordination, equilibrium, and judgement at lower concentrations (350 ppm and above).

Quantitative Indices of Toxicity. EPA has derived both an oral and an inhalation RfD for 1,1,1-trichloroethane of 0.09 and 0.3 mg/kg/day, respectively.

Trichloroethene

Summary of Health Effects. The EPA has classified trichloroethene (TCE) as a B2-Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies. TCE is a central nervous system depressant following acute and chronic exposure (Stephens, 1945). High level exposure can result in death due to respiratory and cardiac failure (EPA, 1985). Hepatotoxicity has been reported in human and animal studies following acute exposure to TCE (EPA, 1985).

Quantitative Indices of Toxicity. The EPA derived an oral CSF for TCE of 0.011 $(mg/kg/day)^{-1}$ and an inhalation CSF of 0.017 $(mg/kg/day)^{-1}$.

Xylene

Summary of Health Effects. Xylene is categorized as a Class D agent which implies there is inadequate evidence of carcinogenicity. The three xylene isomers, compounds having the same compound constituents in a different configuration, have similar toxicological properties and are discussed together. When inhaled at high concentrations, xylene causes central nervous system depression (EPA,1987b). It can also cause reddening of the face, disturbed vision and salivation (GRI, 1988). There is some evidence suggesting that xylene sensitizes the myocardium to the endogenous neurohormone, epinephrine and can precipitate heart failure and death (GRI, 1988). Workers chronically exposed to xylene display symptoms similar to those seen in acutely exposed individuals (Sandmeyer, 1981). In addition there have been reports that disturbances in the blood can occur from xylene exposure (GRI, 1988). There are no studies to indicate that xylene is carcinogenic or mutagenic (GRI, 1988).

Quantitative Indices of Toxicity. RfDs are established for exposure to xylene compounds. The oral RfD is 2 mg/kg/day and the inhalation RfD is 0.085 mg/kg/day. An uncertainty factor of 100 is associated with both of the RfDs.

4.6.2 PCBs

Summary of Health Effects. The EPA has classified PCB's as a B2 carcinogen - Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies. PCBs are readily absorbed through the

gastrointestinal tract and somewhat less readily through the skin (EPA,1985c). PCBs are presumably readily absorbed from the lungs, but few data are available that experimentally define this extent of absorption after inhalation (EPA, 1985c). Dermatitis and chloracne have been the most prominent and consistent findings in studies of occupational exposure to PCBs (CH2M Hill, 1989). Reproductive, hepatic, immunotoxic, and immunosuppressive effects appear to be the most sensitive end points of PCB toxicity in non rodent species, and the liver appears to be the most sensitive target organ for toxicity in rodents (EPA, 1985). Studies have suggested that PCB mixtures can act to promote or inhibit the action of other carcinogens in rats and mice (EPA,1985).

Quantitative Indices of Toxicity. The EPA has derived an oral CSF for PCB's of 7.7 $(mg/kg/day)^{-1}$. A CSF is not available for the inhalation route of exposure.

4.6.3 Quantitative Indices of Toxicity

The oral and inhalation quantitative indices of toxicity for the compounds-of-interest, as discussed above, are summarized in Table 4-5. The table summarizes the reference doses and cancer slope factors for each compound of interest.

4.7 CHEMICAL-SPECIFIC ARARs

Risk assessments under CERCLA are primarily used to supplement "applicable or relevant and appropriate requirements" (ARARs) in setting clean-up levels. They work in two ways: First, where there are no ARARs for a specific compound, risk assessment techniques may set "acceptable exposure levels," based on an individual lifetime cancer risk of between 10^{-4} and 10^{-6} (40 C.F.R. § 300.430(e)(2)(i)(A)(2)). In addition, EPA may consider risk in determining clean-up levels "[i]n cases involving multiple contaminants or pathways where the attainment of chemical- specific ARARs will result in a cumulative risk in excess of 10^{-4}" (40 C.F.R. § 300.430(e)(2)(i)(D)). Thus, if ARARs exist and no multiple contaminants or pathways affect the site segment or compound of interest, ARARs alone should set clean-up levels. Although this risk assessment addresses all compounds-of-interest in the various site media, it should affect clean-up only to the extent that no ARARs exist or multiple contaminants or pathways result in a cumulative risk above the 10^{-4} level.

With regard to the risk assessment, ARARs at the Plant site are the chemical-specific ARARs. Chemical-specific ARARs fall into one of two categories: applicable regulations (i.e., which include clean-up standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under federal

or state law that specifically address a hazardous substance, pollutant, or contaminant) or relevant and appropriate (i.e., other advisories, criteria, or guidance that may not have been established as an enforceable standard but may have been deemed appropriate). Applicable regulations with regard to compounds-of-interest at the Plant site include Safe Drinking Water Act - Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs). This regulation states that ground and surface water at a CERCLA site should attain non-zero MCLGs when they are relevant and appropriate. Where MCLGs are not relevant or appropriate or are set to zero (as is the case with MCLGs for known or suspected carcinogens), the ground or surface water should attain only the corresponding MCLs, if the MCL is applicable or relevant and appropriate. MCLs and MCLGs for compounds-of-interest at the Plant site are summarized in Table 4-6.

A regulation that is applicable for compounds-of-interest in soil is the regulation under the Toxic Substance Control Act regarding PCBs. Part 761 states that soils and sediments with PCB contamination exceeding 50 ppm must be disposed of in facilities specifically permitted for PCBs. In addition, the regulations describe clean soils as those containing less than 1 ppm total PCBs.

5.0 CHARACTERIZATION OF POTENTIAL PUBLIC HEALTH RISKS

In Section 3.0, potential human receptors and exposure pathways were identified, exposure point concentrations were estimated for media that receptors may potentially contact and intakes were estimated for each receptor. In Section 4.0, quantitative indices of toxicity were presented for estimating human health effects associated with appropriate doses or intakes. In this section, the estimated intakes are combined with the quantitative indices of toxicity to estimate potential human health effects.

For compounds that exhibit carcinogenic effects, many authorities believe that one or more molecular events can evoke changes in a single cell or a small number of cells that can lead to tumor formation. This non-threshold theory of carcinogenesis suggests that any level of exposure to a carcinogen can result in some finite possibility of generating the disease. The degree of toxicity of non-carcinogenic compounds is based on the ability of organisms to repair and detoxify after exposure to a compound. This mechanism of repair must be exceeded by some critical concentration (threshold) before the health effect is manifested. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without an appreciable risk of adverse effects.

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The risks calculated are based on EPA recommended assumptions that are intended to be conservative and, therefore, health protective. It is worth noting that the actual incidence of contracting cancer over a lifetime is about one in four, and for those who contact potential carcinogens, about 1 to 2% of these cancers have been associated with ambient or background chemical pollution (Travis and Hester, 1990). According to Travis and Hester, the lifetime cancer risk from exposure to background or ambient levels of chemical residues in the environment is 1 to 5 x 10^{-3}. In contrast, the target risk range utilized by the EPA at Superfund sites is 10^{-4} to 10^{-6} which is one to three orders-of-magnitude lower. Thus, not only are the risks estimated in this risk assessment likely to overstate actual risks, but the target risk range is likely to be an order-of-magnitude or more below levels of cancer incidence in the general population resulting from background levels of chemical residues in the environment.

In this section, potential health effects are evaluated two ways. The first step in this process involves a comparison of estimated exposure point concentrations for compounds-of-

interest in various media with compound specific applicable or relevant and appropriate requirement (ARARs). This analysis is presented in Section 5.1. The second step involves calculation of potential cancer risks and non-carcinogenic hazard indices for all receptors for which intakes were estimated in Section 3.6. The purpose of this analysis, which is presented in Section 5.2 for current land use conditions and Section 5.3 for future land use conditions, is to obtain a relative measure of potential risks and chronic effects.

It should be emphasized that the cancer risks and chronic health effects estimated in this section are not actual risks or hazard indices associated with current exposures or expected risks or hazard indices associated with potential future exposures. These are estimated risks and chronic hazard indices that are based on EPA Guidance for Risk Assessments of Superfund sites (EPA, 1989a) and are associated with reasonable maximum exposure scenarios and conservative quantitative indices of toxicity. Thus, these estimates of risk and hazard indices are conservative and, therefore, health protective, but are likely to overstate actual cancer risks or chronic health effects associated with actual exposures to compounds-of-interest at the Plant site. An uncertainty analysis is presented which identifies uncertainty in the risk characterization. This uncertainty analysis is discussed in more detail in Section 5.4. A summary of this section is provided in Section 5.5.

5.1 COMPARISON OF EXPOSURE POINT CONCENTRATIONS WITH CHEMICAL-SPECIFIC ARARs

As discussed in Section 3.5, exposure point concentrations were estimated based on data collected at the Plant site and from mathematical models. As part of this analysis for the Plant site, chemical-specific applicable or relevant and appropriate regulations (ARARs) were identified. These chemical-specific ARARs are also media-specific. In this section, exposure point concentrations for surface soil, groundwater, surface water and sediments are compared with chemical-specific ARARs if available.

5.1.1 Surface Soil

The detected level of PCBs in Pump House Area soil (approximately 0.5 ppm) is less than the 1 ppm concentrations that is indicative of "clean soils" under Part 761 of TSCA.

5.1.2 Groundwater

There are several chemical-specific ARARs that are applicable to groundwater at the site. Maximum contaminant levels (MCLs) or maximum contaminant level goals (MCLGs) are ARARs for concentrations of compounds in groundwater that may be potentially used

as a drinking water source. The MCLG is considered applicable for all compounds except where the MCLG equals zero. When an MCLG equals zero for a particular compound, such as for carcinogens, then the MCL is considered applicable. Such ARARs are available for 1,1-dichloroethene, 1,2-dichloroethene, 1,2-dichloroethane, 1,1,1-trichloroethane, and trichloroethene. No ARAR (i.e., an MCLG or MCL) is available for 1,1-dichloroethane. MCLGs and MCLs apply to both near-site and distant off-site groundwater for both the current and future land use scenarios since nearby residents and distant off-site residents were assumed to potentially ingest groundwater in both scenarios. Table 5-1 presents the exposure point concentrations for near-site groundwater, for the future land use scenario and distant off-site groundwater, for both the current and future land use scenarios. The chemical-specific ARARs (i.e., the MCLGs or MCLs) have been provided for comparison. The compounds-of-interest in near-site groundwater for the future land use scenario with exposure point concentrations that exceed their respective ARAR include:

- 1,1-dichloroethene; and
- trichloroethene.

For the other compounds-of-interest in near-site groundwater (e.g., 1,2-dichloroethene, 1,2-dichloroethane, and 1,1,1-trichloroethane), the exposure point concentration was below the chemical-specific ARAR. The compound having an exposure point concentration exceeding its ARAR in distant off-site groundwater under the existing land use scenario is:

- trichloroethene.

For the future land use scenario, compounds having exposure point concentrations exceeding their respective ARARs in distant off-site groundwater include:

- 1,1-dichloroethene; and
- trichloroethene.

5.1.3 Surface Water and Sediment

There are no ARARs for surface water and sediment associated with the Plant site.

5.2 PUBLIC HEALTH RISK CHARACTERIZATION: CURRENT LAND USE SCENARIO

This section discusses potential health effects to possible on-site and off-site receptors for the current land use scenario. The health effects presented are potential cancer risks and chronic hazard indices. These potential health effects are estimated for each receptor and are broken down by intake route and compound. By partitioning the cancer risks and chronic hazard indices in this manner, intake routes and compounds contributing the most to the predicted health effects can be identified.

5.2.1 On-Site Maintenance Worker

The on-site maintenance worker was assumed to be exposed to compounds-of-interest in on-site surface soils via incidental ingestion and dermal contact. Potential health effects were evaluated for the on-site maintenance worker from each potential source area and the risks were combined to estimate a total risk. Data regarding potential health effects to on-site maintenance workers from exposure to soils was only presented for soils in the Pump House and Railroad Dock areas as no compounds-of-interest were identified for Remote Fill Line, Degreasing Fluid Storage Tank, and Old Waste Drum Storage areas. Therefore, it was assumed that no risk would result from exposure to soils from these potential source areas.

Carcinogenic Risk

Table 5-2 presents the cancer risk to the maintenance worker and also presents the percent of the total carcinogenic health risk by intake route. The total carcinogenic health risk for the on-site maintenance worker was calculated to be 1.54×10^{-7} which is less than the 10^{-4} to 10^{-6} acceptable cancer risk range specified by EPA. The exposure pathway contributing the most to the overall carcinogenic health risk was incidental ingestion of on-site surface soils (61%), with dermal contact with on-site surface soils contributing the remaining 39%. Potential carcinogenic health risks were due to exposure to PCBs in Pump House Area soils which accounted for 100% of the cancer risk.

Chronic Hazard Index

Table 5-3 presents the chronic hazard index for the on-site maintenance worker and also presents the percent of total hazard index by chemical and exposure pathway. The total hazard index for the on-site maintenance worker was calculated to be less than 0.01, which indicates that chronic intakes are well below the acceptable chronic threshold level of 1.

Incidental ingestion of on-site surface soils accounted for approximately 61% of the total chronic non-carcinogenic hazard index with dermal contact with on-site surface soils accounting for the remaining 39% of the risk. Direct contact exposures to Pump House Area soil accounted for 69% of the total hazard index with direct contact exposures to railroad dock area soils accounting for approximately 31% of the total. The compounds contributing to the hazard index include 1,1,1-trichloroethane (1,1,1-TCA; 58%), xylenes (31%), and 1,1-dichloroethane (1,1-DCA; 11%).

5.2.2 Nearby Resident Adults

Nearby resident adults, in the current and future land use scenario, are exposed to compounds-of-interest in near-site groundwater through potable water uses and irrigation uses of groundwater. The exposure pathways for potable water uses include ingestion, dermal contact while showering, and inhalation of volatiles while showering. Exposure pathways from irrigation uses of groundwater include inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil.

Since nearby residents in both the current and future land use scenarios have identical exposure pathways and exposure point concentrations, the potential health risks to these receptors are the same for both scenarios. Therefore, the discussion of potential health effects for nearby resident adults, children and young children provided here for the current land use scenario is applicable for these receptors in the future land use scenario.

The discussion of potential health effects to nearby residents will be done in two parts. The first part will presents the potential health effects to nearby residents from irrigation uses of groundwater. The second part will present the potential health effects to nearby residents from potable uses and irrigation uses. The presentation of the results into two discussions was done because, with the installation of municipal water mains near the site, potable water uses are less likely to occur than irrigation uses of groundwater. Also, individuals that currently have a well, but are using municipal water for household use, are more likely to be exposed to groundwater via irrigation uses. Therefore, exposures from irrigation uses of groundwater are expected to occur more frequently than exposures from potable uses.

<u>Carcinogenic Risk</u>

Table 5-4 presents the carcinogenic health risk to nearby resident adults for the current and future land use scenario. This table also presents the percent of the total cancer

risk by chemical and pathway. The cancer risk for nearby resident adults to irrigation uses of groundwater was calculated to be 1.49×10^{-7}. The exposure pathway contributing the majority to the overall cancer risk is dermal contact with irrigated soil (54%), followed by inhalation of volatiles and fugitive dusts from irrigated soils accounting for 24% and inhalation of volatiles from irrigation accounting for 21%. 1,1-Dichloroethene (1,1-DCE) accounted for 51% of the risk with trichloroethene (TCE) contributing 48% of the risk.

The total cancer risk from irrigation and potable uses of groundwater for nearby resident adults was calculated to be 2.71×10^{-4} which slightly exceeds the 10^{-4} to 10^{-6} acceptable cancer risk range specified by EPA. The exposure pathway contributing the most to the overall carcinogenic health risk was ingestion of groundwater (approximately 88.5% of the total), with the balance of the risk primarily from the inhalation of volatiles while showering (11%). The remaining exposure pathways; dermal contact with groundwater, dermal contact with irrigated soil, and inhalation of volatiles and fugitive dusts from irrigated soils, all contributed less than 1% of the total when combined. The compounds contributing to the overall carcinogenic health risk were 1,1-DCE, which contributed 71% to the total, and TCE, which contributed 28% to the overall risk. 1,2-DCA contributed approximately 1% to the overall risk. The only pathway that, by itself (all compounds combined), exceeded the 10^{-4} to 10^{-6} risk range was groundwater ingestion. Risks from each compound, when considered by themselves (all pathways combined), were within the 10^{-4} to 10^{-6} acceptable risk range, except for 1,1-DCE which had a combined total risk of 1.79×10^{-4} for all pathways.

Chronic Hazard Index

Table 5-5 presents the chronic hazard index to nearby resident adults and provides the percent of total hazard index by chemical and exposure pathway. The total hazard index from irrigation uses of groundwater was less than 0.01. The total hazard index for the off-site resident adult from irrigation uses and potable uses of groundwater was approximately 0.06, which indicates that chronic intakes are well below the acceptable threshold level of 1. As observed above, the exposure pathway contributing the most to the overall hazard index was groundwater ingestion (99%). All of the other pathways contributed 1% or less of the total hazard index. The compounds contributing to the hazard index include 1,1-DCE (69%), 1,1,1-TCA (23%), total 1,2-DCE (6.5%), and 1,1-DCA (1.5%).

5.2.3 Nearby Resident Children

Similar to nearby resident adults, nearby resident children (aged 2 to 18 years), in the current and future land use scenario, are exposed to compounds-of-interest in near-site

groundwater via ingestion, dermal contact while showering, inhalation of volatiles while showering, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil. As noted above for nearby resident adults, the results reported here for the current land use scenario is applicable for the future land use scenario.

Carcinogenic Risk

Table 5-6 presents the carcinogenic health risk to nearby resident children and also provides a summary of the percent of the total cancer risk by compound and pathway. The cancer risk for nearby resident children to irrigation uses of groundwater was calculated to be 2.62×10^{-7}. The exposure pathway contributing the majority to the overall cancer risk is dermal contact with irrigated soil (72%) with 1,1-DCE accounted for 54% of the risk with trichloroethene (TCE) contributing 45% of the total risk.

The total cancer risk for the nearby resident children from irrigation uses and potable water uses of groundwater was calculated to be 2.3×10^{-4} which slightly exceeds the 10^{-4} to 10^{-6} acceptable cancer risk level specified by EPA. As with nearby resident adults, cancer risks to nearby resident children come primarily from ingestion of groundwater (85%) and inhalation of volatiles from showers (14.5%). The other exposure pathways contributed less then 1% of the total carcinogenic health risk when combined. Risks were primarily from 1,1-DCE, contributing 70%, and TCE, contributing 29% to the total risk. 1,2-DCA contributed approximately 1% to the total risk. It should be noted that the risks from only one pathway (all compounds combined), ingestion groundwater; and from only one compound (all pathways combined), 1,1-DCE, exceeded the acceptable risk range of 10^{-4} to 10^{-6}.

Chronic Hazard Index

Table 5-7 presents the chronic hazard index to nearby resident children and also provides a summary of the percent of total hazard index by compound and pathway. The total hazard index from irrigation uses of groundwater was less than 0.01. The total hazard index for the nearby resident children from irrigation and potable water uses was calculated to be 0.08, which is well below the acceptable chronic threshold level of 1. The majority of the chronic hazard index is from groundwater ingestion (98%), with inhalation of volatiles in shower room air contributing approximately 2%. 1,1-DCE contributed 69%, 1,1,1-TCA contributed 23%, total 1,2-DCE contributed 6%, and 1,1-DCA contributed 2% to the total hazard index.

5.2.4 Nearby Resident Young Children

Nearby resident young children (aged 2 to 6 years), in the current land use scenario, are exposed to compounds-of-interest in near-site groundwater via groundwater ingestion, dermal contact while bathing, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil.

Carcinogenic Risk

Table 5-8 presents the carcinogenic health risk to nearby resident young children and also provides a summary of the percent of the total cancer risk by compound and pathway. The cancer risk for nearby resident children to irrigation uses of groundwater was calculated to be 1.05×10^{-7}. The exposure pathway contributing the majority to the overall cancer risk is dermal contact with irrigated soil (66%) with 1,1-DCE accounted for 54% of the risk with trichloroethene (TCE) contributing approximately 46% of the total risk.

The total cancer risk for nearby resident young children from irrigation uses and potable water uses of groundwater was calculated to be 1.19×10^{-4} which only slightly exceeds the acceptable cancer risk range of 10^{-4} to 10^{-6} specified by EPA. As with adults, cancer risks to nearby resident young children come primarily from groundwater ingestion which accounts for nearly 100% of the total carcinogenic health risk. The risks were primarily from 1,1-DCE, contributing 74%, and TCE, contributing 25% to the total carcinogenic health risk. 1,2-DCA contributed approximately 1% to the total risk.

Chronic Hazard Index

Table 5-9 presents the chronic hazard index for nearby resident young children and also provides a summary of the percent of total hazard index by compound and pathway. The total hazard index from irrigation uses of groundwater was less than 0.01. The total hazard index for the nearby resident young children from irrigation and potable water uses was calculated to be 0.16, which is below the acceptable chronic threshold level of 1. As with potential carcinogenic effects, the majority of the chronic hazard index is from ingestion of groundwater (approximately 100%). 1,1-DCE contributed 70%, 1,1,1-TCA contributed 22%, total 1,2-DCE contributed 7%, and 1,1-DCA contributed 1% to the overall chronic hazard index.

5.2.5 Distant Off-Site Resident Adults

Distant off-site resident adults, in the current land use scenario, are exposed to compounds-of-interest in distant off-site groundwater via ingestion, dermal contact while showering, inhalation of volatiles while showering, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated soil and inhalation of volatiles and fugitive dusts from irrigated garden soil.

Carcinogenic Risk

Table 5-10 presents the carcinogenic health risk to distant off-site resident adults for the current land use scenario. This table also presents the percent of the total cancer risk by chemical and pathway. The total cancer risk for the distant off-site resident adult was calculated to be 1.38×10^{-4} which only slightly exceeds the 10^{-4} to 10^{-6} cancer risk range specified by EPA. The exposure pathway contributing the most to the overall carcinogenic health risk was ingestion of groundwater (approximately 88% of the total), with the balance of the risk primarily from the inhalation of volatiles while showering (11%). The remaining exposure pathways; dermal contact with groundwater, dermal contact with irrigated soil, and inhalation of volatiles and fugitive dusts from irrigated soils, all contributed less than 1% of the total when combined. The compounds contributing to the overall carcinogenic health risk were 1,1-DCE, which contributed 70% to the total, and TCE, which contributed 28% to the overall risk. 1,2-DCA contributed approximately 2% to the overall risk. The only pathway that, by itself (all compounds combined), exceeded the 10^{-4} to 10^{-6} risk range was groundwater ingestion. Risks from each compound, when considered by themselves (all pathways combined), were within the 10^{-4} to 10^{-6} acceptable risk range.

Although these risks were calculated in the current land use scenario, it has not been established whether receptors at this location actually ingest groundwater or if the groundwater ingested actually contains compounds-of-interest. Depending on the actual situation, actual risks could be much lower, possibly even zero. However, the assumptions made for distant off-site residents in the current scenario were made conservatively so that actual risks would not be underestimated.

Chronic Hazard Index

Table 5-11 presents the chronic hazard index for distant off-site resident adults and provides the percent of total hazard index by chemical and exposure pathway. The total hazard index for the off-site resident adult was approximately 0.03, which indicates that chronic intakes are well below the acceptable threshold level of 1. As observed above, the

exposure pathway contributing the most to the overall hazard index was groundwater ingestion (99%). All of the other pathways contributed less than 1% of the total. The compounds contributing to the hazard index include 1,1-DCE (74%), total 1,2-DCE (14%), 1,1,1-TCA (9%), and 1,1-DCA (3%).

5.2.6 Distant Off-Site Resident Children

Similar to distant off-site resident adults, distant off-site resident children (aged 2 to 18 years), in the current land use scenario, are exposed to compounds-of-interest in distant off-site groundwater via ingestion, inhalation of volatiles while showering, dermal contact with groundwater while showering, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil.

Carcinogenic Risk

Table 5-12 presents the carcinogenic health risk to distant off-site resident children and also provides a summary of the percent of the total cancer risk by compound and pathway. The total cancer risk for distant off-site resident children was calculated to be 1.17 x 10^{-4} which only slightly exceeds the 10^{-4} to 10^{-6} acceptable cancer risk level specified by EPA. As with distant off-site resident adults, cancer risks to distant off-site resident children come primarily from ingestion of groundwater (85%) and inhalation of volatiles from showers (15%). All other exposure pathways contributed less then 1% of the total carcinogenic health risk when combined. The risks were primarily from 1,1-DCE, contributing 69%, and TCE contributing 29% to the total risk. 1,2-DCA contributed approximately 2% to the total risk. It should be noted that the risks from any one pathway (all compounds combined) and from any one compound (all pathways combined) falls within the acceptable EPA risk range of 10^{-4} to 10^{-6}.

Chronic Hazard Index

Table 5-13 presents the chronic hazard index to distant off-site resident children and also provides a summary of the percent of total hazard index by compound and pathway. The total hazard index for distant off-site resident children was calculated to be 0.04, which is well below the acceptable chronic threshold level of 1. The majority of the chronic hazard index is from groundwater ingestion (99%), with inhalation of volatiles in shower room air contributing approximately 1%. 1,1-DCE contributed 74%, total 1,2-DCE contributed 14%, 1,1,1-TCA contributed 9%, and 1,1-DCA contributed 3% to the total hazard index.

5.2.7 Distant Off-Site Resident Young Children

Distant off-site resident young children (aged 2 to 6 years), in the current land use scenario, are exposed to compounds-of-interest in distant off-site groundwater via groundwater ingestion, dermal contact while bathing, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil.

Carcinogenic Risk

Table 5-14 presents the carcinogenic health risk to distant off-site resident young children and also provides a summary of the percent of the total cancer risk by compound and pathway. The total cancer risk for the distant off-site resident young children was calculated to be 6.07×10^{-5} which falls within the acceptable cancer risk range of 10^{-4} to 10^{-6} specified by EPA. As with adults, cancer risks to distant off-site resident young children come primarily from groundwater ingestion which accounts for nearly 100% of the total carcinogenic health risk. The risks were primarily from 1,1-DCE, contributing 72%, and TCE, contributing 25% to the total carcinogenic health risk. 1,2-DCA contributed approximately 2% to the total.

Chronic Hazard Index

Table 5-15 presents the chronic hazard index for distant off-site resident young children and also provides a summary of the percent of total hazard index by compound and by pathway. The total hazard index for the distant off-site resident young children was calculated to be 0.08, which is well below the acceptable chronic threshold level of 1. The majority of the chronic hazard index is from ingestion of groundwater (approximately 100%). 1,1-DCE contributed 75%, total 1,2-DCE contributed 14%, 1,1,1-TCA contributed 9% and 1,1-DCA contributed 3% to the overall chronic hazard index.

5.3 PUBLIC HEALTH RISK CHARACTERIZATION: FUTURE LAND USE SCENARIO

This section discusses potential health effects to possible on-site and off-site receptors for the future land use scenario. In order to interpret the health effects for the future land use scenario, some of the assumptions made in Section 3 must be reviewed. First, the concentrations of compounds-of-interest in on-site surface soils are assumed to remain the same. This is considered very conservative since future concentrations should actually be

less due to normal removal mechanisms (i.e., biodegradation, photolysis, abiotic dechlorination, etc.).

Second, the concentrations of compounds-of-interest in near-site groundwater are assumed to remain the same. This assumption is assumed to be valid considering the current on-site groundwater pump and treat system. The concentrations in near-site groundwater should actually decrease over time since the pump and treat system should contain and reduce the on-site source (i.e., on-site groundwater). However, without more substantive information on off-site groundwater conditions and flows at the site, future near-site groundwater concentrations are assumed to remain the same as those presented for the current land use scenario.

Third, future concentrations of compounds-of-interest in distant off-site groundwater were assumed to be the same as those for near-site groundwater in the current land use scenario. The actual concentrations of compounds-of-interest may be much less than what was presented in the current land use scenario. Therefore, to assume that the exposure point concentrations in the future land use scenario actually increase is conservative and health-protective. Near-site groundwater was assumed to be at a location hydraulically up-gradient of distant off-site groundwater. It is anticipated that the compounds-of-interest in near-site groundwater would decrease, as a result of dilution and dispersion, before reaching distant off-site groundwater.

5.3.1 On-Site Maintenance Worker

The estimated carcinogenic risks and hazard indices for the on-site maintenance worker for the future land use scenario are identical to those estimated for the current land use scenario. Thus, the discussion of these health effects in Section 5.2.1 is applicable and will not be repeated here.

5.3.2 Nearby Residents

Nearby residents in the future land use scenario (as in the current land use scenario) are exposed to compounds-of-interest in near-site groundwater via ingestion, dermal contact while showering, inhalation of volatiles while showering, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil. As identified in Section 5.2 above, the potential exposure pathways and exposure point concentrations are identical for both the current and future land use scenarios. Therefore, the discussions provided for potential health effects to nearby resident adults, children and young children in Sections 5.2.2, 5.2.3,

and 5.2.4 are applicable for nearby residents in the future land use scenario.

5.3.3 Distant Off-Site Resident Adults

Distant off-site resident adults, in the future land use scenario, are exposed to compounds-of-interest in distant off-site groundwater via ingestion, dermal contact while showering, inhalation of volatiles while showering, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil.

It should be noted that the exposure assumptions for distant off-site residents (i.e., adults, children, and young children) are identical to those identified for nearby residents for the future scenario. In addition, the exposure point concentrations are assumed to be the same for these two receptors groups. Therefore, the results and following discussion for distant off-site residents in the future scenario duplicates the discussion provided above for nearby residents.

Carcinogenic Risk

Table 5-16 presents the carcinogenic health risk to distant off-site resident adults for the current land use scenario. This table also presents the percent of the total cancer risk by chemical and pathway. The total cancer risk for distant off-site resident adults was calculated to be 2.71×10^{-4} which slightly exceeds the 10^{-4} to 10^{-6} acceptable cancer risk range specified by EPA. The exposure pathway contributing the most to the overall carcinogenic health risk was ingestion of groundwater (approximately 88.5% of the total), with the balance of the risk primarily from the inhalation of volatiles while showering (11%). The remaining exposure pathways; dermal contact with groundwater, dermal contact with irrigated soil, and inhalation of volatiles and fugitive dusts from irrigated soils, all contributed less than 1% of the total when combined. The compounds contributing to the overall carcinogenic health risk were 1,1-DCE, which contributed 71% to the total, and TCE, which contributed 28% to the overall risk. 1,2-DCA contributed approximately 1% to the overall risk. The only pathway that, by itself (all compounds combined), exceeded the 10^{-4} to 10^{-6} risk range was groundwater ingestion. Risks from each compound, when considered by themselves (all pathways combined), were within the 10^{-4} to 10^{-6} acceptable risk range, except for 1,1-DCE which had a combined total risk of 1.79×10^{-4} for all pathways.

Chronic Hazard Index

Table 5-17 presents the chronic hazard index to distant off-site resident adults and

provides the percent of total hazard index by chemical and exposure pathway. The total hazard index for off-site resident adult was approximately 0.06, which indicates that chronic intakes are well below the acceptable chronic threshold level of 1. As observed above, the exposure pathway contributing the most to the overall hazard index was groundwater ingestion (99%). All of the other pathways contributed 1% or less of the total. The compounds contributing to the hazard index include 1,1-DCE (69%), 1,1,1-TCA (23%), total 1,2-DCE (6.5%), and 1,1-DCA (2%).

5.3.4 Distant Off-Site Resident Children

Similar to distant off-site resident adults, distant off-site resident children (aged 2 to 18 years), in the future land use scenario, are exposed to compounds-of-interest in distant off-site groundwater via ingestion, dermal contact while showering, inhalation of volatiles while showering, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil.

Carcinogenic Risk

Table 5-18 presents the carcinogenic health risk to distant off-site resident children and also provides a summary of the percent of the total cancer risk by compound and pathway. The total cancer risk for distant off-site resident children was calculated to be 2.3 x 10^{-4} which slightly exceeds the 10^{-4} to 10^{-6} acceptable cancer risk level specified by EPA. As with distant off-site resident adults, cancer risks to distant off-site resident children come primarily from ingestion of groundwater (85%) and inhalation of volatiles from showers (14.5%). The other exposure pathways contributed less then 1% of the total carcinogenic health risk when combined. The risks were primarily from 1,1-DCE, contributing 70%, and TCE, contributing approximately 29% to the total risk. 1,2-DCA contributed approximately 1% to the total risk. It should be noted that the risks from only one pathway (all compounds combined), ingestion groundwater; and from only one compound (all pathways combined), 1,1-DCE, exceeded the acceptable risk range of 10^{-4} to 10^{-6}.

Chronic Hazard Index

Table 5-19 presents the chronic hazard index to distant off-site resident children and also provides a summary of the percent of total hazard index by compound by pathway. The total hazard index for the distant off-site resident children was calculated to be 0.08, which is well below the acceptable chronic threshold level of 1. The majority of the chronic hazard index is from groundwater ingestion (98%), with inhalation of volatiles in shower room air contributing approximately 2%. The compounds contributing to the hazard index include

1,1-DCE (contributed 69% of the total), 1,1,1-TCA (23%), total 1,2-DCE (6.5%), and 1,1-DCA (approximately 2%).

5.3.5 Distant Off-Site Resident Young Children

Distant off-site resident young children (aged 2 to 6 years), in the current land use scenario, are exposed to compounds-of-interest in distant off-site groundwater via groundwater ingestion, dermal contact while bathing, inhalation of volatiles while irrigating with groundwater, dermal contact with irrigated garden soil and inhalation of volatiles and fugitive dusts from irrigated garden soil.

Carcinogenic Risk

Table 5-20 presents the carcinogenic health risk to distant off-site resident young children and also provides a summary of the percent of the total cancer risk by compound and pathway. The total cancer risk for distant off-site resident young children was calculated to be 1.19×10^{-4} which only slightly exceeds the acceptable cancer risk range of 10^{-4} to 10^{-6} specified by EPA. As with adults, cancer risks to distant off-site resident young children come primarily from groundwater ingestion which accounts for nearly 100% of the total carcinogenic health risk. The risks were primarily from 1,1-DCE, contributing 73.5%, and TCE, contributing 25% to the total carcinogenic health risk. 1,2-DCA contributed approximately 1% to the total risk.

Chronic Hazard Index

Table 5-21 presents the chronic hazard index for distant off-site resident young children (aged 2 to 6 years) and also provides a summary of the percent of total hazard index by compound and pathway. The total hazard index for distant off-site resident young children was calculated to be 0.16, which is below the acceptable chronic threshold level of 1. The majority of the chronic hazard index is from ingestion of groundwater (approximately 100%). 1,1-DCE contributed 70%, 1,1,1-TCA contributed 22%, total 1,2-DCE contributed 6.5%, and 1,1-DCA contributed 1% to the overall chronic hazard index.

5.4 UNCERTAINTY ANALYSIS

The sources of uncertainty for the risk characterization include: uncertainty in the selection of compounds-of-interest; uncertainty in the assumptions for both the current and future land use scenarios; exposure assessment, and toxicity assessment; and uncertainty

associated with combining of the exposure assumptions and toxicity assumptions for the risk characterization. Below is a qualitative discussion of the key site-related variables and assumptions that contribute most of the uncertainty to the risk assessment.

5.4.1 Uncertainties Involving the Selection of Compounds-of-Interest

The compounds-of-interest identified in the Phase II, Sampling and Analysis Plan (Rizzo, 1989b), for chemical analysis include the TCL volatiles, bis(2-ethylhexyl)phthalate, and PCBs (in Pump House Area soil only). These compounds were identified as compounds-of-interest based on compounds used in various plant processes (primarily TCE and 1,1,1-TCA and their derivatives) and those compounds observed in various site media (e.g., on-site surface soils and groundwater; and off-site surface water, sediments and groundwater) from previous investigations. While some additional compounds were detected in various site media, they were eliminated from the analysis because they are either common laboratory contaminants, they are ubiquitous in the environment, or their presence is due to alternative sources not generated by operations at the Plant site. The compounds-of-interest for the Phase II investigation were then subjected to further evaluation in the risk assessment. Compounds were eliminated from the risk assessment if they are common laboratory contaminants and not compounds associated with site operations, if they were found at or near background levels or if they were not identified in any site media. Following the data evaluation, a list of compounds-of-interest was provided for the different media (e.g., on-site surface soils, on-site and off-site groundwater, surface water, and sediments) for the quantitative risk assessment. This master list of compounds-of-interest includes:

- 1,1-dichloroethene;
- 1,1-dichloroethane;
- total 1,2-dichloroethene;
- 1,2-dichloroethane;
- 1,1,1-trichloroethane;
- trichloroethene;
- xylenes; and
- PCB-1254.

A more detailed list of compounds-of-interest by media and location is provided in Table 2-21.

Of the compounds-of-interest selected for the quantitative risk assessment, TCE was

the most prevalent compound. The other compounds were detected at much lower concentrations with some that were reported at or near the detection limit. Many compounds were retained as compounds-of-interest for the quantitative risk assessment because they are degradation compounds of TCE or 1,1,1-TCA, the chemicals actually used in the degreasing operations at the site. Therefore, the probability of underestimating actual risks is low.

5.4.2 Uncertainties Involving Land Use Scenarios

The exposure pathways (and receptors) identified in this risk assessment were developed following a site visit and a preliminary review of site data. The likelihood of exposure to compounds-of-interest by potential receptors identified in this risk assessment may not occur and is a source of some uncertainty.

Current Land Use Scenario

For the current land use scenario, the on-site receptors identified included the on-site maintenance worker (i.e., an individual who would be exposed to compounds-of-interest in on-site surface soils). This receptor was identified based on a review of existing site operations and was selected for further evaluation. The maintenance worker, when compared to an office worker or plant worker, was assumed to have the highest potential exposure to compounds-of-interest in on-site soils. The other two potential on-site receptor groups (i.e., office worker and plant worker) were assumed to come into contact with compounds-of-interest in surface soils very infrequently, if at all.

Potential off-site receptors include nearby residents and distant off-site residents. These receptors were identified as hypothetical off-site groundwater users. Nearby residents were identified as potential receptors because of the potential use of groundwater for irrigation purposes and for domestic uses (i.e., a potable water source). An alternative potable water source has been provided for residents near the Plant site. However, a detailed accounting of near-site groundwater uses is currently not available.

The distant off-site resident was identified as a potential receptor because of the uncertainty associated with the delineation of off-site groundwater contamination down-gradient from the site. The deep down gradient groundwater monitoring well, PMW-16B, installed and sampled during the Phase II investigation, showed total volatile concentrations of 250 ppb, approximately 1000 feet east of the Plant site property boundary. The extent of COI in groundwater east of this well is currently not known. A conservative approach was taken which evaluated a distant off-site groundwater user that used groundwater as a

potable water source. Due to the uncertainty in the extent of COI in groundwater, the concentrations of the compounds-of-interest in PMW-16B were used to estimate exposure point concentrations for distant off-site residents. It is likely that the actual concentrations of compounds-of-interest are much lower than estimated for the current land use scenario. For both off-site groundwater use scenarios (i.e., the near-site groundwater user and distant off-site groundwater user), potential health risks were evaluated for a residential scenario and potential risks were calculated for adults, children, and young children.

To summarize, the uncertainties associated with the receptors chosen for the current land use scenario include:

For on-site maintenance workers:

- On-site maintenance workers were chosen for the quantitative risk assessment because they were assumed to have the greatest potential contact with on-site surface soils. It is unlikely that the other on-site workers (e.g., office workers and plant workers) would experience greater exposures. Therefore, the uncertainty associated with underestimating risks to these individuals is low.

For nearby residents:

- Since it is not known whether near-site groundwater is actually used for irrigation or ingestion, the assumption that it is used is for these purposes is conservative. However, irrigation uses are much more likely to occur than potable uses. Also, if groundwater is used, assuming that concentrations of compounds-of-interest in on-site monitoring wells are representative of near-site groundwater concentrations is conservative. Considering these two assumptions, it is likely that potential exposures are underestimated for nearby residents in the current or future land use scenarios. The likelihood of overestimation of risks to nearby residents is moderate.

For distant off-site residents:

- The presence of compounds-of-interest east of the Plant site is currently not known. However, to assume that a distant off-site resident is using groundwater as a potable water source and that the exposure point concentrations at this location are equal to the

concentration at monitoring well PMW-16B is very conservative. Therefore, it is unlikely that risks to distant off-site residents will be underestimated. The uncertainty associated with overestimation of risk is considered low to moderate.

Future Land Use Scenario

For the future land use scenario, the receptors identified for the current land use scenario were assumed applicable. No on-site receptors other than maintenance workers were added because future uses of the site are assumed to be industrial. This assumption is considered valid as the land is zoned commercial/ industrial and operations at the plant are currently on-going. No additional future off-site receptors were identified since the receptors identified for the current land use scenario were sufficient to identify all potential existing and future exposure pathways.

To summarize, the uncertainties regarding the receptors chosen for the future land use scenario include:

For on-site maintenance workers:

- Similar to the uncertainty presented above for the current land use scenario, the uncertainty associated with underestimating risks to on-site maintenance workers is low for the future land use scenario.

For nearby residents:

- Since an alternative potable water source has been provided for most nearby residents, it is very conservative to assume future groundwater ingestion. Therefore, the overestimation of risk to nearby residents in the future land use scenario is considered to be moderate.

For distant off-site residents:

- As identified above for the current land use scenario, the extent of contamination to the east of the Plant site is currently not known. However, to assume that future groundwater concentrations for compounds-of-interest equals current near-site groundwater concentrations is very conservative for two reasons:

- If distant off-site groundwater was contaminated, future concentrations would be less than near-site groundwater because of dilution and dispersion.

- On-site monitoring wells were used to estimate near-site groundwater contamination. It is very conservative to assume distant off-site groundwater concentrations would equal the concentrations detected in on-site monitoring wells.

Therefore, the overestimation of risk to distant off-site residents in the future land use scenario is assumed to be moderate.

5.4.3 Uncertainties in the Exposure Assessment

A variety of uncertainties are associated with the exposure assessment portion of the risk assessment at the Plant site, as discussed in Section 3.7. Seven exposure pathways were evaluated for seven receptors in two land use scenarios. These exposure pathways include:

- incidental ingestion of on-site surface soils;
- dermal contact with on-site surface soils;
- ingestion of groundwater;
- dermal contact with groundwater while showering or bathing;
- inhalation of volatiles while showering;
- inhalation of volatiles from groundwater while irrigating;
- dermal contact with irrigated soils; and
- inhalation of volatiles and fugitive dusts from irrigated soils.

The uncertainties for the exposure assessment were discussed in detail in Section 3.7. A summary of the uncertainty associated with the exposure assessment is provided below.

Uncertainties in the exposure assessment include those associated with environmental sampling, analysis and data evaluation, those associated with fate and transport, and those associated with exposure parameter estimation.

The uncertainties associated with sampling, analysis and data evaluation include:

- the number of samples collected;
- the choice of parameters analyzed;

- the actual chemical analysis performed;
- sample analytical detection limits; and
- the combining of data from the different investigations.

The uncertainties associated with fate and transport include:

- the calculation of a potential source concentration;
- the fate and transport models used; and
- the specific fate and transport assumptions used within each model.

The estimation of the source concentration based on the upper 95% confidence level or maximum is considered very conservative. In addition, the assumptions for the fate and transport models were conservatively chosen to prevent an underestimation of the exposure point concentrations and calculated risk. The overestimation of risks associated with fate and transport modeling and the calculation of exposure point concentrations is considered low to moderate.

The uncertainties associated with the exposure parameter estimation include:

- the standard assumptions regarding ingestion rates, period exposed, life expectancy, etc.;
- the use of body surface area and body weight assumptions;
- the assumption that the amount of media intake is assumed to be constant and representative;
- the assumption of an absorption factor of 1 or 100% for all exposure pathways; and
- the assumptions associated with daily lifetime exposures.

Current EPA guidance requires the use of reasonable maximum exposure (RME) assumptions for all receptor-exposure pathways. The use of RME assumptions is intended to estimate intakes to even the most exposed or sensitive sub-populations to ensure that the risk assessment is protective of human health and the environment. However, the intake calculated with RME assumptions will overestimate intake to the population on the average.

5.4.4 Uncertainties Associated with the Toxicity Assessment

Uncertainties associated with the toxicity assessment were discussed in great detail in Section 4.5. A summary of these uncertainty is provided below.

As stated in Section 4.5, the degree of uncertainty associated with quantitative indices of toxicity is dependent on both the strength of evidence and confidence of these indices. For non-carcinogenic effects, an uncertainty factor is used in calculating an RfD and reflects scientific judgement regarding the various types of data used to estimate RfD values. Based on a series of 10 fold safety factors uncertainty is accounted for in RfD's.

For carcinogens, uncertainties are compensated for by using upper bounds for cancer slope factors. Cancer slope factors are estimated through the use of mathematical models for estimating the largest possible linear slope at low extrapolated doses that is consistent with the experimental data. The slope factor is characterized as an upper-bound estimate, where at best, the dose-response assumptions used in a risk assessment provide a rough but plausible estimate of the upper limit of risk, i.e. it is not likely that the true risk would be much more than the estimated risk, but it could very well be considerably lower, even approaching zero (HEAST, 1990).

In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given compound. The summation of the risks associated with all potential carcinogens, which is done for each evaluated exposure pathway, tends to overestimate risk by including probable human carcinogens (Group B) with demonstrated human carcinogens (Class A).

The methodology typically employed to estimate cancer slope factors (i.e., extrapolating from risks generated at high doses in animal studies to risks at low doses) has considerable uncertainty associated with it suggesting that risks estimated with this methodology could greatly overestimate actual risks. Thus as stated in Section 4.6, the current practice of assuming that carcinogenic effects do not exhibit threshold behavior and assuming that carcinogenic effects observed at high doses in test animals can be used to predict cancer effects at lower doses is likely to be incorrect, at least for some compounds.

5.4.5 Uncertainties Associated with the Risk Characterization

Uncertainties associated with the risk characterization portion of the risk assessment of the Plant site are a combination of the uncertainties evaluated through both exposure assessment and toxicity assessment. As discussed above, the assumptions used for both the exposure and toxicity assessment are conservative. While the use of conservative assumptions within itself tends to overstate the actual risk to the population on the average, the use of RME assumptions are made to ensure protection of even the most exposed or sensitive sub-populations that may be associated with compounds-of-interest at a site.

5.5 SUMMARY OF PUBLIC HEALTH RISK CHARACTERIZATION

This section presented the public health risk characterization of the risk assessment for the Plant site. First, a comparison of exposure point concentrations and chemical-specific ARARs was conducted. Second, a baseline risk characterization was presented for current and future land use conditions. Third, an uncertainty analysis was presented where uncertainties from the exposure and toxicity assessment were discussed to qualify the results of the risk characterization.

6.0 ECOLOGICAL RISK ASSESSMENT

6.1 SITE CHARACTERIZATION

6.1.1 Land Use and Ecology

The Plant site is an elevator and escalator manufacturing facility located on approximately 90 acres in south-central Pennsylvania near Gettysburg. The immediate area outside the plant is gently sloping lawn, landscaped with ornamental trees and shrubs. Previously, the property was a farm and included a pond. North of the Plant is a wooded area; to the south are farmlands and residences; and, the areas west and east are mainly residential. Oak Ridge is west of the site, and unnamed tributaries to Rock Creek are to the north and east of the site. Rock Creek is east of the site and is designated by Pennsylvania as a warm water fishery according to Chapter 93 of the Rules and Regulations of the Pennsylvania Department of Environmental Resources.

The surrounding area is semirural with residential development, light industry and agriculture. Local foliage consists of broad-leafed, deciduous trees, particularly hickory, chestnut, walnut and remnants of Appalachian Oak Forest (USSCS, 1965). The vegetation in the open areas consists mostly of low bushy cover. The Gettysburg area supports an abundant small and big game population, but this region of Pennsylvania has not been identified as habitat for any endangered species (Wolf, 1981). Small game includes cottontail rabbits, ring-necked pheasant, ruffed grouse, doves, squirrels, quail, woodchucks, and raccoons. Big game is limited to an over population of white-tail deer. Common species of amphibians and reptiles include the eastern wood bullfrog, northern dusky salamander, eastern milksnake, and northern fence lizard.

6.1.2 Physical Characteristics of the Plant Site

Surface Water

As identified in Section 2, two intermittent streams drain the site: the Northern Tributary and Eastern Tributary. These tributaries converge and then flow into Rock Creek. Based on discussions with Rizzo Associates (personnel communication Pat O'Hara, Rizzo Associates, January 1990), the Eastern and Northern Tributaries are primarily losing streams (streams that serve to recharge groundwater rather than to serve as discharge points for groundwater), and are dry some portion of the year.

Two storm drain systems, a northern and a southeastern system, collect storm water from the site. The outfall for the northern system is near the northeast boundary of the site along Boyd's School Road and discharges into the Northern Tributary. The southeastern storm drain system discharges through an outfall across from the plant entrance along Biglerville Road into the Eastern Tributary. In addition, there is an on site groundwater pump and treat system (described in the Phase I RI/FS report) that discharges treated groundwater to the Northern Tributary at a permitted NPDES outfall near the northern storm drain outfall.

During Plant construction, the farm pond was filled. The Phase I RI report (Rizzo, 1989) identified a possible spring formerly near the front entrance area to the Plant that may have also been filled.

Soil

The Soil Conversation Service (USSCS, 1967) classified natural soils on site. The natural soils are gently to moderately sloping, shallow to moderately deep shalely soils derived from the underlying Triassic red beds. During Plant construction, natural soils were disturbed near the Plant. The surficial layer of natural soil or fill varies in thickness from 5 to 15 feet. Two to four feet from the surface, the natural soil consists of red to brown clay frequently with fragments of shale.

Within the area of the former pond, the soil is fill and approximately 13 to 20 feet deep. The fill is a mixture of grain sizes ranging from clay to boulders. The fill in the pond was apparently rock cut from the slope to the western border of the plant. Bedrock is beneath the surficial layer, and the former pond was probably constructed by excavating into it. A channel in the bedrock exists and follows the trend of fill under the plant. This bedrock channel passes through the area of the former pond and connects with a shallow, southeast-dipping channel corresponding to the buried drainage system (Phase I RI, Rizzo, 1989).

Groundwater

As described in Section 3.2.3, groundwater flow primarily occurs through bedrock and is intermittent through the largely unsaturated surficial soil layer. The buried depression associated with the former pond may channel groundwater. Once groundwater reaches bedrock, there may be some preferential flow along bedrock fractures that are oriented west to east, just north of the plant. Groundwater generally flows from east to west toward Rock Creek.

Near the plant, the depth of the water table appears to range from 5 to 20 feet below the surface. Groundwater monitoring wells were installed at two depths identified as shallow monitoring wells and deep monitoring wells. Shallow monitoring wells were generally screened at a depth of 40 to 50 feet below the surface and deep groundwater monitoring wells were screened at a depth of 120 to 200 feet below the surface. Groundwater at this depth is anticipated to be too deep to discharge to the tributaries and probably represents groundwater that would eventually discharge to Rock Creek. Monitoring wells were not installed to sample surficial groundwater (i.e., the groundwater that would occasionally discharge into the tributaries).

6.2 ECOLOGICAL HAZARD IDENTIFICATION

6.2.1 Media-of-Interest

Media-of-interest for the ecological assessment are those media through which ecological receptors could contact compounds-of-interest. The media sampled in the Phase I and Phase II investigations at the Plant site include:

- soils;
- groundwater;
- surface water; and
- sediments.

Of these media, only surface water and sediments represent exposure media for ecological receptors. Soils at the Plant site do not represent ecological exposure media because contamination in soils is limited to a few potential source areas around the process buildings. These soils are within or near the process areas at the plant and do not exhibit potential significant exposure points for ecological receptors. Therefore, potential exposures to compounds-of-interest in on-site surface soils were not considered for further evaluation in the ecological assessment. Also, direct contact exposures cannot occur between ecological receptors and compounds-of-interest in groundwater. However, groundwater could serve as a potential source media for ecological receptors if groundwater discharged to surface water. Thus, compounds-of-interest in groundwater were only considered based on the potential for compounds-of-interest in groundwater to discharge into surface water bodies, namely the Eastern and Northern Tributaries.

To summarize, the media-of-interest for the ecological assessment includes surface water and sediments in the Northern and Eastern Tributaries.

6.2.2 Selection of Compounds-of-Interest

Section 2 presented a detailed summary of surface water and sediment data from the Plant site. A review of data for surface water and sediments showed detectable levels of acetone and TCE in surface water and methylene chloride, acetone and bis(2-ethylhexyl)phthalate in sediments. Although surface water and sediments represent different media, the compounds-of-interest for the ecological evaluation for these media were assumed to be the same since some partitioning would occur for compounds between surface water and sediment. Of the four compounds detected in these media, only TCE was considered a compound of interest for the ecological evaluation for three reasons. First, methylene chloride, acetone and bis(2-ethylhexyl)phthalate are common laboratory contaminants. Second, these compounds are not associated with past or current plant processes. Third, these compounds were only detected at concentrations near the detection limit. TCE was detected in one surface water sample and one duplicate sample: SW-1 and SW-1D. The range of concentrations of TCE in surface water was 10 μg/L, in SW-1D, to 11 μg/L, in SW-1. No compounds-of-interest were detected in sediments for the quantitative risk assessment.

The compounds-of-interest for surface water and sediments for the quantitative risk assessment can be expanded to include the compounds-of-interest in groundwater since surficial and possibly shallow groundwater may occasionally discharge to the tributaries. The compounds-of-interest in groundwater include:

- 1,1-dichlorethene;
- 1,1-dichloroethane;
- 1,2-dichloroethene;
- 1,2-dichloroethane;
- 1,1,1-trichloroethane; and
- trichloroethene.

However, many of these compounds were detected at very low concentrations in groundwater when compared to the concentrations of TCE in groundwater. Since TCE accounts for 90 to 95% of total chlorinated aliphatics in groundwater and it was the only compound detected in surface water, TCE will be retained as a surrogate compound to evaluate potential toxicological effects to ecological receptors resulting from exposure to total chlorinated aliphatics.

Three conclusions can be made about fate and transport processes in the tributaries near the site. First, sediments are not currently acting as a source for surface water

contamination. Second, the adsorption of compounds-of-interest to sediments does not appear to be a significant fate mechanism for compounds-of-interest from the site. Third, based on the results from the Phase I and Phase II investigations, it appears that these tributaries are not currently acting as significant migration corridors for compounds-of-interest from the Plant site.

6.2.3 Potential Exposure Pathways

This section identifies potential exposure pathways between the compounds-of-interest in various media at the site and potential ecological receptors. Two potential exposure scenarios were evaluated in the ecological evaluation: exposures for ecological receptors under current conditions; and, potential exposures for ecological receptors under possible future conditions.

Potential exposure pathways under current conditions were based on surface water and sediment data from the Phase I and Phase II investigation, summarized in Section 2. For surface water, potential ecological effects were based on an assessment of toxicity of TCE to aquatic life in the tributaries. For sediment, potential ecological effects were based on an estimate of the interstitial pore water concentration of TCE since toxicity of compounds on sediments is more closely tied to the interstitial concentrations than total sediment concentration (EPA, 1989e). However, since no compounds were detected in sediments, potential ecological effects to benthos under current conditions were assessed assuming interstitial pore water concentrations were the same as surface water concentrations.

For future conditions, potential ecological effects were based on a review of groundwater data that may discharge to surface water. Potential exposure pathways for future conditions included only the toxicity of compounds-of-interest in interstitial pore water to benthic invertebrates.

A qualitative assessment of toxic effects to terrestrial vertebrates will also be made to evaluate potential ecological effects to these receptors based on potential exposures to compounds-of-interest in the tributaries.

6.3 DOSE/RESPONSE ASSESSMENT

Information on the environmental effects of site compounds was obtained from Water Quality Criteria documents, and computer searches of EPA's AQUIRE and PHYTOTOX

data bases. Very little useful data were obtained from the PHYTOTOX data base. Because the AQUIRE data base includes information on the toxicity of the site compounds to aquatic invertebrates and plants that are phylogenetically related to terrestrial species, information on aquatic species was used to evaluate potential ecological effects.

Results of various toxicity studies are summarized in Appendix E and are discussed below for TCE and 1,1,1-TCA.

Trichloroethylene (TCE)

The data on the toxicity of trichloroethylene to fish, invertebrates and plants (algae) from the EPA databases are summarized in Appendix E. Concentrations estimated to kill 50% of test organisms within specified periods of time (LC50s) are on the order of 50,000 μg/L for fish. The lowest reported value was 44,000 μg/L for a 96 hour exposure period. A value of 0.3 of the acute LC50 value was calculated for protection against acute (short term) exposures; this yields a value of 13,230 μg/L for fish. A value of 0.05 of the acute LC50 value was used to derive a concentration that approximates the No Observed Effect Concentration for protection from long-term (chronic) effects. Thus, 2,200 μg/L is a calculated estimate of a threshold value for protection against chronic effects to fish. This value is less than the 5,000 μg/L concentration reported as a LOEL for respiratory effects on fish but greater than the 100 μg/L level found in a long-term study with goldfish. Based on the above information, it is concluded that a 100 μg/L level could be considered a threshold above where chronic effects could occur. Values of 2,200 and 100 μg/L will be used to evaluate potential ecological effects on fish.

The lowest short-term LC50 value reported for invertebrates is 18,000 μg/L; other values generally fall between 25,000 and 75,000 μg/L. Protection against acute effects is estimated as 0.3 x 18,000 μg/L = 5,400 μg/L. Protection against chronic effects is estimated as 0.05 x 18,000 μg/L = 900 μg/L. A NOEL of 2,000 μg/L was measured for short-term toxicity studies with the water flea; this is roughly comparable with the calculated value of 5,400 μg/L.

A literature review on the toxic effects of TCE to small mammals was conducted to provide a basis for assessing risks to small animals drinking water from the tributaries. Results of several studies are summarized in Table 6-1.

Trichloroethane (1,1,1- TCA)

Data on toxicity of trichloroethanes to fish from the EPA databases are provided in Appendix E. The lowest LC50 value measured is 40,000 μg/L; the highest is 133,000 μg/L. Acute and chronic threshold values can be calculated as 0.3 x 40,000 = 12,000 μg/L and 0.05 x 40,000 = 2,000 μg/L.

Among the invertebrates, the lowest LC50 value was estimated to be 18,000 μg/L for the water flea. Acute and chronic threshold values can be calculated as 0.3 x 18,000 = 5,400 μg/L and 0.05 x 18,000 = 900 μg/L. A short-term NOEL of 1,000 μg/L has been measured.

To summarize, the toxicities of TCE and 1,1,1-TCA to fish and invertebrates are very similar. Therefore, the acute and chronic toxicity values for TCE will serve as a surrogate compound to evaluate the toxicity of total chlorinated aliphatics to ecological receptors.

6.4 EXPOSURE ASSESSMENT

6.4.1 Potential Environmental Receptors

Potential environmental receptors include aquatic biota that inhabit the tributaries and terrestrial species that may be associated with these tributaries.

With regard to the tributaries, the major receptors include algal plants, benthic invertebrates, and amphibians. The Eastern and Northern tributaries below the Plant are too small to support fish populations. The Eastern and Northern tributaries flow into Rock Creek which does support fish. TCE was detected near the detection limit at the outfall in the Eastern Tributary (SW-1). This surface water sampling station is approximately 2000 ft upstream from the discharge point of the connecting stream to Rock Creek. Based on dilution, and the flow of this connecting stream, TCE would most likely not be detected at the discharge point of the unnamed stream to Rock Creek. It was assumed that fish within Rock Creek would not be exposed to TCE contaminated surface water.

Benthic invertebrates and plants might encounter compounds-of-interest from discharged groundwater as pore water within the sediments rather than from surface water. Assuming that contaminated groundwater potentially discharges to these tributaries, this discharge is a source of potential exposure to the benthic community and possibly other stream biota.

In the wooded areas near the Plant; small game may include skunk, cottontail rabbits, ring-necked pheasants, ruffed grouse, doves, squirrels, quail, woodchucks, and raccoons. These terrestrial fauna may come in contact with stream water or sediment. Exposure activities include drinking, wading or bathing. Exposure points would include feathers, fur, dermis and pads of feet. Ingestion of the contaminated surface water would be the primary source of exposure to the indigenous fauna.

Deep groundwater flow may migrate toward Rock Creek. Although there is no evidence that compounds-of-interest in on-site groundwater is or is not serving as a source of contaminants to Rock Creek, the potential for future ecological effects in Rock Creek was evaluated based on groundwater monitoring data. Potential ecological effects in Rock Creek could occur to the stream benthic community and possibly stream biota.

6.4.2 Exposure Point Concentrations

Exposure point concentrations were estimated for surface water and interstitial pore water in sediments. The chlorinated aliphatic compounds are expected to have a cumulative effect with regard to toxicity. Therefore, the maximum concentrations of chlorinated aliphatic compounds within a particular medium were added together to yield a maximum potential exposure concentration. This concentration is viewed as a worst-case or upper bound estimate on exposure. Potential exposures were evaluated for individual samples to evaluate potential ecological effects.

Surface Water

For the current conditions, the exposure point concentrations for surface water were based on the maximum concentration detected in a surface water sample, or 11 $\mu g/L$. For future conditions, exposure point concentrations for surface water were estimated based on the interstitial pore water concentrations discussed below.

Inter-Stream Sediments from Groundwater Discharge

Interstitial pore water concentrations were calculated for both the tributaries near the site, and for Rock Creek. Although it is believed that surface water in the tributaries recharge groundwater most of the year (pers. comm., Pat O'Hara, Rizzo Associates, January 1990), surficial groundwater from the site may occasionally discharge to these tributaries. As identified above, no surficial monitoring wells were installed to monitor compounds-of-interest in surficial groundwater. For this analysis, shallow groundwater wells were used to estimate interstitial pore concentrations in the tributaries and Rock Creek under future

conditions. This is considered very conservative and health protective for the ecological risk assessment because the concentrations discharged to surface water would actually be much lower due to dilution, dispersion, and adsorption/desorption processes.

Interstitial pore water concentrations in the tributaries were calculated based on data from shallow monitoring wells PMW-12A, PMW-13A and PMW-16A. More discussion of these monitoring wells is provided below.

Monitoring well 12A is a shallow groundwater monitoring well across from the outfall in the Eastern Tributary. The concentrations detected in groundwater samples from this monitoring well were 190 µg/l for TCE and 16 µg/L for 1,1,1 TCA. It is assumed that groundwater from this well could infiltrate into the sediment interstitial pore water within the Eastern Tributary. The concentrations of chlorinated compounds detected in this monitoring well were low when compared to concentrations in other on-site wells. As groundwater flows through soil and bedrock, the concentrations detected in the groundwater are expected to decrease due to dispersion, dilution and adsorption processes prior to discharge to groundwater. However, it was conservatively assumed that the concentrations detected in this monitoring well would equal interstitial pore concentrations in the Eastern Tributary.

Monitoring well 13A is a shallow groundwater monitoring well across Boyd's School Road from the Northern Tributary near the northeastern boundary of the Plant site. It is possible that groundwater from this well could infiltrate into the sediment interstitial pore water within the Northern Tributary. However, no compounds-of-interest were detected in groundwater samples taken from this monitoring well. Similarly no compounds-of-interest were detected in SW-2 and SED-2 near this well.

Monitoring well 16A is approximately 600 ft from the Northern Tributary. It is possible that groundwater from this well could infiltrate into the sediment interstitial pore water within the Northern tributary. However, as identified above for monitoring well PMW-13A, no compounds-of-interest were detected in this shallow monitoring well. This corresponds to no detection of compounds in the Northern Tributary near this well SW-6 and SED-6, and SW-4 and SED-4.

It is assumed that groundwater from both shallow and deep zones would eventually discharge into Rock Creek. The compounds-of-interest detected in these monitoring wells would similarly discharge with the groundwater. Due to the distance between these wells and Rock Creek, the discharged concentrations would be much less than observed in these monitoring wells due to dilution, dispersion and adsorption / desorption processes. However,

the discharged concentrations could not be modeled for this analysis because of insufficient data. Therefore, interstitial pore water concentrations in Rock Creek were based on the off-site groundwater data at monitoring wells PMW-16B and PMW-14, both of which are deep monitoring wells. Only deep monitoring wells were used since no compounds were detected in the shallow monitoring well PMW-16A. A more detailed discussion of these monitoring wells is provided below.

Monitoring wells PMW-16B and PMW-14 are both deep monitoring wells located closest to Rock Creek. It is possible that compounds-of-interest in these monitoring wells could eventually migrate and discharge to Rock Creek although significant dilution and dispersion would occur. Analysis of groundwater from these wells show TCE at a concentration of 230 μg/l, in monitoring well PMW-16B, and at 13 μg/L in monitoring well PMW-14. In addition, 1,1,1-TCA was detected at 7 μg/L at both of these wells. This analysis conservatively assumed that the concentrations in the interstitial pore water of Rock Creek sediments were equal to the groundwater concentrations at these wells. Although the actual concentrations would be much lower due to dilution and dispersion, this assumption was made to evaluate a worst case condition.

The concentration of total chlorinated aliphatics in a monitoring well represents a potential exposure point concentration for interstitial pore water in these tributaries where the groundwater may discharge. The interstitial pore water concentrations were assumed to be 100 percent of the groundwater concentration. Each well is considered to represent a separate potential exposure point concentration.

The exposure point concentrations for the ecological assessment are provided in Table 6-2.

6.5 ENVIRONMENTAL RISK CHARACTERIZATION

Environmental risks are evaluated by comparing exposure point concentrations to threshold values where chronic and acute toxic effects may occur. Potential ecological effects were evaluated using the Toxicity Quotient approach. This involves comparing exposure point concentrations to benchmark levels of the compounds. Toxicity Quotients are calculated as follows:

$$TQ = \frac{\text{Exposure Point Concentration}}{\text{Benchmark Value}}$$

Potential ecological effects were assumed to occur if the value of TQ exceeded 1. Table 6-3 presents the calculated TQ values for the ecological evaluation. A detailed discussion of potential ecological effects is provided below.

6.5.1 Evaluation of Ecological Risks under Current Conditions

Aquatic Biota Within the Tributaries

In Figure 6-1, the exposure point concentrations for TCE in surface waters of tributaries of Rock Creek are compared with appropriate benchmark values derived from toxicological data. As can be seen from the figure, the exposure point concentrations are well below levels considered to pose chronic or acute toxic effects.

Because these compounds are only intermittently observed in surface waters and because they are at levels that are well below those that may cause toxicity, there appears to be little or no risks to aquatic biota in surface waters.

Benthic invertebrates may experience different exposure concentrations than organisms that live within the water column, i.e., exposures from surface water versus exposure to sediments. However, sediment data shows no detectable concentrations of compounds-of-interest. Therefore, interstitial pore water concentrations were assumed to be the same as ambient surface water concentrations. Since no acute or chronic effects were noted for aquatic organisms, it appears that there are no risks to benthic invertebrates.

Aquatic Biota Within Rock Creek

No data exists suggesting there are potential current risks to ecological receptors within Rock Creek. With regard to the migration of compounds-of-interest in surface water from the tributaries, since no risks have been identified for ecological receptors in the tributaries, it could be assumed that, because of dilution and dispersion, there would be no risk to aquatic biota in Rock Creek. With regard to groundwater migration of compounds-of-interest and eventual discharge to Rock Creek, no evidence exists to suggest that the compounds-of-interest have reached Rock Creek. Residential well sampling performed in the historical investigations shows non detectable concentrations of compounds-of-interest beyond Table Rock Road. Therefore, it appears that there is no risk to aquatic biota in Rock Creek.

Terrestrial Vertebrates

Terrestrial birds and mammals may ingest surface water from the tributaries and from Rock Creek. Data indicate that there could be some exposure to TCE at low levels. Risks to small mammals drinking from the tributaries were evaluated by considering the available toxicological data presented in Table 6-1. The NOAEL data was used to calculate corresponding drinking water concentrations by applying standard assumptions on water consumption (5 ml/day for mice, and 25 ml/day for rats). Based on the data provided in Table 6-1, a threshold value of 120 mg/l was calculated for trichloroethylene. If a safety factor of 10 is applied to the threshold value to protect other mammal species, a final threshold concentration of 12 mg/l respectively is derived. Concentrations of TCE are in the range of about 10 μg/L. Such levels are below the final threshold concentration for small mammals. Thus, the levels of compounds in the surface waters of these tributaries are not considered to pose a risk to these animals.

6.5.2 Evaluation of Ecological Risks Under Future Conditions

As discussed above, potential ecological risks for future conditions were based on estimates of the interstitial pore water concentration in the tributaries and Rock Creek.

Aquatic Biota Within the Tributaries

In Figure 6-2, groundwater concentrations of volatile organic compounds in PMW-12A, 13A, and 16A are compared to the range of levels reported to result in chronic or acute toxic effects. With regard to the discharge of this groundwater, only exposures to the benthic community of the tributaries was assessed. The assessment assumed that the compounds-of-interest in shallow groundwater monitoring wells PMW-12A, 13A, and 16B would enter the interstitial pore space of tributary sediment. As can be seen from Figure 6-2, concentrations of total chlorinated aliphatics in PMW-12A only slightly exceed the chronic benchmark value for these compounds of 100 μg/L. The range for potential effects is between 100 and 2,000 μg/L. This suggests that if groundwater discharging to surface waters contains concentrations of compounds-of-interest observed in these wells (Figure 6-2), then there would be some risk to benthic invertebrates in the zone of discharge. However, as stated above, these groundwater concentrations are expected to undergo significant dispersion and dilution prior to their discharge to the tributaries. Therefore, no risk to aquatic biota is anticipated.

Aquatic Biota Within Rock Creek

Groundwater concentrations of volatile organic compounds in monitoring wells PMW-14 and 16B were compared to the range of levels reported to have chronic or acute toxic effects in Figure 6-3. With regard to the discharge of this groundwater, only exposures to the benthic community in the sediments of Rock Creek was assessed. The assessment assumed that the compounds-of-interest in these deep groundwater monitoring wells will eventually enter the interstitial pore space of the sediment in Rock Creek. As can be seen from Figure 6-3, concentrations of total chlorinated aliphatics in PMW-16B only slightly exceed the chronic benchmark value for these compounds of 100 μg/L. The range for potential effects is between 100 and 2,000 μg/L. This suggests that if groundwater discharging to surface waters contains the concentrations of compounds-of-interest observed in the wells (Figure 6-3), then there would be some risk to benthic invertebrates in the zone of discharge. However, as stated above, these groundwater concentrations are expected to undergo significant dispersion and dilution prior to their discharge to Rock Creek. Therefore, no risk to aquatic biota is anticipated.

Terrestrial Vertebrates

As identified above for current conditions, terrestrial birds and mammals may ingest surface water from the tributaries and from Rock Creek. Data indicate that there could be some exposure to TCE at low levels. Based on the analysis performed under current conditions, the levels in the groundwater wells used to calculate interstitial pore water concentrations are well below the final threshold concentration for terrestrial vertebrates. Thus, the predicted levels of compounds in the surface waters of the stream and Rock Creek are not considered to pose a future risk to these animals.

6.6 UNCERTAINTY IN THE ECOLOGICAL ASSESSMENT

Uncertainty in the ecological assessment results from the selection of compounds-of-interest, toxicity assessment, exposure assessment, and risk characterization. Of the compounds-of-interest selected for the quantitative risk assessment, TCE was the most prevalent compound. The other compounds were detected at much lower concentrations with some that were detected at or near the detection limit in groundwater. Uncertainty regarding compounds-of-interest was reduced by considering total chlorinated aliphatics rather than the individual compounds. Uncertainty regarding the toxicity assessment comes primarily from the use of toxicity of TCE as a surrogate compound for toxic effects of total chlorinated aliphatics. TCE, although the most prevalent compound, is also one of the more

toxic of the chlorinated aliphatics and may result in an overestimation of risk when evaluating risks to total chlorinated aliphatics. For the exposure assessment, the greatest uncertainty is associated with the estimation of exposure point concentrations for future conditions. Groundwater concentrations at various monitoring wells near the tributaries and monitoring wells PMW-14 and 16B were used to estimate exposure point concentrations for sediment interstitial pore water. The groundwater data was used directly to evaluate potential effects rather than modeled to estimate the interstitial pore water concentration. The actual concentration would probably much less due to dilution, dispersion and adsorption/desorption processes. For risk characterization, the greatest uncertainty is associated with calculation of potential ecological risks for future conditions and it is the result of the assumptions made for calculating future exposure point concentrations. The estimated ecological risks for future conditions may overestimate the actual risk by one to two orders-of-magnitude.

6.7 SUMMARY OF ECOLOGICAL RISK CHARACTERIZATION

Under current conditions at the Plant site, the observed concentrations of compounds-of-interest in surface water and sediments are below the threshold level for chronic or acute effects to aquatic organisms and benthic organisms. Additionally, no risks are anticipated for terrestrial vertebrates that may be associated with these streams. For future conditions, a potential for chronic effects exists for benthic organisms in the Eastern Tributary based on total chlorinated aliphatic concentrations in groundwater samples from monitoring well PMW-12A. In addition, a potential for future chronic effects to benthic organisms in Rock Creek may occur based on groundwater samples from monitoring well PMW-16B. However, it is very unlikely that these groundwater concentration will equal the future interstitial pore water concentrations due to dilution and dispersion of the contaminates during migration.

7.0 HEALTH-BASED CLEAN-UP LEVELS

7.1 OVERVIEW

This section presents health-based clean-up levels for media-of-interest at the Plant site. Health-based clean-up levels are concentrations of compounds-of-interest in a particular medium that will not result in significant risks to persons or ecological receptors based on the exposure and toxicological assumptions made in the risk assessment. Media requiring health-based clean-up levels include:

- on-site surface soils;
- off-site groundwater;
- surface water; and
- sediments.

Clean-up levels for on-site surface soils and groundwater were based on the human health risk assessment. For surface water and sediments, health-based clean-up levels were based on the ecological risk assessment. it should be emphasized that the term "health" in the expression "health-based clean-up levels" refers to the health or welfare of ecological receptors as well as human receptors.

7.2 METHODOLOGY

Different methods were used to calculate clean-up levels for soils and groundwater (based on the human health evaluation) and for surface water and sediments (based on the ecological evaluation). The discussions of these methodologies are provided below.

7.2.1 Methodology for Calculating Clean-Up Levels for Soils and Groundwater

As identified above, the calculation of clean-up levels for soils and groundwater was based on the human health risk assessment presented in Sections 3, 4 and 5. The methodology for calculating clean-up levels based on a human health risk assessment is a three step process. First, for each medium, critical receptors are identified. Critical receptors are those receptors experiencing the highest estimated cancer risks or chronic hazard indices from intake routes where this medium is the ultimate source. For the Plant site, all receptors experience exposures from a single source medium (i.e., on-site

maintenance workers are exposed to on-site surface soils which serves as both source medium and exposure medium and nearby residents and distant off-site residents are exposed to media which derive from off-site groundwater as their ultimate source), so the linkage of source media and exposure media for each receptor is straightforward.

Second, for each critical receptor, a unit risk factor (URF) is estimated for each for each compound of interest. URFs are derived from either the cancer risk or hazard index estimated in the risk assessment for the overall site. For example, if H_j is the health effect (i.e., cancer risk or hazard index) for a receptor from potential exposure to on-site surface soil associated with chemical j and Cs_j is the source concentration of the chemical in the on-site surface soil, then the URF for this receptor and chemical is given by:

$$URF_j = H_j / Cs_j$$

It is important to note that the relevant concentration for Cs_j is the source concentration and not the exposure point concentration used in the baseline assessment to calculate intakes and then risks. Source concentrations are used because the exposure point concentrations are linearly related to the source concentrations and potential health effects are linearly related to the exposure point concentrations. Thus, the health effect is linearly related to the source concentration, with the URF being the coefficient relating these two variables.

Third, health-based clean-up levels are calculated for each compound of interest based on either an acceptable risk level for carcinogens (i.e., typically 10^{-4} or 10^{-6}) or a hazard index of 1 for noncarcinogens. For example, if URF_j is the unit risk factor for a receptor associated with chemical j in a particular source medium, and ARL is the acceptable risk level (i.e., for carcinogens, a cancer risk of 10^{-4} or 10^{-6}; or for noncarcinogens, a hazard index of 1), then the health-based clean-up level for compound j ($HBCL_j$) in that medium is given by:

$$HBCL_j = ARL / URF_j$$

This procedure is repeated for each compound in that medium. Since separate HBCL values can be obtained for compounds evaluated based on both carcinogenic effects and non-carcinogenic effects, the clean-up level is equal to the lower value.

7.2.2 Methodology for Calculating Clean-Up Levels for Surface Water and Sediments

Health-based clean-up levels for surface water and sediments were based on the ecological evaluation. For surface water, the clean-up level was assumed to be equal to the lowest chronic effect concentration for aquatic organisms in surface water.

Clean-up levels for sediments were calculated based on the concentration of a compound of interest in sediment interstitial pore water that will not result in adverse effects to benthic organisms. The corresponding sediment concentration was then calculated from this acceptable interstitial pore water concentration using the Equilibrium Partitioning (EP) approach (EPA, 1988b). The EP approach is the method used by EPA for generating sediment quality criteria. This approach was developed because recent studies have shown that the bioavailability and toxicity of a compound is more directly correlated with the interstitial pore water concentration than the total sediment chemical concentration. This procedure assumes that a compound detected in sediment is actually in equilibrium between the sediment and interstitial pore water. The EP method estimates the partitioning of a compound between sediment and the interstitial pore water. For non-polar hydrophobic organic contaminants, partitioning between sediments and sediment pore water is influenced primarily by the amount of organic carbon in the sediment; the higher the organic carbon content, the less partitioning of the contaminant to the water phase. This relationship is given by the equation:

$$Csed = Cw * foc * Koc$$

where:

Csed = concentration of compound in sediment (mg/kg);
Cw = interstitial water concentration compound (mg/l);
foc = fraction of organic carbon in soil(fraction);
Koc = organic carbon partition coefficient (L/Kg).

By substituting the acceptable concentration for compounds-of-interest in sediment interstitial pore water for Cw, an acceptable concentration for sediments can be calculated based on the above equation.

7.3 HEALTH-BASED CLEAN-UP LEVELS

7.3.1 Health-Based Clean-Up Levels for On-Site Surface Soils

The only receptors exposed to compounds-of-interest in on-site surface soils are on-site maintenance workers. The intake routes evaluated for on-site maintenance workers exposed to on-site surface soils include:

- incidental ingestion; and
- dermal contact.

Table 7-1 presents the calculations for estimating health-based clean-up levels for compounds-of-interest in on-site surface soils. Clean-up levels for carcinogens are presented for both the 10^{-4} and 10^{-6} risk levels. Clean-up levels for noncarcinogens are presented for a hazard index of 1. The compounds-of-interest in on-site surface soils include:

- 1,1-dichloroethane;
- 1,1,1-trichloroethane;
- xylenes (total); and
- PCB Arochlor 1254.

Of these four compounds, only PCB is a potential carcinogen. The clean-up levels for PCBs are 336 mg/Kg, based on a 10^{-4} acceptable risk level, and 3.36 mg/Kg, based on a 10^{-6} acceptable risk level. For 1,1-dichloroethane and total xylenes, the acceptable concentrations exceed 1,000,000 mg/Kg. The acceptable concentration for 1,1,1-trichloroethane is 931,000 mg/Kg.

7.3.2 Health-Based Clean-Up Levels for Off-Site Groundwater

The receptor groups exposed to off-site groundwater (note, off-site groundwater refers to both near-site groundwater and distant off-site groundwater) for both the current and future land use scenario include:

- nearby residents - exposed to compounds-of-interest in near-site groundwater used for potable water and irrigation; and

- distant off-site residents - exposed to compounds-of-interest in distant off-site groundwater used as a potable water source and for irrigation.

The compounds-of-interest associated with off-site groundwater include:

- 1,1-dichlorethene;
- 1,1-dichloroethane;
- 1,2-dichloroethene;
- 1,2-dichloroethane;
- 1,1,1-trichloroethane; and
- trichloroethene.

Although two receptor groups were identified for each of the two land use scenarios, the assumptions regarding the intake routes for nearby residents and distant off-site residents in both the current and future scenario were identical. There are two different exposure scenarios associated with off-site groundwater: those associated with irrigation uses of off-site groundwater and those associated with potable uses of off-site groundwater. The exposure pathways relevant for the potable water use and irrigation use of off-site groundwater include:

- For potable uses:
  - ingestion;
  - dermal contact while showering;
  - inhalation of volatiles while showering;
- For irrigation uses:
  - inhalation of volatiles from groundwater during irrigation;
  - inhalation of volatiles and fugitive dusts from irrigated soil; and
  - dermal contact with irrigated soil.

The installation of water mains near the Plant site provides an alternative source for household drinking water. However, it is reasonable to assume that groundwater may still be used to supplement household water for irrigation. Also, if groundwater use restrictions are implemented that prevent the use of groundwater for household use (i.e., drinking, cooking, bathing, etc.), then cleanup levels for irrigation uses alone would be relevant. Therefore, separate discussions of clean-up levels will be presented for off-site groundwater used for irrigation and groundwater used for both potable and irrigation uses.

Clean-Up Levels for Irrigation Uses of Groundwater

As identified above, off-site residents (i.e., both nearby residents and distant off-site residents) in both the current and future land use scenarios are assumed exposed to off-site groundwater from irrigation uses. The specific receptors are off-site resident adults, children (aged 2 to 18 years), and young children (aged 2 to 6 years). Table 7-2 presents the calculations of health-based clean-up levels for off-site residents. This table presents separate clean-up levels for adults, children, and young children. The clean-up levels for individual compounds were selected based on the lowest acceptable concentration calculated for either adults, children, or young children and for the lower of either the carcinogenic assessment or the non-carcinogenic assessment. For example, 1,1-dichloroethene was evaluated both as a carcinogen and as a noncarcinogen. However, the health-based clean-up levels for this compound based on the carcinogenic assessment are much lower for all receptors.

The clean-up levels for carcinogenic compounds were selected based on exposures to children since the acceptable concentrations for children are lower than for adults or young children. For 1,1-dichloroethene, the health-based clean-up levels are 8.4 mg/L, for the 10^{-4} acceptable risk level, and 0.084 mg/L, for the 10^{-6} acceptable risk level. For 1,2-dichloroethane, the health-based clean-up levels are 99.4 mg/L, for the 10^{-4} acceptable risk level, and 0.994 mg/L, for the 10^{-6} acceptable risk level. For trichloroethene, the health-based clean-up levels are 384 mg/L, for the 10^{-4} acceptable risk level, and 3.84 mg/L, for the 10^{-6} acceptable risk level.

The clean-up levels for non-carcinogenic compounds were based on exposures to young children. For 1,1-dichloroethane, the health-based clean-up level is 2,466 mg/L. For 1,2-dichloroethene (total), the health-based clean-up level is 2,310 mg/L. For 1,1,1-trichloroethane, the health-based clean-up level is 844 mg/L.

Clean-Up Levels for Potable Uses and Irrigation Uses of Groundwater

As identified above, the receptor groups exposed to off-site groundwater by both potable and irrigation uses include nearby residents and distant off-site residents in both the current and future land use scenarios. All of these receptors groups have identical exposure assumptions for the intake routes associated with exposure to off-site groundwater. Because the exposure assessments are identical, the calculated health-based clean-up levels will be identical for similar receptors (e.g., adults). For this analysis, the exposure pathways for near-site residents in the future land use scenario were used to represent all receptors groups which use off-site groundwater for potable and irrigation uses. Although this

discussion focuses on nearby residents, the clean-up levels are applicable for distant off-site residents in both scenarios. The specific receptors are nearby resident adults, children (aged 2 to 18 years), and young children (aged 2 to 6 years). Table 7-3 presents the calculations of health-based clean-up levels for nearby residents. This table presents separate clean-up levels for adults, children and young children. As stated above, the clean-up levels for individual compounds were selected based on the lowest acceptable concentration calculated for either adults, children, or young children and for the lower of either the carcinogenic assessment or the non-carcinogenic assessment.

The clean-up levels for carcinogenic compounds were selected based on exposures to adults. For 1,1-dichloroethene, the health-based clean-up levels are 0.0062 mg/L, for the 10^{-4} acceptable risk level, and 0.000062 mg/L, for the 10^{-6} acceptable risk level. For 1,2-dichloroethane, the health-based clean-up levels are 0.0764 mg/L, for the 10^{-4} acceptable risk level, and 0.0008 mg/L, for the 10^{-6} acceptable risk level. For trichloroethene, the health-based clean-up levels are 0.5966 mg/L, for the 10^{-4} acceptable risk level, and 0.006 mg/L, for the 10^{-6} acceptable risk level.

The clean-up levels for non-carcinogenic compounds were based on exposures to young children. For 1,1-dichloroethane, the health-based clean-up level is 1.17 mg/L. For 1,2-dichloroethene (total), the health-based clean-up level is 0.23 mg/L. For 1,1,1-trichloroethane, the health-based clean-up level is 1.05 mg/L.

7.3.3 Health-Based Clean-Up Levels for Surface Water

Clean-up levels for surface water are the concentration of compounds-of-interest in surface water that are protective of critical ecological receptors. The critical receptors identified for compounds-of-interest in surface water are aquatic organisms. The compounds-of-interest in surface water are total chlorinated aliphatics. Since TCE was the only compound detected in surface water and is the chemical detected most frequently in groundwater, the toxicity data for TCE was used as a surrogate for all chlorinated aliphatics to develop a clean-up level. The clean-up level for total chlorinated aliphatics in surface water was established at the lowest chronic effect level or 0.1 mg/L (100 μg/L).

7.3.4 Health-Based Clean-Up Levels for Sediments

Clean-up levels for sediments are the concentrations of compounds-of-interest in sediments that will result in a concentration in interstitial pore water just below an adverse effect level for benthic organisms. The compounds-of-interest for sediments are total chlorinated aliphatics. An acceptable concentration for total chlorinated aliphatics in

interstitial pore water was assumed to be the same as the clean-up level for surface water or 0.1 mg/L. As stated above, the Equilibrium Partitioning approach was used to estimate sediment health-based clean-up levels using the equation presented in Section 7.2.2. The parameters and their corresponding values used in this equation are:

- Cw = 0.1 mg/L;
- foc = 0.02 (or 2%);
- Koc = 126 L/Kg.

The assumed value for foc was 0.02 (which corresponds to 2% percent organic carbon in sediments and is a typical value for such materials). The value used for Koc was for TCE from Appendix A of the Superfund Public Health Manual (EPA, 1986). The clean-up level for total chlorinated aliphatics based on these assumptions is 0.252 mg/Kg.

7.4 SUMMARY OF HEALTH-BASED CLEAN-UP LEVELS

This section presented the health-based clean-up levels for compounds-of-interest in exposure media at the Plant site. The exposure media include:

- on-site surface soils;
- off-site groundwater;
- surface water; and
- sediments.

Health-based clean-up levels for on-site surface soils and groundwater were based on the human health evaluation. Health-based clean-up levels for surface water and sediments were based on the ecological evaluation. A summary of the health-based clean-up levels is provided in Table 7-4.

For on-site surface soils, health-based clean-up levels were based on exposures to on-site maintenance workers. Health-based clean-up levels for groundwater were calculated under two scenarios: exposures to off-site groundwater from irrigation uses and exposures to off-site groundwater from both potable uses and irrigation uses. Health-based clean-up levels from irrigation use of off-site groundwater were based on the exposure assumption for off-site residents under the current and future land use scenario. The clean-up levels for carcinogens were based on exposures to children (aged 2 to 18 years), while clean-up levels for noncarcinogens were based on exposures for young children (aged 2 to 6 years). Health-based clean-up levels for irrigation and potable uses of off-site groundwater were based on

exposures to off-site residents in the current and future scenarios. The clean-up levels for carcinogens were based on exposures to adults while clean-up levels for noncarcinogens were based on exposures for young children (aged 2 to 6 years).

Health-based clean-up levels for compounds-of-interest in surface water were based on the lowest benchmark concentration for chronic effects to aquatic organisms. The compound of interest for surface water was total chlorinated aliphatics while clean-up levels were based on toxicity data for TCE.

Health-based clean-up levels for sediments were based on an acceptable concentration of total chlorinated aliphatics in sediment interstitial pore water. It was assumed that the acceptable concentration of total chlorinated aliphatics in interstitial pore water was equal to the clean-up level for surface water. The clean-up level for sediments was then calculated based on the Equilibrium Partitioning Approach for Generating Sediment Quality Criteria (EPA, 1988b).

8.0 SUMMARY OF RISK ASSESSMENT

This section provides a summary of the risk assessment. This summary is presented in three sections: a summary of the public health evaluation; a summary of the ecological evaluation; and a summary of the health-based clean-up levels. This summary is intended to briefly present the major issues and assumptions used in the risk assessment and the results of the human health and ecological risk characterization.

8.1 SUMMARY OF THE HUMAN HEALTH EVALUATION

This section provides a summary of the human health evaluation for the former Westinghouse Elevator Plant site. The summary includes discussion of compounds-of-interest, exposure assessment, toxicity assessment and risk characterization.

8.1.1 Compounds-of-Interest

The analytical data collected in the Phase I and Phase II site investigations were combined and grouped by environmental media for data evaluation. The media at the Plant site include:

- soils;
- groundwater,;
- surface water; and
- sediment.

Samples were submitted for chemical analysis for the target compound list (TCL) volatiles, bis(2-ethylhexyl)phthalate, and PCBs based on the Phase II Sampling and Analysis Plan (Rizzo, 1990). The data evaluation involved the following procedures:

- For each data set, the analytical methods were evaluated for their suitability for risk assessment.
- For each data set, the quantitation limits were valuated for their suitability for risk assessment.
- For each data set, qualified or coded data were evaluated.
- For each data set, data from field samples were compared with field and laboratory blanks.

- For each data set, tentatively identified compounds, if they were reported, were evaluated.
- For each data set, field samples were compared with background samples, when available.

The above procedure was applied to all data sets associated with each medium. The result of the data evaluation was a list of compounds-of-interest for quantitative risk assessment. The compounds-of-interest for the Plant site risk assessment are provided in Table 8-1. The compounds-of-interest in each environmental medium are briefly described below.

Surface and Subsurface Soils

Surface soil samples were taken during the Phase I and Phase II investigations. During the Phase I investigation, five composite soil samples were taken from the five potential source areas identified in the Phase I. These potential source areas include:

- Remote Tank Fill Line Area;
- Degreasing Fluid Storage Tank Area;
- Pump House Area;
- Railroad Dock Area; and
- Old Waste Drum Storage Area.

For the Phase II investigation, a series of borings were made at the site and soil samples were taken from various intervals within the boring. Samples taken from the interval from groundsurface to two feet below grade were considered surface soil samples. Based on the data evaluation, the compounds-of-interest for surface soils included:

- 1,1-dichloroethane;
- 1,1,1-trichloroethane;
- xylenes; and
- PCB Arochlor 1254.

Samples taken from depths greater than two feet from the soil borings were considered subsurface soil samples. Subsurface soil samples were obtained during the Phase II investigation. The compounds-of-interest for subsurface soils included:

- 1,1-dichloroethene;
- 1,1-dichloroethane;
- 1,2-dichloroethene;

- 1,1,1-trichloroethane; and
- trichloroethene.

Groundwater

Groundwater samples taken from monitoring wells both on-site and off-site were analyzed during the Phase I and Phase II investigations. The location of groundwater monitoring wells is provided in Figure 2-3. Samples were taken from two depths: shallow, screened at an interval of approximately 40 feet below grade; and deep, screened at intervals from 120 feet to 200 feet below grade. Detectable concentrations of total volatiles in on-site groundwater were detected as high as 60,000 ppb, in Phase I, and as high as 25,000 ppb, in Phase II. The area containing the highest concentrations of compounds-of-interest in on-site groundwater was near the former pond immediately in front of the facility. The extent of compounds-of-interest detected in off-site groundwater was 500 ppb total volatiles in PMW-13B, on the plant boundary, 250 ppb at monitoring well PMW-16B and 20 ppb in PMW-14 to the east of the plant site, 7 ppb at PMW-17 to the north, to non-detect at PMW-11 and PMW-15 to the south of the plant. Some general observations can be drawn regarding compound migration in groundwater from the site:

- The highest concentrations of compounds-of-interest are limited to a relatively small area in front of the Plant site near the former pond area (see Figure 3-1).

- Compounds-of-interest in shallow groundwater appear to be limited to just a few wells near the former pond area which indicates that compounds are migrating downward as they disperse away from the former pond area.

- Compounds-of-interest were only detected in deep groundwater off-site in the Phase II investigation.

- Groundwater concentrations of compounds-of-interest have decreased from the Phase I investigation to the Phase II investigation with operation of pump and treat.

Based on results from the data evaluation, the compounds-of-interest for groundwater included:

- 1,1-dichloroethene;

- 1,1-dichloroethane;
- 1,2-dichloroethene;
- 1,2-dichloroethane;
- 1,1,1-trichloroethane; and
- trichloroethene.

Surface Water. Surface water bodies near the Plant site include the Eastern and Northern Tributaries of Rock Creek, both of which are off-site. Surface water samples were taken during the Phase I and Phase II investigations from both of these streams. The locations of these streams and the sampling locations are provided in Figure 2-4. The data summarized eight surface water samples from seven areas. Based on results from the data evaluation, the compound of interest for surface water was trichloroethene. However, for the ecological assessment, it was assumed that the compounds-of-interest in surface water should be expanded to include the compounds-of-interest in groundwater since groundwater may discharge to surface water. Potential ecological effects to these compounds were based on exposure to total chlorinated aliphatics rather than to exposure to individual volatile constituents.

Sediment. Sediment samples were taken simultaneously with surface water sampling from the Northern and Eastern Tributaries. No compounds-of-interest were detected in sediments based on the data evaluation. For the ecological assessment, the compounds-of-interest for sediments were assumed the same as surface water.

8.1.2 Exposure Assessment

The exposure assessment identifies persons potentially exposed, both now and in the future, to compounds-of-interest associated with the Plant site. This assessment assumes the site remains essentially as it is, or in other words, discusses potential exposures associated with existing site conditions. The exposure assessment identifies pathways by which humans are potentially exposed to compounds at a site and estimates the magnitude, frequency and duration of actual or potential human exposures. In the exposure assessment, reasonable maximum estimates of exposure are developed for both current and future land use scenarios. The exposure assessment included the following elements:

- discussion of potential sources and migration pathways;
- identification of potential human receptors;
- delineation of potential receptor-specific exposure pathways;
- development of intake assumptions associated with each exposure pathway;

- estimation of exposure point concentrations; and
- estimation of pathway and receptor-specific intakes and doses of compounds-of-interest.

The intakes estimated in the exposure assessment were intended to approximate reasonable maximum exposures (RMEs) as suggested by the Risk Assessment Guidance for Superfund (EPA, 1989a). These exposures were based on conservative assumptions and should overestimate actual intakes. Thus, while these intakes were estimated with methodologies consistent with EPA procedures, it is important to emphasize that these were not estimates of actual intakes or even potential typical intakes, but rather were estimates of intakes that were intended to approximate maximum exposures. Actual intakes or potential future intakes are likely to be lower.

Potential Sources, Receptors and Exposure Pathways

Potential sources of compounds-of-interest include surface soils, groundwater, surface water and sediments. Exposure pathways are routes whereby compounds-of-interest could be assimilated by a potential receptor. Exposure pathways require the existence of a receptor, the presence of compounds-of-interest in a medium that the receptor contacts, and an intake route associated with the receptor. Since exposure pathways require the presence of a receptor, these pathways depend upon the uses of the site. Both current and potential future land uses were considered in this analysis. Table 8-2 summarizes the potential sources, receptors and exposure pathways.

Intake Assumptions

The intake assumptions presented were based on the Risk Assessment Guidance for Superfund (EPA, 1989a) and were intended to estimate reasonable maximum exposures. The use of RME intake assumptions were not intended to estimate intakes for the population on the average but for the most exposed or sensitive sub-populations. The is to ensure that the risk assessment is protective of human health and the environment. A summary of the intake assumptions used is presented in Table 8-3, for the current land use scenario, and Table 8-4, for the future land use scenario.

Estimation of Potential Exposure Point Concentrations

Each intake route involves receptor contact with compounds-of-interest in an exposure media (e.g., soil, water, or air). Thus, to quantify intakes, concentrations at the point of exposure must be estimated. These exposure point concentrations were estimated

using site investigation data in conjunction with mathematical models. The source of compounds-of-interest in the exposure medium may be compounds in the medium at the point of exposure, compounds that are initially in the medium at another location and are subsequently transported through that medium to the point of exposure; or compounds that are initially in another medium, are then transported from the source medium to the exposure medium and finally transported through the exposure medium to the point of exposure. As compounds move between and through site media, concentrations can change over time though transformation, dilution, dispersion and degradation processes.

Consequently, knowing the concentration of the chemical in a particular medium at the current time is not necessarily enough, since the concentration of the chemical may change over time. To help estimate the potential change of chemical concentrations over time in a medium from transport or transformation processes, mathematical models were employed. A description of these models and the application of the models to estimate exposure point concentrations for each receptor are provided in Appendix B for a more detailed discussion. The exposure point concentrations calculated for the exposure media at the Plant site are presented in Table 8-5.

Estimated Intakes and Doses

Intake assumptions, were combined with the exposure point concentrations to calculate intakes and doses, which are presented in Appendix D. Two intakes or doses are estimated for each receptor: 1) An average lifetime intake was estimated that can be combined with an appropriate cancer slope factor to estimate a cancer risk; and 2) A chronic intake was also estimated that can be combined with an appropriate RfD to generate a chronic hazard index. Potential intakes or doses are presented by pathway and by compounds-of-interest for each receptor.

Uncertainties in the Public Health Exposure Assessment

Uncertainties associated with the exposure assessment for the Plant site include those associated with the environmental sampling, analysis, and data evaluation and those associated with the parameters used to estimate intakes. The sources of uncertainty associated with the estimates of exposure were evaluated by investigating the assumptions used in the exposure assessment. The uncertainties in the exposure assessment are discussed in more detail in Section 3.7. The approach employed in this analysis tends to bias estimates of exposure in the direction of overestimation. Thus, although there is considerable uncertainty associated with the exposures estimated in this analysis it is much more likely that the values estimated here will overestimate any actual or potential exposures rather

than underestimate them.

8.1.3 Toxicity Assessment

The purpose of the toxicity assessment is to weigh available evidence regarding the potential for compounds-of-interest to cause adverse health effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a chemical and the increased likelihood or severity of the adverse effect. A toxicity assessment considers:

- the types of adverse health effects associated with exposures to compounds-of-interest;
- the relationship between the magnitude of exposure and the adverse effects; and
- related uncertainties such as the weight of evidence of a particular chemical's carcinogenicity in humans.

The toxicity assessment for the Plant site was accomplished in two steps: hazard identification and dose-response assessment. The first step, hazard identification, is the process of determining whether exposure to an agent can cause an increase in the incidence of an adverse health effect. Hazard identification also involves characterizing the nature and strength of the evidence of causation. The second step, dose-response evaluation, is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values are derived that can be used to estimate the incidence of adverse effects occurring in humans at different exposure levels.

It should be emphasized that the dose-response values are based on methodology that is consistent with EPA risk assessment guidelines and is intended to be conservative and, therefore, health protective. However, because these dose-response values are conservative, they are likely to overstate the actual relationship between an actual dose and the manifestation of an adverse health effect to the population of the average. The use of conservative dose-response factors are made to ensure that the risk assessment is protective of even the more sensitive sub-populations.

The toxicity assessment provides information that is used in conjunction with the identification of exposure pathways to estimate the risks posed to both human health and the environment. Table 8-6 presents toxicity information for compounds-of-interest for non-

carcinogenic and carcinogenic effects.

As stated earlier, an RfD is an estimate (with uncertainty spanning perhaps an order-of-magnitude or more) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. An uncertainty factor is used in calculating the RfD and reflects scientific judgement regarding the various types of data used to estimate RfD values. An uncertainty factor of 10 is generally used to account for variations in human sensitivity when extrapolating from valid human studies involving long term exposure of average healthy subjects. An additional 10-fold factor is usually used for each of the following extrapolations: from long-term animal studies to the case of humans, from a LOAEL (the lowest observed adverse effect level) to a NOAEL (the no observed adverse effect level) and from subchronic studies to a chronic RfD. In order to reflect professional assessment of the uncertainties of the study and data base not explicitly addressed by the above uncertainty factors, an additional uncertainty factor or modifying factor ranging from greater than 0 to less than or equal to ten is applied. The default value for this modifying factor is 1 (HEAST, 1990).

Uncertainties for assessing potential carcinogenic effects are compensated for by using upper bounds for cancer slope factors for carcinogens. Cancer slope factors are estimated through the use of mathematical models for estimating the largest possible linear slope (within the 95% confidence limit) at low extrapolated doses that is consistent with the data. The slope factor is characterized as an upper-bound estimate, where at best, the dose-response assumptions used in a risk assessment provide a rough but plausible estimate of the upper limit of risk , i.e. it is not likely that the true risk would be much more than the estimated risk, but it could very well be considerably lower, even approaching zero (HEAST, 1990). In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. EPA's weight of evidence classification provides information which can indicate the level of confidence or uncertainty in the carcinogenicity data obtained from studies in humans or experimental animals. Some of the uncertainties in the hazard evaluation are further compensated for by assuming that animal carcinogens behave as human carcinogens. The summation of the risks associated with all potential carcinogens, which is done for each evaluated exposure pathway, tends to overestimate risk by including probable human carcinogens (Group B) with demonstrated human carcinogens (Class A).

It is important to emphasize that the methodology typically employed to estimate cancer slope factors (i.e., extrapolating from risks generated at high doses in animal studies to risks at low doses) has considerable uncertainty associated with it suggesting that risks

estimated with this methodology could greatly overestimate actual risks. First, the carcinogenic effect is assumed to not exhibit a threshold effect. However, the human body has mechanisms to detoxify compounds, particularly at low doses.

Second, the metabolite of a chemical as opposed to the chemical itself is often the carcinogenic entity. For such compounds, it is likely that the risk of carcinogenic effects is low at low doses where the detoxifying systems in the body work smoothly. However, at high doses, the detoxifying system may be overwhelmed allowing carcinogenic metabolites to escape into the body and greatly increase the risk of cancer. Thus, this type of behavior also suggests that carcinogenic risk increases considerably above threshold dose levels.

Third, there is considerable uncertainty regarding the appropriateness of extrapolating from carcinogenic effects at high doses in animals to low doses in either animals or humans. The high doses are often near the maximum tolerated dose for a test animal species and these high doses are believed to cause cell proliferation which, in itself, will result in increased cancer risk because the odds of mutation increase (Cohen, 1990; Ames, B.N. and L.S. Gold, 1990). These findings call into question the animal test protocol used as the basis for developing dose-response relationships for carcinogenic effects.

These three items suggest that the current practice of assuming that carcinogenic effects do not exhibit threshold behavior and assuming that carcinogenic effects observed at high doses in test animals can be used to predict cancer effects at lower doses are likely to be incorrect, at least for some compounds. Thus, while the current practice is conservative and, therefore, health protective and is likely to overstate the actual risk from exposure to compounds at low doses.

8.1.4 Risk Characterization

In the risk characterization, the estimated intakes were combined with the quantitative indices of toxicity to estimate potential health effects. For carcinogens, risks were estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. The risks calculated are based on EPA recommended assumptions that are very conservative. The risks are also based on land use scenarios that are not particularly realistic, such as residential use of the site or individuals using contaminated surficial groundwater as a drinking water source. Therefore, the risks associated with these assumptions are very conservative and reflect highly improbable land use scenarios. It is worth noting that the actual incidence of contracting cancer over a lifetime is about one in four, and of those who contract cancer, about 1 to 2% have been associated with ambient or background chemical pollution (Travis and Hester,

1990). Thus, according to Travis and Hester, the lifetime cancer risk from exposure to background or ambient levels of chemical residues in the environment is 1 to 5 x 10^{-3}. In contrast, the target risk range utilized by the EPA at Superfund sites is 10^{-4} to 10^{-6} which is about one to three orders-of-magnitude lower. Thus, it should be kept in mind that not only are the risks estimated here likely to overstate actual risks to the population on the average, but the target risk range is likely to be an order-of-magnitude or more below levels of cancer incidence in the general population resulting from background levels of chemical residuals in the environment.

Comparison of Exposure Point Concentrations with Chemical-Specific ARARs

As part of the risk assessment for the Plant site, chemical-specific applicable or relevant and appropriate regulations (ARARs) were identified. The ARARs identified for this analysis were chemical-specific and apply to specific media. Table 8-7 present the chemical-specific ARARs applicable to the site.

Public Health Risk Characterization

Potential health effects to potential on-site and off-site receptors for current and future land use conditions are presented in Table 8-8. The health effects presented were the total potential cancer risk and total chronic hazard index summed over all intake routes and compounds for each receptor. These potential health effects are estimated for each receptor and are broken down by intake route and chemical constituent in Section 5. By partitioning the cancer risks and chronic hazard indices in this manner, intake routes and compounds contributing the most to the predicted health effects can be identified. As seen in Table 8-8, for current uses, cancer risks are less than the 10^{-4} to 10^{-6} acceptable cancer risk range, specified by EPA, for on-site receptors and off-site residents (nearby and distant off-site) only slightly exceed this acceptable risk range. All receptors had a total chronic hazard index less than 1. The cancer risks calculated for off-site residents was based on the assumption that they are currently using groundwater as a potable water source and for irrigation purposes. The risks to off-site residents via irrigation uses of groundwater were all less than 10^{-6}. For the total cancer risks from irrigation uses and potable uses of groundwater, the pathways associated with the potable water uses of groundwater account for over 99% of the intake. It should be noted, however, that the probability of potable uses of groundwater are much less than the irrigation uses of groundwater since an alternative potable water supply has been provided for residences near the site.

Uncertainties associated with the risk characterization portion of the risk assessment of the Plant site are a combination of the uncertainties evaluated through both exposure

assessment and toxicity assessment. As discussed above, the assumptions used for both the exposure and toxicity assessment lend to be conservative to ensure protection of even the most sensitive or exposed sub-populations.

8.2 SUMMARY OF THE ECOLOGICAL ASSESSMENT

This section presents a summary of the ecological assessment. This summary is presented in five parts: selection of compounds of environmental interest; dose/response assessment; exposure assessment; risk characterization; and uncertainty in the ecological evaluation.

8.2.1 Compounds-of-Interest

Compounds-of-interest for the ecological assessment were selected based on the compounds associated with the media-of-interest for the ecological evaluation. The media-of-interest were surface water and sediments in Rock Creek and the two tributaries of Rock Creek associated with the Plant site: the Northern Tributary and Eastern Tributary. Data was available for samples taken from surface water and sediments in the tributaries. These samples were submitted for chemical analysis for TCL volatiles and bis(2-ethylhexyl)phthalate. The compounds-of-interest for the ecological evaluation were selected based on a review of these samples. The only compound identified as a compound of interest in surface water and sediments was TCE. TCE was detected in two surface water samples and one duplicate sample at concentrations from 9 to 11 $\mu g/L$. Since groundwater may occasionally discharge to surface water in these tributaries, the compounds-of-interest for groundwater were added to the list of compounds-of-interest for the ecological evaluation. However, potential ecological effects to these compounds was based on exposure to total chlorinated aliphatics rather than to the individual constituents. TCE was used as a surrogate compound for total chlorinated aliphatics to evaluate potential ecological effects since TCE is found at greater concentrations in groundwater than the other compounds.

8.2.2 Ecological Toxicity Assessment

The ecological toxicity assessment accomplished two tasks: a review of relevant toxicity data for the compounds of environmental interest and establishment of a benchmark acceptable concentration for each chemical in surface water and sediment interstitial pore water. The review of relevant toxicity information was based primarily on the toxicity of TCE since it was used as a surrogate compound to evaluate potential ecological effects. The

toxicity assessment reviewed EPA databases AQUIRE and PHYTOTOX. Information was gathered on acute and chronic effects to aquatic vertebrates and invertebrates, plants and terrestrial vertebrate species. This information is presented in Appendix D. Benchmark concentrations were assumed equal to the lowest observed effect level, for evaluating chronic effects in surface water, and, for evaluating acute effects, based on LC_{50} data for TCE. Benchmark concentrations for interstitial pore water were assumed equal to the benchmark levels for surface water.

8.2.3 Ecological Exposure Assessment

The ecological exposure assessment involved the determination of potential ecological receptors and the calculation of exposure point concentrations. Potential receptors include aquatic organisms and benthic invertebrates in the streams and Rock Creek, and terrestrial vertebrates that may ingest surface water. The exposure assessment identified two conditions where potential exposures could occur: current conditions and future conditions. Exposure point concentrations were estimated separately for current and future conditions. For current conditions, the exposure point concentrations for the surface water and sediment interstitial pore water were assumed equal to the observed concentrations for TCE in surface water from the site investigations. For future conditions, exposure point concentrations were only estimated for the sediment interstitial pore concentrations for the tributaries and Rock Creek based on sample data for monitoring wells near these streams. Sample data from the shallow monitoring wells PMW-12A, PMW-13A and PMW-16A were assumed equal to the future exposure point concentrations for interstitial pore water for the tributaries. Sample data from the deep monitoring wells PMW-14 and PMW-16B were used to estimate the future exposure point concentrations for interstitial pore water for Rock Creek.

8.2.4 Ecological Risk Characterization

Risk characterization involved a determination of potential ecological impacts to aquatic receptors (e.g., aquatic organisms and benthic organisms) and terrestrial vertebrates. Potential impacts to aquatic receptors were determined based on the comparison of the exposure point concentration of a chemical, in either surface water or sediment pore water, to a media specific benchmark concentration. The methodology for evaluating the magnitude of ecological effects was based on the toxicity quotient method. This involves the calculation of a toxicity quotient (TQ) value. The TQ value is calculated by dividing the exposure point concentration of a chemical by its environmental benchmark. A potential risk would occur where the TQ value exceeded 1. This TQ approach was used on each sample rather than on an estimate of a single exposure point concentration. Potential

impacts to terrestrial vertebrates was based on the calculation of a daily dose, based on ingestion, to a no observed adverse effect level (NOAEL) for TCE.

For current conditions, there were no potential ecological risks. For future conditions, potential chronic effects to benthic organisms could occur in the Eastern Tributary, based on shallow groundwater data from monitoring well PMW-12A, and in Rock Creek, based on deep groundwater data from monitoring well PMW-16B.

8.2.5 Uncertainty in the Ecological Assessment

Uncertainty in the ecological assessment results from the selection of compounds-of-interest, toxicity assessment, exposure assessment, and risk characterization. Of the compounds-of-interest selected for the quantitative risk assessment, TCE was the most prevalent compound. The other compounds were detected at much lower concentrations with some that were detected at or near the detection limit in groundwater. Uncertainty regarding compounds-of-interest was reduced by considering total chlorinated aliphatics rather than the individual compounds. Uncertainty regarding the toxicity assessment comes primarily from the use of toxicity of TCE as a surrogate compound for toxic effects of total chlorinated aliphatics. TCE, although the most prevalent compound, is also one of the more toxic of the chlorinated aliphatics and may result in an overestimation of risk when evaluating risks to total chlorinated aliphatics. For the exposure assessment, the greatest uncertainty is associated with the estimation of exposure point concentrations for future conditions. Groundwater concentrations at various monitoring wells near the tributaries and monitoring wells PMW-14 and 16B were used to estimate exposure point concentrations for sediment interstitial pore water. The groundwater data was used directly to evaluate potential effects rather than modeled to estimate the interstitial pore water concentration. The actual concentration would probably much less due to dilution, dispersion and adsorption/desorption processes. For risk characterization, the greatest uncertainty is associated with calculation of potential ecological risks for future conditions and it is the result of the assumptions made for calculating future exposure point concentrations. The estimated ecological risks for future conditions may overestimate the actual risk by one to two orders-of-magnitude.

8.3 SUMMARY OF HEALTH-BASED CLEAN-UP LEVELS

Section 7.0 presented the health-based clean-up levels for compounds-of-interest in exposure media at the Plant site. The exposure media include:

- on-site surface soils;
- off-site groundwater;
- surface water; and
- sediments.

Health-based clean-up levels for on-site surface soils and groundwater were based on the human health evaluation. Health-based clean-up levels for surface water and sediments were based on the ecological evaluation. A summary of the health-based clean-up levels is provided in Table 8-9.

For on-site surface soils, health-based clean-up levels were based on exposures to on-site maintenance workers. Health-based clean-up levels for groundwater were calculated under two scenarios: exposures to off-site groundwater from irrigation uses; and, exposures to off-site groundwater from both potable uses and irrigation uses. Health-based clean-up levels from irrigation use of off-site groundwater were based on the exposure assumption for off-site residents under both the current and future land use scenario. The clean-up levels for carcinogens were based on exposures to children (aged 2 to 18 years), while clean-up levels for noncarcinogens were based on exposures for young children (aged 2 to 6 years). Health-based clean-up levels for irrigation and potable uses of off-site groundwater were based on exposures to off-site residents in both the current and future scenarios. The clean-up levels for carcinogens were based on exposures to adults while clean-up levels for noncarcinogens were based on exposures for young children (aged 2 to 6 years).

Health-based clean-up levels for compounds-of-interest in surface water were based on the lowest benchmark concentration for chronic effects to aquatic organisms. The compounds-of-interest for surface water were total chlorinated aliphatics while clean-up levels were based on toxicity data for TCE.

Health-based clean-up levels for sediments were based on an acceptable concentration for total chlorinated aliphatics in sediment interstitial pore water. It was assumed that the acceptable concentration for total chlorinated aliphatics in interstitial pore water was equal to the clean-up level for surface water. The clean-up level for sediments was then calculated based on the Equilibrium Partitioning Approach for Generating Sediment Quality Criteria (EPA, 1988b).

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TABLES

ORIGINAL
(Red)

TABLE 2-1
SUMMARY OF SURFACE SOIL DATA

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/Kg							
Chloromethane	9	0	9	11.21	1333.33		
Bromomethane	9	0	9	11.21	1333.33		
Vinyl Chloride	9	0	9	11.21	1333.33		
Chloroethane	9	0	9	11.21	1333.33		
Methylene Chloride	9	6	3	5.81	646.15	12.51	37.04
Acetone	9	3	6	11.38	12.56	11.63	2564.10
Carbon Disulfide	9	0	9	5.61	646.15		
1,1-Dichloroethene	10	0	10	5.61	646.15		
1,1-Dichloroethane	10	1	9	5.61	646.15	88.89	88.89
1,2-Dichloroethene (total)	10	0	10	5.61	646.15		
Chloroform	9	0	9	5.61	646.15		
1,2-Dichloroethane	9	0	9	5.61	646.15		
2-Butanone	9	0	9	11.21	1333.33		
1,1,1-Trichloroethane	10	1	9	5.61	646.15	432.10	432.10
Carbon Tetrachloride	9	0	9	5.61	646.15		
Vinyl Acetate	9	0	9	11.21	1333.33		
Bromodichloromethane	9	0	9	5.61	646.15		
1,2-Dichloropropane	9	0	9	5.61	646.15		
cis-1,3-Dichloropropene	9	0	9	5.61	646.15		
Trichloroethene	10	0	10	5.61	646.15		
Dibromochloromethane	9	0	9	5.61	646.15		
1,1,2-Trichloroethane	9	0	9	5.61	646.15		
Benzene	9	0	9	5.61	646.15		
trans-1,3-Dichloropropene	9	0	9	5.61	646.15		
Bromoform	9	0	9	5.61	646.15		
4-Methyl-2-Pentanone	9	0	9	11.21	1333.33		
2-Hexanone	9	0	9	11.21	1333.33		
Tetrachloroethene	10	0	10	5.61	646.15		
1,1,2,2-Tetrachloroethane	9	0	9	5.61	646.15		
Toluene	9	0	9	5.61	646.15		
Chlorobenzene	9	0	9	5.61	646.15		
Ethylbenzene	9	0	9	5.61	646.15		
Styrene	9	0	9	5.61	646.15		
Xylenes (total)	9	1	8	5.61	6.28	5128.21	5128.21
SEMI-VOLATILE, mg/Kg							
bis (2-ethylhexyl) phthalate	6	1	5	0.38	0.41	24.32	24.32
PCBs (ug/Kg)							
PCB-1016	5	0	5	96.38554216	100.50		
PCB-1221	5	0	5	96.38554216	100.50		
PCB-1232	5	0	5	96.38554216	100.50		
PCB-1242	5	0	5	96.38554216	100.50		
PCB-1248	5	0	5	96.38554216	100.50		
PCB-1254	5	1	4	192.7710843	201.01	518.52	518.52
PCB-1260	5	0	5	192.7710843	201.01		

TABLE 2-2
SUMMARY OF COMPOUNDS OF INTEREST FOR
ON-SITE SURFACE SOILS

SEMI VOLATILES

Bis (2-ethylhexyl)phthalate

VOLATILES

Methylene Chloride
Acetone
1,1-Dichloroethane
1,1,1-Trichloroethane
Xylenes

PCB - Arochlor 1254

TABLE 2-3
SUMMARY OF DATA FOR REMOTE FILL SPOUT AREA SURFACE SOILS

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/Kg							
Chloromethane	1	0	1	12.56	12.56		
Bromomethane	1	0	1	12.56	12.56		
Vinyl Chloride	1	0	1	12.56	12.56		
Chloroethane	1	0	1	12.56	12.56		
Methylene Chloride	1	1	0			20.10	20.10
Acetone	1	0	1	12.56	12.56		
Carbon Disulfide	1	0	1	6.28	6.28		
1,1-Dichloroethene	1	0	1	6.28	6.28		
1,1-Dichloroethane	1	0	1	6.28	6.28		
1,2-Dichloroethene (total)	1	0	1	6.28	6.28		
Chloroform	1	0	1	6.28	6.28		
1,2-Dichloroethane	1	0	1	6.28	6.28		
2-Butanone	1	0	1	12.56	12.56		
1,1,1-Trichloroethane	1	0	1	6.28	6.28		
Carbon Tetrachloride	1	0	1	6.28	6.28		
Vinyl Acetate	1	0	1	12.56	12.56		
Bromodichloromethane	1	0	1	6.28	6.28		
1,2-Dichloropropane	1	0	1	6.28	6.28		
cis-1,3-Dichloropropene	1	0	1	6.28	6.28		
Trichloroethene	1	0	1	6.28	6.28		
Dibromochloromethane	1	0	1	6.28	6.28		
1,1,2-Trichloroethane	1	0	1	6.28	6.28		
Benzene	1	0	1	6.28	6.28		
trans-1,3-Dichloropropene	1	0	1	6.28	6.28		
Bromoform	1	0	1	6.28	6.28		
4-Methyl-2-Pentanone	1	0	1	12.56	12.56		
2-Hexanone	1	0	1	12.56	12.56		
Tetrachloroethene	1	0	1	6.28	6.28		
1,1,2,2-Tetrachloroethane	1	0	1	6.28	6.28		
Toluene	1	0	1	6.28	6.28		
Chlorobenzene	1	0	1	6.28	6.28		
Ethylbenzene	1	0	1	6.28	6.28		
Styrene	1	0	1	6.28	6.28		
Xylenes (total)	1	0	1	6.28	6.28		
SEMI-VOLATILE, mg/Kg							
bis (2-ethylhexyl) phthalate	1	0	1	0.41	0.41		

TABLE 2-4
SUMMARY OF DATA FOR DEGREASING FLUID STORAGE AREA SURFACE SOILS

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/Kg							
Chloromethane							
Bromomethane							
Vinyl Chloride							
Chloroethane							
Methylene Chloride							
Acetone							
Carbon Disulfide							
1,1-Dichloroethene	1	0	1	20.00	20.00		
1,1-Dichloroethane	1	0	1	20.00	20.00		
1,2-Dichloroethene (total)	1	0	1	20.00	20.00		
Chloroform							
1,2-Dichloroethane							
2-Butanone							
1,1,1-Trichloroethane	1	0	1	10.00	10.00		
Carbon Tetrachloride							
Vinyl Acetate							
Bromodichloromethane							
1,2-Dichloropropane							
cis-1,3-Dichloropropene							
Trichloroethene	1	0	1	10.00	10.00		
Dibromochloromethane							
1,1,2-Trichloroethane							
Benzene							
trans-1,3-Dichloropropene							
Bromoform							
4-Methyl-2-Pentanone							
2-Hexanone							
Tetrachloroethene	1	0	1	10.00	10.00		
1,1,2,2-Tetrachloroethane							
Toluene							
Chlorobenzene							
Ethylbenzene							
Styrene							
Xylenes (total)							
SEMI-VOLATILE, mg/Kg							
bis (2-ethylhexyl) phthalate							

TABLE 2-5
SUMMARY OF DATA FOR PUMP HOUSE AREA SURFACE SOILS

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/Kg							
Chloromethane	2	0	2	11.38	12.35		
Bromomethane	2	0	2	11.38	12.35		
Vinyl Chloride	2	0	2	11.38	12.35		
Chloroethane	2	0	2	11.38	12.35		
Methylene Chloride	2	2	0			12.51	37.04
Acetone	2	0	2	11.38	12.35		
Carbon Disulfide	2	0	2	5.69	6.17		
1,1-Dichloroethene	2	0	2	5.69	6.17		
1,1-Dichloroethane	2	1	1	5.69	5.69	88.89	88.89
1,2-Dichloroethene (total)	2	0	2	5.69	6.17		
Chloroform	2	0	2	5.69	6.17		
1,2-Dichloroethane	2	0	2	5.69	6.17		
2-Butanone	2	0	2	11.38	12.35		
1,1,1-Trichloroethane	2	1	1	5.69	5.69	432.10	432.10
Carbon Tetrachloride	2	0	2	5.69	6.17		
Vinyl Acetate	2	0	2	11.38	12.35		
Bromodichloromethane	2	0	2	5.69	6.17		
1,2-Dichloropropane	2	0	2	5.69	6.17		
cis-1,3-Dichloropropene	2	0	2	5.69	6.17		
Trichloroethene	2	0	2	5.69	6.17		
Dibromochloromethane	2	0	2	5.69	6.17		
1,1,2-Trichloroethane	2	0	2	5.69	6.17		
Benzene	2	0	2	5.69	6.17		
trans-1,3-Dichloropropene	2	0	2	5.69	6.17		
Bromoform	2	0	2	5.69	6.17		
4-Methyl-2-Pentanone	2	0	2	11.38	12.35		
2-Hexanone	2	0	2	11.38	12.35		
Tetrachloroethene	2	0	2	5.69	6.17		
1,1,2,2-Tetrachloroethane	2	0	2	5.69	6.17		
Toluene	2	0	2	5.69	6.17		
Chlorobenzene	2	0	2	5.69	6.17		
Ethylbenzene	2	0	2	5.69	6.17		
Styrene	2	0	2	5.69	6.17		
Xylenes (total)	2	0	2	5.69	6.17		
SEMI-VOLATILE, mg/Kg							
bis (2-ethylhexyl) phthalate	2	1	1	375.43	375.43	24.32	24.32
PCBs (ug/Kg)							
PCB-1016	1	0	1	98.77	98.77		
PCB-1221	1	0	1	98.77	98.77		
PCB-1232	1	0	1	98.77	98.77		
PCB-1242	1	0	1	98.77	98.77		
PCB-1248	1	0	1	98.77	98.77		
PCB-1254	1	1	0			518.52	518.52
PCB-1260	1	0	1	197.53	197.53		

TABLE 2-6
SUMMARY OF DATA FOR RAILROAD DOCK AREA SURFACE SOILS

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/Kg							
Chloromethane	2	0	2	12.17	1333.33		
Bromomethane	2	0	2	12.17	1333.33		
Vinyl Chloride	2	0	2	12.17	1333.33		
Chloroethane	2	0	2	12.17	1333.33		
Methylene Chloride	2	0	2	6.08	646.15		
Acetone	2	1	1	12.17	12.17	2564.10	2564.10
Carbon Disulfide	2	0	2	6.08	646.15		
1,1-Dichloroethene	2	0	2	6.08	646.15		
1,1-Dichloroethane	2	0	2	6.08	646.15		
1,2-Dichloroethene (total)	2	0	2	6.08	646.15		
Chloroform	2	0	2	6.08	646.15		
1,2-Dichloroethane	2	0	2	6.08	646.15		
2-Butanone	2	0	2	12.17	1333.33		
1,1,1-Trichloroethane	2	0	2	6.08	646.15		
Carbon Tetrachloride	2	0	2	6.08	646.15		
Vinyl Acetate	2	0	2	12.17	1333.33		
Bromodichloromethane	2	0	2	6.08	646.15		
1,2-Dichloropropane	2	0	2	6.08	646.15		
cis-1,3-Dichloropropene	2	0	2	6.08	646.15		
Trichloroethene	2	0	2	6.08	646.15		
Dibromochloromethane	2	0	2	6.08	646.15		
1,1,2-Trichloroethane	2	0	2	6.08	646.15		
Benzene	2	0	2	6.08	646.15		
trans-1,3-Dichloropropene	2	0	2	6.08	646.15		
Bromoform	2	0	2	6.08	646.15		
4-Methyl-2-Pentanone	2	0	2	12.17	1333.33		
2-Hexanone	2	0	2	12.17	1333.33		
Tetrachloroethene	2	0	2	6.08	646.15		
1,1,2,2-Tetrachloroethane	2	0	2	6.08	646.15		
Toluene	2	0	2	6.08	646.15		
Chlorobenzene	2	0	2	6.08	646.15		
Ethylbenzene	2	0	2	6.08	646.15		
Styrene	2	0	2	6.08	646.15		
Xylenes (total)	2	1	1	6.08	6.08	5128.21	5128.21
SEMI-VOLATILE, mg/Kg							
bis (2-ethylhexyl) phthalate	1	0	1	0.40	0.40		

TABLE 2-7
SUMMARY OF DATA FOR OLD WASTE DRUM STORAGE AREA SURFACE SOILS

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/Kg							
Chloromethane	1	0	1	12.05	12.05		
Bromomethane	1	0	1	12.05	12.05		
Vinyl Chloride	1	0	1	12.05	12.05		
Chloroethane	1	0	1	12.05	12.05		
Methylene Chloride	1	1	0			24.10	24.10
Acetone	1	0	1	12.05	12.05		
Carbon Disulfide	1	0	1	6.02	6.02		
1,1-Dichloroethene	1	0	1	6.02	6.02		
1,1-Dichloroethane	1	0	1	6.02	6.02		
1,2-Dichloroethene (total)	1	0	1	6.02	6.02		
Chloroform	1	0	1	6.02	6.02		
1,2-Dichloroethane	1	0	1	6.02	6.02		
2-Butanone	1	0	1	12.05	12.05		
1,1,1-Trichloroethane	1	0	1	6.02	6.02		
Carbon Tetrachloride	1	0	1	6.02	6.02		
Vinyl Acetate	1	0	1	12.05	12.05		
Bromodichloromethane	1	0	1	6.02	6.02		
1,2-Dichloropropane	1	0	1	6.02	6.02		
cis-1,3-Dichloropropene	1	0	1	6.02	6.02		
Trichloroethene	1	0	1	6.02	6.02		
Dibromochloromethane	1	0	1	6.02	6.02		
1,1,2-Trichloroethane	1	0	1	6.02	6.02		
Benzene	1	0	1	6.02	6.02		
trans-1,3-Dichloropropene	1	0	1	6.02	6.02		
Bromoform	1	0	1	6.02	6.02		
4-Methyl-2-Pentanone	1	0	1	12.05	12.05		
2-Hexanone	1	0	1	12.05	12.05		
Tetrachloroethene	1	0	1	6.02	6.02		
1,1,2,2-Tetrachloroethane	1	0	1	6.02	6.02		
Toluene	1	0	1	6.02	6.02		
Chlorobenzene	1	0	1	6.02	6.02		
Ethylbenzene	1	0	1	6.02	6.02		
Styrene	1	0	1	6.02	6.02		
Xylenes (total)	1	0	1	6.02	6.02		
SEMI-VOLATILE, mg/Kg							
bis (2-ethylhexyl) phthalate	1	0	1	0.40	0.40		

ORIGINAL (Red)

TABLE 2-8
SUMMARY OF COMPOUNDS OF INTEREST FOR
ON-SITE SURFACE SOILS BY SOURCE AREA

Remote Fill Spout Area	Degreasing Fluid Storage Tank Area	Pumphouse Area
VOLATILES:		**SEMI VOLATILES:**
Methylene Chloride		Bis (2-ethylhexyl)phthalate
		VOLATILES:
		Methylene Chloride 1,1-Dichloroethane 1,1,1-Trichloroethane
		PCB – Arochlor 1254

Railroad Track Area	Old Waste Drum Storage Area
VOLATILES:	**VOLATILES:**
Acetone Xylenes	Methylene Chloride

TABLE 2-9
SUMMARY OF SUBSURFACE SOIL DATA

ORIGINAL (Red.)

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/Kg							
Chloromethane	11	0	11	10.27	12.12		
Bromomethane	11	0	11	10.27	12.12		
Vinyl Chloride	11	0	11	10.27	12.12		
Chloroethane	11	0	11	10.27	12.12		
Methylene Chloride	11	5	6	5.13	6.06	6.47	11.99
Acetone	11	8	3	10.37	11.24	15.40	71.52
Carbon Disulfide	11	0	11	5.13	6.06		
1,1-Dichloroethene	11	1	10	5.13	6.06	72.64	72.64
1,1-Dichloroethane	11	1	10	5.13	6.06	19.37	19.37
1,2-Dichloroethene (total)	11	2	9	5.19	6.06	12.32	96.85
Chloroform	11	0	11	5.13	6.06		
1,2-Dichloroethane	11	1	10	5.13	6.06	6.00	6.00
2-Butanone	11	0	11	10.27	12.12		
1,1,1-Trichloroethane	11	2	9	5.19	6.06	9.24	69.01
Carbon Tetrachloride	11	0	11	5.13	6.06		
Vinyl Acetate	11	0	11	10.27	12.12		
Bromodichloromethane	11	0	11	5.13	6.06		
1,2-Dichloropropane	11	0	11	5.13	6.06		
cis-1,3-Dichloropropene	11	0	11	5.13	6.06		
Trichloroethene	11	2	9	5.19	6.06	302.66	308.01
Dibromochloromethane	11	0	11	5.13	6.06		
1,1,2-Trichloroethane	11	0	11	5.13	6.06		
Benzene	11	0	11	5.13	6.06		
trans-1,3-Dichloropropene	11	0	11	5.13	6.06		
Bromoform	11	0	11	5.13	6.06		
4-Methyl-2-Pentanone	11	0	11	10.27	12.12		
2-Hexanone	11	0	11	10.27	12.12		
Tetrachloroethene	11	0	11	5.13	6.06		
1,1,2,2-Tetrachloroethane	11	0	11	5.13	6.06		
Toluene	11	0	11	5.13	6.06		
Chlorobenzene	11	0	11	5.13	6.06		
Ethylbenzene	11	0	11	5.13	6.06		
Styrene	11	0	11	5.13	6.06		
Xylenes (total)	11	0	11	5.13	6.06		
SEMI-VOLATILE, mg/Kg							
bis (2-ethylhexyl) phthalate	4	0	4	0.36	0.40		
PCBs (ug/Kg)							
PCB-1016	2	0	2	86.58	87.21		
PCB-1221	2	0	2	86.58	87.21		
PCB-1232	2	0	2	86.58	87.21		
PCB-1242	2	0	2	86.58	87.21		
PCB-1248	2	0	2	86.58	87.21		
PCB-1254	2	0	2	173.16	174.42		
PCB-1260	2	0	2	173.16	174.42		

TABLE 2-10
SUMMARY OF COMPOUNDS OF INTEREST FOR
ON-SITE SUBSURFACE SOILS

VOLATILES
Methylene Chloride
Acetone
1,1-Dichloroethene
1,1-Dichloroethane
1,2-Dichloroethene
1,1,1-Trichloroethane
Trichloroethene

ORIGINAL
(Red)

TABLE 2-11
SUMMARY OF PHASE I AND PHASE II GROUNDWATER DATA

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/L							
Chloromethane	43	0	43	10	1000		
Bromomethane	43	0	43	10	1000		
Vinyl Chloride	43	0	43	10	1000		
Chloroethane	43	0	43	10	1000		
Methylene Chloride	43	0	43	5	500		
Acetone	43	16	27	10	1000	12	23
Carbon Disulfide	43	2	41	5	500	10	11
1,1-Dichloroethene	43	16	27	5	5	6	3200
1,1-Dichloroethane	43	3	40	5	500	21	77
1,2-Dichloroethene (total)	43	6	37	5	5	3	800
Chloroform	43	0	43	5	500		
1,2-Dichloroethane	43	2	41	5	500	7	9
2-Butanone	43	1	42	10	1000	55	55
1,1,1-Trichloroethane	43	14	29	5	5	7	6000
Carbon Tetrachloride	43	0	43	5	1500		
Vinyl Acetate	43	0	43	10	1000		
Bromodichloromethane	43	0	43	5	500		
1,2-Dichloropropane	43	0	43	5	500		
cis-1,3-Dichloropropene	43	0	43	5	500		
Trichloroethene	43	21	22	5	5	9	54000
Dibromochloromethane	43	0	43	5	500		
1,1,2-Trichloroethane	43	0	43	5	500		
Benzene	43	0	43	5	500		
trans-1,3-Dichloropropene	43	0	43	5	500		
Bromoform	43	0	43	5	500		
4-Methyl-2-Pentanone	43	0	43	10	1000		
2-Hexanone	43	0	43	10	1000		
Tetrachloroethene	43	0	43	5	500		
1,1,2,2-Tetrachloroethane	43	0	43	5	500		
Toluene	43	1	42	5	500	6	6
Chlorobenzene	43	0	43	5	500		
Ethylbenzene	43	0	43	5	500		
Styrene	43	0	43	5	500		
Xylenes (total)	43	0	43	5	500		
TCL SEMI-VOLATILE, ug/L							
bis (2-ethylhexyl) phthalate	32	2	30	10	20	30	90

ORIGINAL
(Red)

TABLE 2-12
SUMMARY OF COMPOUNDS OF INTEREST FOR
GROUNDWATER

VOLATILES

Acetone
Carbon disulfide
1,1-Dichloroethene
1,1-Dichloroethane
1,2-Dichloroethene
1,2-Dichloroethene
2-Butanone
1,1,1-Trichloroethene
Trichloroethene
Toluene

SEMI VOLATILES

Bis (2-ethylhexyl)phthalate

TABLE 2-13
SUMMARY OF DATA FOR ON-SITE SHALLOW GROUNDWATER DATA

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/L							
Chloromethane	15	0	14	10	1000		
Bromomethane	15	0	14	10	1000		
Vinyl Chloride	15	0	14	10	1000		
Chloroethane	15	0	14	10	1000		
Methylene Chloride	15	0	14	5	500		
Acetone	15	6	10	10	1000	14	23
Carbon Disulfide	15	1	13	5	500	11	11
1,1-Dichloroethene	15	6	8	5	5	6	3200
1,1-Dichloroethane	15	1	13	5	500	77	77
1,2-Dichloroethene (total)	15	2	12	5	5	490	800
Chloroform	15	0	14	5	500		
1,2-Dichloroethane	15	1	13	5	500	7	7
2-Butanone	15	0	14	10	1000		
1,1,1-Trichloroethane	15	4	10	5	5	16	3200
Carbon Tetrachloride	15	0	14	5	500		
Vinyl Acetate	15	0	14	10	1000		
Bromodichloromethane	15	0	14	5	500		
1,2-Dichloropropane	15	0	14	5	500		
cis-1,3-Dichloropropene	15	0	14	5	500		
Trichloroethene	15	6	8	5	5	41	54000
Dibromochloromethane	15	0	14	5	500		
1,1,2-Trichloroethane	15	0	14	5	500		
Benzene	15	0	14	5	500		
trans-1,3-Dichloropropene	15	0	14	5	500		
Bromoform	15	0	14	5	500		
4-Methyl-2-Pentanone	15	0	14	10	1000		
2-Hexanone	15	0	14	10	1000		
Tetrachloroethene	15	0	14	5	500		
1,1,2,2-Tetrachloroethane	15	0	14	5	500		
Toluene	15	0	14	5	500		
Chlorobenzene	15	0	14	5	500		
Ethylbenzene	15	0	14	5	500		
Styrene	15	0	14	5	500		
Xylenes (total)	15	0	14	5	500		
TCL SEMI-VOLATILE, ug/L							
bis (2-ethylhexyl) phthalate	11	1	9	10	20	30	30

ORIGINAL
(Red)

TABLE 2-14
SUMMARY OF DATA FOR ON-SITE DEEP GROUNDWATER DATA

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/L							
Chloromethane	21	0	20	10	100		
Bromomethane	21	0	20	10	100		
Vinyl Chloride	21	0	20	10	100		
Chloroethane	21	0	20	10	100		
Methylene Chloride	21	0	20	5	50		
Acetone	21	7	14	10	100	12	23
Carbon Disulfide	21	1	19	5	50	10	10
1,1-Dichloroethene	21	8	13	5	5	8	3200
1,1-Dichloroethane	21	2	18	5	50	21	50
1,2-Dichloroethene (total)	21	4	16	5	5	8	330
Chloroform	21	0	20	5	50		
1,2-Dichloroethane	21	1	19	5	50	9	9
2-Butanone	21	1	19	10	100	55	55
1,1,1-Trichloroethane	21	8	13	5	5	7	6000
Carbon Tetrachloride	21	0	20	5	1500		
Vinyl Acetate	21	0	20	10	100		
Bromodichloromethane	21	0	20	5	50		
1,2-Dichloropropane	21	0	20	5	50		
cis-1,3-Dichloropropene	21	0	20	5	50		
Trichloroethene	21	12	9	5	5	20	45000
Dibromochloromethane	21	0	20	5	50		
1,1,2-Trichloroethane	21	0	20	5	50		
Benzene	21	0	20	5	50		
trans-1,3-Dichloropropene	21	0	20	5	50		
Bromoform	21	0	20	5	50		
4-Methyl-2-Pentanone	21	0	20	10	100		
2-Hexanone	21	0	20	10	100		
Tetrachloroethene	21	0	20	5	50		
1,1,2,2-Tetrachloroethane	21	0	20	5	50		
Toluene	21	1	19	5	50	6	6
Chlorobenzene	21	0	20	5	50		
Ethylbenzene	21	0	20	5	50		
Styrene	21	0	20	5	50		
Xylenes (total)	21	0	20	5	50		
TCL SEMI-VOLATILE, ug/L							
bis (2-ethylhexyl) phthalate	15	1	13	10	20	90	90

TABLE 2-15
SUMMARY OF DATA FOR OFF-SITE SHALLOW GROUNDWATER DATA

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/L							
Chloromethane	2	0	3	10	10		
Bromomethane	2	0	3	10	10		
Vinyl Chloride	2	0	3	10	10		
Chloroethane	2	0	3	10	10		
Methylene Chloride	2	0	3	5	5		
Acetone	2	1	1	10	10	15	15
Carbon Disulfide	2	0	2	5	5		
1,1-Dichloroethene	2	0	2	5	5		
1,1-Dichloroethane	2	0	2	5	5		
1,2-Dichloroethene (total)	2	0	2	5	5		
Chloroform	2	0	2	5	5		
1,2-Dichloroethane	2	0	2	5	5		
2-Butanone	2	0	2	10	10		
1,1,1-Trichloroethane	2	0	2	5	5		
Carbon Tetrachloride	2	0	2	5	5		
Vinyl Acetate	2	0	2	10	10		
Bromodichloromethane	2	0	2	5	5		
1,2-Dichloropropane	2	0	2	5	5		
cis-1,3-Dichloropropene	2	0	2	5	5		
Trichloroethene	2	0	2	5	5		
Dibromochloromethane	2	0	2	5	5		
1,1,2-Trichloroethane	2	0	2	5	5		
Benzene	2	0	2	5	5		
trans-1,3-Dichloropropene	2	0	2	5	5		
Bromoform	2	0	2	5	5		
4-Methyl-2-Pentanone	2	0	2	10	10		
2-Hexanone	2	0	2	10	10		
Tetrachloroethene	2	0	2	5	5		
1,1,2,2-Tetrachloroethane	2	0	2	5	5		
Toluene	2	0	2	5	5		
Chlorobenzene	2	0	2	5	5		
Ethylbenzene	2	0	2	5	5		
Styrene	2	0	2	5	5		
Xylenes (total)	2	0	2	5	5		
TCL SEMI-VOLATILE, ug/L							
bis (2-ethylhexyl) phthalate	2	0	2	10	10		

ORIGINAL (Red)

TABLE 2-16
SUMMARY OF DATA FOR OFF-SITE DEEP GROUNDWATER DATA

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/L							
Chloromethane	5	0	5	10	10		
Bromomethane	5	0	5	10	10		
Vinyl Chloride	5	0	5	10	10		
Chloroethane	5	0	5	10	10		
Methylene Chloride	5	0	5	5	5		
Acetone	5	3	2	10	10	12	20
Carbon Disulfide	5	0	5	5	5		
1,1-Dichloroethene	5	2	3	5	5	6	6
1,1-Dichloroethane	5	0	5	5	5		
1,2-Dichloroethene (total)	5	0	5	5	5		
Chloroform	5	0	5	5	5		
1,2-Dichloroethane	5	0	5	5	5		
2-Butanone	5	0	5	10	10		
1,1,1-Trichloroethane	5	2	3	5	5	7	7
Carbon Tetrachloride	5	0	5	5	5		
Vinyl Acetate	5	0	5	10	10		
Bromodichloromethane	5	0	5	5	5		
1,2-Dichloropropane	5	0	5	5	5		
cis-1,3-Dichloropropene	5	0	5	5	5		
Trichloroethene	5	3	2	5	5	9	230
Dibromochloromethane	5	0	5	5	5		
1,1,2-Trichloroethane	5	0	5	5	5		
Benzene	5	0	5	5	5		
trans-1,3-Dichloropropene	5	0	5	5	5		
Bromoform	5	0	5	5	5		
4-Methyl-2-Pentanone	5	0	5	10	10		
2-Hexanone	5	0	5	10	10		
Tetrachloroethene	5	0	5	5	5		
1,1,2,2-Tetrachloroethane	5	0	5	5	5		
Toluene	5	0	5	5	5		
Chlorobenzene	5	0	5	5	5		
Ethylbenzene	5	0	5	5	5		
Styrene	5	0	5	5	5		
Xylenes (total)	5	0	5	5	5		
TCL SEMI-VOLATILE, ug/L							
bis (2-ethylhexyl) phthalate	4	0	4	10	10		

TABLE 2-17
SUMMARY OF PHASE I AND PHASE II SURFACE WATER DATA

	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/L							
Chloromethane	8	0	8	10	10		
Bromomethane	8	0	8	10	10		
Vinyl Chloride	8	0	8	10	10		
Chloroethane	8	0	8	10	10		
Methylene Chloride	8	0	8	5	5		
Acetone	8	4	4	10	10	17	24
Carbon Disulfide	8	0	8	5	5		
1,1-Dichloroethene	8	0	8	5	5		
1,1-Dichloroethane	8	0	8	5	5		
1,2-Dichloroethene (total)	8	0	8	5	5		
Chloroform	8	0	8	5	5		
1,2-Dichloroethane	8	0	8	5	5		
2-Butanone	8	0	8	10	10		
1,1,1-Trichloroethane	8	0	8	5	5		
Carbon Tetrachloride	8	0	8	5	5		
Vinyl Acetate	8	0	8	10	10		
Bromodichloromethane	8	0	8	5	5		
1,2-Dichloropropane	8	0	8	5	5		
cis-1,3-Dichloropropene	8	0	8	5	5		
Trichloroethene	8	2	6	5	5	10	11
Dibromochloromethane	8	0	8	5	5		
1,1,2-Trichloroethane	8	0	8	5	5		
Benzene	8	0	8	5	5		
trans-1,3-Dichloropropene	8	0	8	5	5		
Bromoform	8	0	8	5	5		
4-Methyl-2-Pentanone	8	0	8	10	10		
2-Hexanone	8	0	8	10	10		
Tetrachloroethene	8	0	8	5	5		
1,1,2,2-Tetrachloroethane	8	0	8	5	5		
Toluene	8	0	8	5	5		
Chlorobenzene	8	0	8	5	5		
Ethylbenzene	8	0	8	5	5		
Styrene	8	0	8	5	5		
Xylenes (total)	8	0	8	5	5		
SEMI-VOLATILE, ug/L							
bis (2-ethylhexyl) phthalate	8	0	8	10	20		

TABLE 2-18
SUMMARY OF COMPOUNDS OF INTEREST FOR
OFF-SITE SURFACE WATER

VOLATILES
Acetone
Trichloroethene

TABLE 2-19
SUMMARY OF PHASE I AND PHASE II SEDIMENT DATA

Parameters	# Samples	# Hits	# BDL	Minimum BDL	Maximum BDL	Minimum Detected	Maximum Detected
TCL VOLATILES, ug/Kg							
Chloromethane	8	0	8	12.36	22.08		
Bromomethane	8	0	8	12.36	22.08		
Vinyl Chloride	8	0	8	12.36	22.08		
Chloroethane	8	0	8	12.36	22.08		
Methylene Chloride	8	1	7	6.18	11.04	10.69	10.69
Acetone	8	5	3	12.36	22.08	15.70	45.80
Carbon Disulfide	8	0	8	6.18	11.04		
1,1-Dichloroethene	8	0	8	6.18	11.04		
1,1-Dichloroethane	8	0	8	6.18	11.04		
1,2-Dichloroethene (total)	8	0	8	6.18	11.04		
Chloroform	8	0	8	6.18	11.04		
1,2-Dichloroethane	8	0	8	6.18	11.04		
2-Butanone	8	0	8	12.36	22.08		
1,1,1-Trichloroethane	8	0	8	6.18	11.04		
Carbon Tetrachloride	8	0	8	6.18	11.04		
Vinyl Acetate	8	0	8	12.36	22.08		
Bromodichloromethane	8	0	8	6.18	11.04		
1,2-Dichloropropane	8	0	8	6.18	11.04		
cis-1,3-Dichloropropene	8	0	8	6.18	11.04		
Trichloroethene	8	0	8	6.18	11.04		
Dibromochloromethane	8	0	8	6.18	11.04		
1,1,2-Trichloroethane	8	0	8	6.18	11.04		
Benzene	8	0	8	6.18	11.04		
trans-1,3-Dichloropropene	8	0	8	6.18	11.04		
Bromoform	8	0	8	6.18	11.04		
4-Methyl-2-Pentanone	8	0	8	12.36	22.08		
2-Hexanone	8	0	8	12.36	22.08		
Tetrachloroethene	8	0	8	6.18	11.04		
1,1,2,2-Tetrachloroethane	8	0	8	6.18	11.04		
Toluene	8	0	8	6.18	11.04		
Chlorobenzene	8	0	8	6.18	11.04		
Ethylbenzene	8	0	8	6.18	11.04		
Styrene	8	0	8	6.18	11.04		
Xylenes (total)	8	0	8	6.18	11.04		
SEMI-VOLATILE, mg/Kg							
bis (2-ethylhexyl) phthalate	8	1	7	0.41	0.52	0.73	0.73

TABLE 2-20
SUMMARY OF COMPOUNDS OF INTEREST FOR OFF-SITE SEDIMENT

SEMI VOLATILES

Bis (2-ethylhexyl)phthalate

VOLATILES

Methylene Chloride
Acetone

ORIGINAL
(Red)

TABLE 2-21
LIST OF COMPOUNDS OF INTEREST BY MEDIA

Compounds of Interest	Surface Soils					Subsurface Soils	Onsite Groundwater		Offsite Groundwater		Surface Water	Sediments
	Remote Fill Spout	Degreasing Storage Tank	Pumphouse	Railroad Dock	Old Waste Drum Storage		Shallow	Deep	Shallow	Deep		
TCL VOLATILES												
Chloromethane												
Bromomethane												
Vinyl Chloride												
Chloroethane												
Methylene Chloride	(1)		(1)		(1)	(1)						(1)
Acetone				(2)		(2)	(2)	(2)	(2)	(2)	(2)	(2)
Carbon Disulfide							(3)	(4)				
1,1-Dichloroethene						yes (6)	yes	yes		yes		
1,1-Dichloroethane			yes			yes	yes	yes				
1,2-Dichloroethene (total)						yes	yes	yes				
Chloroform												
1,2-Dichloroethane							yes	yes				
2-Butanone								(8)				
1,1,1-Trichloroethane			yes			yes	yes	yes		yes		
Carbon Tetrachloride												
Vinyl Acetate												
Bromodichloromethane												
1,2-Dichloropropane												
cis-1,3-Dichloropropene												
Trichloroethene						yes	yes	yes		yes	yes	
Dibromochloromethane												
1,1,2-Trichloroethane												
Benzene												
trans-1,3-Dichloropropene												
Bromoform												
4-Methyl-2-Pentanone												
2-Hexanone												
Tetrachloroethene												
1,1,2,2-Tetrachloroethane												
Toluene								(4)				
Chlorobenzene												
Ethylbenzene												
Styrene												
Xylenes (total)				yes								
SEMI-VOLATILES												
bis (2-ethylhexyl) phthalate			(7)				(7)	(7)	(7)			(5)
PCBs												
PCB-1016												
PCB-1221												
PCB-1232												
PCB-1242												
PCB-1248												
PCB-1254			yes									
PCB-1260												

Notes:

(1) - A backround concentration of 33 ppb was detected in soils. Compound is a common lab contaminant and was detected at a concentration less than 10 times MDL.

(2) - Compound is a common lab contaminant and was detected at a concentration less than 10 times the MDL in all media.

(3) - Compound was found in only 1 of 14 samples at a concentration less than 5 times MDL.

(4) - Compound was found in only 1 of 20 samples at a concentration less than 5 times MDL.

(5) - Compound was found in only 1 of 8 samples at a concentration less than 10 times the MDL (actual concentration was equal to the detection limit).

(6) - A yes indicates the chemical is a compound of interest for that media.

(7) - Compound is a common lab contaminant and was detected at a concentration less than 10 times the MDL in all media.

(8) - Compound was detected in only 1 of 20 samples at a concentration of about 5 times the detection limit.

MDL - Method Detection Limit.

ORIGINAL
(Red)

TABLE 3-1
POTENTIAL HUMAN RECEPTORS FOR CURRENT AND FUTURE LAND USE CONDITIONS

ON-SITE

MAINTENANCE WORKERS

OFF-SITE

NEARBY RESIDENTS:
Adults
Children
Young Children

DISTANT OFF-SITE RESIDENTS:
Adults
Children
Young Children

TABLE 3-2
POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS FOR THE CURRENT LAND USE SCENARIO

Receptor	Exposure Media	Location	Intake Route
Maintenance Workers	Surface Soils	Plant Area	Dermal contact with surface soils
			Incidental ingestion with surface soils
Nearby Resident Adults	Nearby Groundwater (a)	Nearby Residents	Groundwater ingestion
			Dermal contact with groundwater while showering
			Inhalation groundwater while showering
			Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils
			Inhalation of volatiles and dust from irrigated soils
Nearby Resident Children	Nearby Groundwater (a)	Nearby Residents	Groundwater ingestion
			Dermal contact with groundwater while showering
			Inhalation groundwater while showering
			Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils
			Inhalation of volatiles and dust from irrigated soils
Nearby Resident Young Children	Nearby Groundwater (a)	Nearby Residents	Groundwater ingestion
			Dermal contact with groundwater while bathing
			Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils
			Inhalation of volatiles and dust from irrigated soils
Distant Resident Adults	Distant Off-site Groundwater (a)	Distant Offsite Residents	Groundwater ingestion
			Dermal contact with groundwater while showering
			Inhalation groundwater while showering
			Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils
			Inhalation of volatiles and dust from irrigated soils
Distant Resident Children	Distant Off-site Groundwater (a)	Distant Offsite Residents	Groundwater ingestion
			Dermal contact with groundwater while showering
			Inhalation groundwater while showering
			Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils
			Inhalation of volatiles and dust from irrigated soils
Distant Resident Young Children	Distant Off-site Groundwater (a)	Distant Offsite Residents	Groundwater ingestion
			Dermal contact with groundwater while bathing
			Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils
			Inhalation of volatiles and dust from irrigated soils

Notes:

a - Groundwater exposures will be evaluated as a Hypothetical Offsite Groundwater Use Scenario.

TABLE 3-3
POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS FOR THE FUTURE LAND USE SCENARIO

Receptor	Exposure Media	Location	Intake Route
Maintenance Workers	Surface Soils	Plant Area	Dermal contact with surface soils Incidental ingestion with surface soils
Nearby Resident Adults	Nearby Groundwater (a)	Nearby Residents	Groundwater ingestion Dermal contact with groundwater while showering Inhalation groundwater while showering Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils Inhalation of volatiles and dust from irrigated soils
Nearby Resident Children	Nearby Groundwater (a)	Nearby Residents	Groundwater ingestion Dermal contact with groundwater while showering Inhalation groundwater while showering Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils Inhalation of volatiles and dust from irrigated soils
Nearby Resident Young Children	Nearby Groundwater (a)	Nearby Residents	Groundwater ingestion Dermal contact with groundwater while bathing Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils Inhalation of volatiles and dust from irrigated soils
Distant Resident Adults	Distant Off-site Groundwater (a)	Distant Offsite Residents	Groundwater ingestion Dermal contact with groundwater while showering Inhalation groundwater while showering Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils Inhalation of volatiles and dust from irrigated soils
Distant Resident Children	Distant Off-site Groundwater (a)	Distant Offsite Residents	Groundwater ingestion Dermal contact with groundwater while showering Inhalation groundwater while showering Inhalation of volatiles from groundwater with irrigation
	Irrigated Soils		Dermal contact with irrigated soils Inhalation of volatiles and dust from irrigated soils
Distant Resident Young Children	Distant Off-site Groundwater (a) Irrigated Soils	Distant Offsite Residents	Groundwater ingestion Dermal contact with groundwater while bathing Inhalation of volatiles from groundwater with irrigation Dermal contact with irrigated soils Inhalation of volatiles and dust from irrigated soils

Notes:
a - Groundwater exposures will be evaluated as a Hypothetical Offsite Groundwater Use Scenario.

TABLE 3-4
SUMMARY OF HUMAN INHALATION RATES FOR
MEN, WOMEN, AND CHILDREN BY ACTIVITY LEVEL (CU. M/HR) (a)

	RESTING (b)	LIGHT (c)	MODERATE (d)	HEAVY (e)
Adult Male	0.7	0.8	2.5	4.8
Adult Female	0.3	0.5	1.6	2.9
Average Adult (f)	0.5	0.6	2.1	3.9
Child, age 6	0.4	0.8	2	2.4
Child, age 10	0.4	1	3.2	4.2

(a) Values of inhalation rates for males, females and children presented in this table are based on values reported for each activity level in the Exposures Factors Handbook (US EPA, 1989)
(b) Includes watching television, reading and sleeping.
(c) Includes most domestic work, attending to personal needs and care, hobbies, and conducting minor indoor repairs and home improvements.
(d) Includes heavy indoor cleanup, performance of major indoor repairs and alterations, and climbing stairs.
(e) Includes vigourous physical exercise and climbing stairs carrying a load.
(f) Derived by taking the mean of the adult male and female values for each activity level.

TABLE 3-5
PERCENTAGE OF TOTAL BODY SURFACE AREA BY PART OF BODY

Body Part	Men			Women		
	Mean (s.d.)	Min-Max.	n	Mean (s.d.)	Min-Max.	n
Head	7.8 (1.0)	6.1–10.6	48	7.1 (0.6)	5.6– 8.1	57
Trunk	35.9 (2.1)	30.5–41.4	48	34.8 (1.9)	32.8–41.7	57
Upper Extremities	18.8 (1.1)	16.4–21.0	48	17.9 (0.9)	15.6–19.9	57
Arms	14.1 (0.9)	12.5–15.5	32	14.0 (0.6)	12.4–14.8	13
Upper Arms	7.4 (0.5)	6.7– 8.1	6	–	–	–
Forearms	5.9 (0.3)	5.4– 6.3	6	–	–	–
Hands	5.2 (0.5)	4.6– 7.0	32	5.1 (0.3)	4.4– 5.4	13
Lower Extremities	37.5 (1.9)	33.3–41.2	48	40.3 (1.6)	36.0–43.2	57
Legs	31.2 (1.6)	26.1–33.4	32	32.4 (1.6)	29.8–35.3	13
Thighs	18.4 (1.2)	15.2–20.2	32	19.5 (1.1)	18.0–21.7	13
Lower Legs	12.8 (1.0)	11.0–15.8	32	12.8 (1.0)	11.4–14.9	13
Feet	7.0 (0.5)	6.0– 7.9	32	6.5 (0.3)	6.0– 7.0	13

s.d. = standard deviation.

n = number of observations.

Source: Exposure Factors Handbook (U.S. EPA, 1989).

TABLE 3-6
SUMMARY OF INTAKE EQUATIONS FOR ON-SITE MAINTENANCE WORKERS

Incidental Ingestion of On-site Surface Soils:

$$Iing\text{-}s = \frac{CS * IR * CF * FI * AB * EF * ED}{BW * AT}$$

Dermal Contact With On-site Surface Soils:

$$Ider\text{-}s = \frac{CS * CF * SA * AF * ABS * ET * EF * ED}{BW * AT}$$

where: SA = TBS * FBE

with:
TBS = total body surface area; and
FBE = fraction of body exposed.

TABLE 3-7
SUMMARY OF INTAKE PARAMETER VALUES FOR ON-SITE MAINTENANCE WORKERS

Assumptions				Comments/Reference
General Assumptions for Maintenance Workers				
BW (body weight)	=	70 Kg		mean body weight for an adult [a]
TBS (total body surface area)	=	1.94 m2	(19,400 cm2)	50% percentile for adult male [a]
ET (exposure time)	=	4 hrs		assumed for dermal contact
EF (exposure frequency)	=	1 day/wk, 30 wks/yr		assumed exposure to each source area
ED (exposure duration)	=	30 yrs		assumed
AT (averaging times):				
Carcinogenic effects	=	70 years		mean life expectency [b]
Chronic effects (noncarc.)	=	30 years		based on exposure duration (ED)
Assumptions for Incidental Ingestion of Surface Soils:				
IR (ingestion rate)	=	100 mg/day		recommended for adult [c]
FI (fraction ingested)	=	0.5	(or 50%)	based on area of contaminated source
AB (absorption factor)	=	1	(or 100%)	assumed
Assumptions for Dermal Contact With Surface Soils:				
FBE (fraction of body exposed)	=	0.111	(11.1%)	50th percentile of hands and forearms [b]
AF (soil adherence factor)	=	1.5 mg/cm2		value for potting soil [d]
ABS (skin absorption factor)	=	0.25%/hr		1.5%/hr absorption times 15% matrix [e]

Notes:

[a] U.S. EPA, 1989. Risk Assessment Guidance For Superfund. Volume I:Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

[b] U.S. EPA, 1989. Exposure Factors Handbook. EPA/600/8-89/043.

[c] U.S. EPA, 1989. Interim Final Guidance for Soil Ingestion Rates. Memorandum from J. W. Porter. 1/27/89.

[d] Harger, J.R.E. 1979. A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil. Memorandum to P.S. Cole, Executive Director, Toxic Substance Control Commision. Lansing Mi.

[e] Hawley, J. 1985. Assessment of Health Risk Associated with Exposure to Contaminated Soil. Risk Analysis, 5:289-302.

TABLE 3-8
SUMMARY OF INTAKE EQUATIONS FOR NEARBY RESIDENTS IN THE CURRENT AND FUTURE LAND USE SCENARIOS

Ingestion of Groundwater:

$$Iing\text{-}w = \frac{CW * IR * ABS * EF * ED}{BW * AT}$$

Dermal Contact With Irrigated Soils:

$$Ider\text{-}s = \frac{CS * CF * SA * AF * ABS * ET * EF * ED}{BW * AT}$$

where: SA = TBS * FBE

with:
TBS = total body surface area; and
FBE = fraction of body exposed.

Inhalation of Volatiles and Fugitive Dusts:

$$Iinhal = \frac{CA * IR * ET * EF * ED}{BW * AT}$$

Dermal Contact With Groundwater (while showering):

$$Ider\text{-}w = \frac{CS * CF * SA * AF * ABS * ET * EF * ED}{BW * AT}$$

TABLE 3-9

SUMMARY OF INTAKE PARAMETER VALUES FOR NEARBY RESIDENT ADULTS
FOR THE CURRENT AND FUTURE LAND USE SCENARIOS

Assumptions				Comments/Reference
General Assumptions for Nearby Resident Adults:				
BW (body weight)	=	70 Kg		mean body weight for an adult [a]
TBS (total body surface area)	=	1.94 m2		50th percentile for adult male [b]
EF (exposure frequency)	=	365 days/yr		for groundwater, 48 irrigated soils, 24 vols in gw
ED (exposure duration)	=	30 yrs		assumed for resident adults
ET (exposure time)	=	4 hrs		for dermal, 15 min shower, 24 for inhalation, 1 for volatiles in gw
ABS (absorption factor)	=	1	(or 100%)	assumed absorption for ingestion and inhalation
AT (averaging times):				
Carcinogenic effects	=	70 years		mean life expectancy [b]
Chronic effects (noncarc.)	=	30 years		based on exposure duration (ED)
Assumptions for Groundwater Ingestion:				
IR (ingestion rate)	=	2 L/day		recommended for adult [c]
Assumptions for Inhalation:				
IR (inhalation rate)	=	30 m3/day	(1.25 m3/hr)	reasonable maximum daily exposure rate for adult [b]
IR (inhalation rate for shower)	=	0.89 m3/hr		reasonable maximum indoor exposure rate [b]
Assumptions for Dermal Contact to Soils:				
FBE (fraction of body exposed)	=	11.1%		area of hands and forearms [b]
AF (soil adherence factor)		1.5 mg/cm2		value for potting soil [d]
ABS (skin absorption factor)		0.25%/hr		1.5%/hr absorption times 15% matrix [e]
Assumptions for Dermal Contact to Groundwater (showering):				
FBE (fraction of body exposed)	=	100%		assumes whole body exposed while showering
PC (chemical permiability factor)	=	0.0008 cm/hr		value for water [a]

Notes:

[a] U.S. EPA, 1989. Risk Assessment Guidance For Superfund. Volume I:Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

[b] U.S. EPA, 1989. Exposure Factors Handbook. EPA/600/8-89/043.

[c] U.S. EPA, 1989. Interim Final Guidance for Soil Ingestion Rates. Memorandum from J. W. Porter. 1/27/89.

[d] Harger, J.R.E. 1979. A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil. Memorandum to P.S. Cole, Executive Director, Toxic Substance Control Commision. Lansing Mi.

[e] Hawley, J. 1985. Assessment of Health Risk Associated with Exposure to Contaminated Soil. Risk Analysis, 5:289-302.

TABLE 3-10
SUMMARY OF INTAKE PARAMETER VALUES FOR NEARBY RESIDENT CHILDREN FOR THE CURRENT AND FUTURE LAND USE SCENARIOS

Assumptions				Comments/Reference
General Assumptions for Nearby Resident Children:				
BW (body weight)	=	34.3 Kg		mean body weight for child aged <3 - 18 yrs [a]
TBS (total body surface area)	=	1.21 m2		50th percentile for male child 3 - 18 yrs [b]
EF (exposure frequency)	=	365 days/yr		for groundwater, 96 irrigated soils, 24 vols in gw
ED (exposure duration)	=	16 years		assumed for children
ET (exposure time)	=	4 hrs		for dermal, 15 min shower, 24 for inhalation, 1 for volatiles in gw
ABS (absorption factor)	=	1	(or 100%)	assumed absorption for ingestion and inhalation
AT (averaging times):				
Carcinogenic effects	=	70 years		mean life expectency [b]
Chronic effects (noncarc.)	=	16 years		based on exposure duration (ED)
Assumptions for Groundwater Ingestion:				
IR (ingestion rate)	=	1.5 L/day		assumed for a child, 75% of an adult
Assumptions for Inhalation:				
IR (inhalation rate)	=	30 m3/day	(1.25 m3/hr)	reasonable maximum daily exposure rate for adult [b]
IR (inhalation rate for shower)	=	0.89 m3/hr		reasonable maximum indoor exposure rate [b]
Assumptions for Dermal Contact to Soils:				
FBE (fraction of body exposed)	=	18.9%		area of hands, forearms and head [b]
AF (soil adherence factor)		1.5 mg/cm2		value for potting soil [d]
ABS (skin absorption factor)		0.25%/hr		1.5%/hr absorption times 15% matrix [e]
Assumptions for Dermal Contact to Groundwater (showering):				
FBE (fraction of body exposed)	=	100%		assumes whole body exposed while showering
PC (chemical permiability factor)	=	0.0008 cm/hr		value for water [a]

Notes:

[a] U.S. EPA, 1989. Risk Assessment Guidance For Superfund. Volume I:Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

[b] U.S. EPA, 1989. Exposure Factors Handbook. EPA/600/8-89/043.

[c] U.S. EPA, 1989. Interim Final Guidance for Soil Ingestion Rates. Memorandum from J. W. Porter. 1/27/89.

[d] Harger, J.R.E. 1979. A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil. Memorandum to P.S. Cole, Executive Director, Toxic Substance Control Commision. Lansing Mi.

[e] Hawley, J. 1985. Assessment of Health Risk Associated with Exposure to Contaminated Soil. Risk Analysis, 5:289-302.

TABLE 3-11
SUMMARY OF INTAKE PARAMETER VALUES FOR NEARBY RESIDENT YOUNG CHILDREN
FOR THE CURRENT AND FUTURE LAND USE SCENARIOS

Assumptions				Comments/Reference
General Assumptions for Nearby Resident Young Children:				
BW (body weight)	=	17.6 Kg		mean body weight for child aged 3 – 6 yrs [a]
TBS (total body surface area)	=	0.73 m2		50th percentile for male child 3 – 6 yrs [b]
EF (exposure frequency)	=	365 days/yr		for groundwater, 96 irrigated soils, 24 vols in gw
ED (exposure duration)	=	5 years		assumed for young children
ET (exposure time)	=	4 hrs		for dermal, 15 min for bath, 24 for inhalation, 1 for volatiles in gw
ABS (absorption factor)	=	1	(or 100%)	assumed absorption for ingestion and inhalation
AT (averaging times):				
Carcinogenic effects	=	70 years		mean life expectency [b]
Chronic effects (noncarc.)	=	5 years		based on exposure duration (ED)
Assumptions for Groundwater Ingestion:				
IR (ingestion rate)	=	1.5 L/day		assumed for a child, 75% of an adult
Assumptions for Inhalation:				
IR (inhalation rate)	=	24 m3/day	(1 m3/hr)	reasonable maximum daily exposure rate for child age 6 [b]
Assumptions for Dermal Contact to Soils:				
FBE (fraction of body exposed)	=	18.9%		area of hands, forearms and head [b]
AF (soil adherence factor)		1.5 mg/cm2		value for potting soil [d]
ABS (skin absorption factor)		0.25%/hr		1.5%/hr absorption times 15% matrix [e]
Assumptions for Dermal Contact to Groundwater (showering):				
FBE (fraction of body exposed)	=	100%		assumes whole body exposed while bathing
PC (chemical permiability factor)	=	0.0008 cm/hr		value for water [a]

Notes:

[a] U.S. EPA, 1989. Risk Assessment Guidance For Superfund. Volume I:Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

[b] U.S. EPA, 1989. Exposure Factors Handbook. EPA/600/8-89/043.

[c] U.S. EPA, 1989. Interim Final Guidance for Soil Ingestion Rates. Memorandum from J. W. Porter. 1/27/89.

[d] Harger, J.R.E. 1979. A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil. Memorandum to P.S. Cole, Executive Director, Toxic Substance Control Commision. Lansing Mi.

[e] Hawley, J. 1985. Assessment of Health Risk Associated with Exposure to Contaminated Soil. Risk Analysis, 5:289-302.

TABLE 3-12
SUMMARY OF INTAKE EQUATIONS FOR DISTANT OFF-SITE RESIDENTS IN THE CURRENT AND FUTURE LAND USE SCENARIO

Ingestion of Groundwater:

$$I_{ing-w} = \frac{CW * IR * ABS * EF * ED}{BW * AT}$$

Dermal Contact With Irrigated Soils:

$$I_{der-s} = \frac{CS * CF * SA * AF * ABS * ET * EF * ED}{BW * AT}$$

where: $SA = TBS * FBE$

with:
TBS = total body surface area; and
FBE = fraction of body exposed.

Inhalation of Volatiles and Fugitive Dusts:

$$I_{inhal} = \frac{CA * IR * ET * EF * ED}{BW * AT}$$

Dermal Contact With Groundwater (while showering):

$$I_{der-w} = \frac{CS * CF * SA * AF * ABS * ET * EF * ED}{BW * AT}$$

TABLE 3-13
SUMMARY OF INTAKE PARAMETER VALUES FOR DISTANT OFF-SITE RESIDENT ADULTS FOR THE CURRENT AND FUTURE LAND USE SCENARIO

Assumptions				Comments/Reference
General Assumptions for Distant Off-site Resident Adults:				
BW (body weight)	=	70 Kg		mean body weight for an adult [a]
TBS (total body surface area)	=	1.94 m2		50th percentile for adult male [b]
EF (exposure frequency)	=	365 days/yr		for groundwater, 48 irrigated soils, 24 vols in gw
ED (exposure duration)	=	30 yrs		assumed for resident adults
ET (exposure time)	=	4 hrs		for dermal, 15 min for shower, 24 for inhalation, 1 volatiles in gw
ABS (absorption factor)	=	1	(or 100%)	assumed absorption for ingestion and inhalation
AT (averaging times):				
Carcinogenic effects	=	70 years		mean life expectency [b]
Chronic effects (noncarc.)	=	30 years		based on exposure duration (ED)
Assumptions for Groundwater Ingestion:				
IR (ingestion rate)	=	2 L/day		recommended for adult [c]
Assumptions for Inhalation:				
IR (inhalation rate)	=	30 m3/day	(1.25 m3/hr)	reasonable maximum daily exposure rate for adults [b]
IR (inhalation rate for shower)	=	0.89 m3/hr		reasonable maximum indoor exposure rate [b]
Assumptions for Dermal Contact to Soils:				
FBE (fraction of body exposed)	=	11.1%		area of hands and forearms [b]
AF (soil adherence factor)		1.5 mg/cm2		value for potting soil [d]
ABS (skin absorption factor)		0.25%/hr		1.5%/hr absorption times 15% matrix [e]
Assumptions for Dermal Contact to Groundwater (showering):				
FBE (fraction of body exposed)	=	100%		assumes whole body exposed while showering
PC (chemical permiability factor)	=	0.0008 cm/hr		value for water [a]

Notes:

[a] U.S. EPA, 1989. Risk Assessment Guidance For Superfund. Volume I:Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

[b] U.S. EPA, 1989. Exposure Factors Handbook. EPA/600/8-89/043.

[c] U.S. EPA, 1989. Interim Final Guidance for Soil Ingestion Rates. Memorandum from J. W. Porter. 1/27/89.

[d] Harger, J.R.E. 1979. A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil. Memorandum to P.S. Cole, Executive Director, Toxic Substance Control Commision. Lansing Mi.

[e] Hawley, J. 1985. Assessment of Health Risk Associated with Exposure to Contaminated Soil. Risk Analysis, 5:289-302.

TABLE 3-14
SUMMARY OF INTAKE PARAMETER VALUES FOR DISTANT OFF-SITE RESIDENT CHILDREN FOR THE CURRENT AND FUTURE LAND USE SCENARIO

Assumptions				Comments/Reference
General Assumptions for Distant Off-site Resident Children:				
BW (body weight)	=	34.3 Kg		mean body weight for child aged <3 - 18 yrs [a]
TBS (total body surface area)	=	1.21 m2		50th percentile for male child 3 - 18 yrs [b]
EF (exposure frequency)	=	365 days/yr		for groundwater, 96 irrigated soils, 24 vols in gw
ED (exposure duration)	=	16 years		assumed for children
ET (exposure time)	=	4 hrs		for dermal, 15 min for shower, 24 for inhalation, 1 volatiles in gw
ABS (absorption factor)	=	1	(or 100%)	assumed absorption for ingestion and inhalation
AT (averaging times):				
Carcinogenic effects	=	70 years		mean life expectency [b]
Chronic effects (noncarc.)	=	16 years		based on exposure duration (ED)
Assumptions for Groundwater Ingestion:				
IR (ingestion rate)	=	1.5 L/day		assumed for a child, 75% of an adult
Assumptions for Inhalation:				
IR (inhalation rate)	=	30 m3/day	(1.25 m3/hr)	reasonable maximum daily exposure rate for adults [b]
IR (inhalation rate for shower)	=	0.89 m3/hr		reasonable maximum indoor exposure rate [b]
Assumptions for Dermal Contact to Soils:				
FBE (fraction of body exposed)	=	18.9%		area of hands, forearms and head [b]
AF (soil adherence factor)		1.5 mg/cm2		value for potting soil [d]
ABS (skin absorption factor)		0.25%/hr		1.5%/hr absorption times 15% matrix [e]
Assumptions for Dermal Contact to Groundwater (showering):				
FBE (fraction of body exposed)	=	100%		assumes whole body exposed while showering
PC (chemical permiability factor)	=	0.0008 cm/hr		value for water [a]

Notes:

[a] U.S. EPA, 1989. Risk Assessment Guidance For Superfund. Volume I:Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

[b] U.S. EPA, 1989. Exposure Factors Handbook. EPA/600/8-89/043.

[c] U.S. EPA, 1989. Interim Final Guidance for Soil Ingestion Rates. Memorandum from J. W. Porter. 1/27/89.

[d] Harger, J.R.E. 1979. A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil. Memorandum to P.S. Cole, Executive Director, Toxic Substance Control Commision. Lansing Mi.

[e] Hawley, J. 1985. Assessment of Health Risk Associated with Exposure to Contaminated Soil. Risk Analysis, 5:289-302.

TABLE 3-15
SUMMARY OF INTAKE PARAMETER VALUES FOR DISTANT OFF-SITE RESIDENT YOUNG CHILDREN FOR THE CURRENT AND FUTURE LAND USE SCENARIO

Assumptions				Comments/Reference
General Assumptions for Distant Off-site Resident Young Children:				
BW (body weight)	=	17.6 Kg		mean body weight for child aged 3 – 6 yrs [a]
TBS (total body surface area)	=	0.73 m2		50th percentile for male child 3 – 6 yrs [b]
EF (exposure frequency)	=	365 days/yr		for groundwater, 96 irrigated soils, 24 vols in gw
ED (exposure duration)	=	5 years		assumed for young children
ET (exposure time)	=	4 hrs		for dermal, 15 min for bath, 24 for inhalation, 1 volatiles in gw
ABS (absorption factor)	=	1	(or 100%)	assumed absorption for ingestion and inhalation
AT (averaging times):				
Carcinogenic effects	=	70 years		mean life expectency [b]
Chronic effects (noncarc.)	=	5 years		based on exposure duration (ED)
Assumptions for Groundwater Ingestion:				
IR (ingestion rate)	=	1.5 L/day		assumed for a child, 75% of an adult
Assumptions for Inhalation:				
IR (inhalation rate)	=	24 m3/day	(1 m3/hr)	assumed daily exposure rate for child age 6
Assumptions for Dermal Contact to Soils:				
FBE (fraction of body exposed)	=	18.9%		area of hands, forearms and head [b]
AF (soil adherence factor)		1.5 mg/cm2		value for potting soil [d]
ABS (skin absorption factor)		0.25%/hr		1.5%/hr absorption times 15% matrix [e]
Assumptions for Dermal Contact to Groundwater (showering):				
FBE (fraction of body exposed)	=	100%		assumes whole body exposed while bathing
PC (chemical permiability factor)	=	0.0008 cm/hr		value for water [a]

Notes:

[a] U.S. EPA, 1989. Risk Assessment Guidance For Superfund. Volume I:Human Health Evaluation Manual (Part A). EPA/540/1-89/002.

[b] U.S. EPA, 1989. Exposure Factors Handbook. EPA/600/8-89/043.

[c] U.S. EPA, 1989. Interim Final Guidance for Soil Ingestion Rates. Memorandum from J. W. Porter. 1/27/89.

[d] Harger, J.R.E. 1979. A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil. Memorandum to P.S. Cole, Executive Director, Toxic Substance Control Commision. Lansing Mi.

[e] Hawley, J. 1985. Assessment of Health Risk Associated with Exposure to Contaminated Soil. Risk Analysis, 5:289-302.

ORIGINAL
(Red)

TABLE 3-16
LOCATIONS, MEDIA, RECEPTORS AND EXPOSURE PATHWAYS ASSOCIATED WITH THE WESTINGHOUSE ELEVATOR PLANT SITE

Locations	Source Media	Exposure Media		Receptors	Exposure Pathway
Current Land Use Scenario:					
On-site	Surface soils	Surface soils	(a)	Maintenance Workers	incidental ingestion dermal contact
Off-site	On-site groundwater	Nearsite groundwater	(a)	Nearby Residents	ingestion dermal contact (shower)
		Nearsite indoor showerroom air	(b)		inhalation
		Nearsite irrigated soils	(c)		dermal contact
		Nearsite air	(d)		inhalation
		Distant off-site groundwater	(a)	Distant Off-site Residents	ingestion dermal contact (shower)
		Distant off-site showerroom air	(b)		inhalation
		Distant off-site irrigated soils	(c)		dermal contact
		Distant off-site air	(d)		inhalation
Future Land Use Scenario:					
On-site	Surface soils	Surface soils	(a)	Maintenance Workers	incidental ingestion dermal contact
Off-site	On-site groundwater	Nearsite groundwater	(a)	Nearby Residents	ingestion dermal contact (shower)
		Nearsite indoor showerroom air	(b)		inhalation
		Nearsite irrigated soils	(c)		dermal contact
		Nearsite air	(d)		inhalation
		Distant off-site groundwater	(a)	Distant Off-site Residents	ingestion dermal contact (shower)
		Distant off-site showerroom air	(b)		inhalation
		Distant off-site irrigated soils	(c)		dermal contact
		Distant off-site air	(d)		inhalation

Notes:
(a) – Exposure point concentrations based on a statistical summary of Phase I and/or II analytical data.
(b) – Exposure point concentrations estimated with a shower volatilization model.
(c) – Exposure point concentrations based on a soil irrigation model.
(d) – Exposure point concentrations based on volatilization and fugitive dust emission models and an air dispersion model.

ORIGINAL (Red)

TABLE 3-17
EXPOSURE POINT CONCENTRATIONS FOR VARIOUS SITE MEDIA

EXPOSURE POINT CONCENTRATIONS FOR ON-SITE SURFACE SOILS

Chemical-of-Interest	Concentration in Remote Spout Fill Line Area (mg/Kg)	Concentration Degreasing Fluid Storage Tank Area (mg/Kg)	Concentration Pumphouse Area (mg/Kg)	Concentration Railroad Dock Area (mg/Kg)	Concentration Old Waste Drum Storage Area (mg/Kg)
1,1-Dichloroethane	na	na	0.088	na	na
1,1,1-Trichloroethane	na	na	0.432	na	na
Xylenes (total)	na	na	na	5.128	na
PCB-1254	na	na	0.518	na	na

EXPOSURE POINT CONCENTRATIONS FOR NEARSITE GROUNDWATER FOR CURRENT AND FUTURE LAND USE SCENARIOS

Chemical-of-Interest	Concentration Irrigated Soil (mg/Kg)	Concentration Air from Irrigated Soil (mg/m3)	Concentration Showerroom Air (mg/m3)	Concentration Groundwater (mg/L)	Concen in Air from Groundwater during Irrigation (mg/m3)
1,1-Dichloroethene	1.56E-02	1.04E-07	1.91E-02	1.20E-02	5.36E-05
1,1-Dichloroethane	1.50E-03	9.96E-09	3.95E-03	2.50E-03	1.11E-05
1,2-Dichloroethene (total)	7.00E-04	4.65E-09	3.46E-03	2.50E-03	9.73E-06
1,2-Dichloroethane	2.95E-03	1.96E-08	3.89E-03	2.50E-03	1.09E-05
1,1,1-Trichloroethane	1.15E-01	7.66E-07	5.37E-02	3.80E-02	1.51E-04
Trichloroethene	1.13E+00	7.52E-06	6.34E-01	4.50E-01	1.78E-03

EXPOSURE POINT CONCENTRATIONS FOR DISTANT OFF-SITE GROUNDWATER FOR CURRENT LAND USE SCENARIO

Chemical-of-Interest	Concentration Irrigated Soil (mg/Kg)	Concentration Air from Irrigated Soil (mg/m3)	Concentration Showerroom Air (mg/m3)	Concentration Groundwater (mg/L)	Concen in Air from Groundwater during Irrigation (mg/m3)
1,1-Dichloroethene	7.80E-03	5.18E-08	9.54E-03	6.00E-03	2.68E-05
1,1-Dichloroethane	1.50E-03	9.96E-09	3.95E-03	2.50E-03	1.11E-05
1,2-Dichloroethene (total)	7.00E-04	4.65E-09	3.46E-03	2.50E-03	9.73E-06
1,2-Dichloroethane	2.95E-03	1.96E-08	3.89E-03	2.50E-03	1.09E-05
1,1,1-Trichloroethane	2.13E-02	1.41E-07	9.89E-03	7.00E-03	2.78E-05
Trichloroethene	5.79E-01	3.85E-06	3.24E-01	2.30E-01	9.10E-04

EXPOSURE POINT CONCENTRATIONS FOR DISTANT OFF-SITE GROUNDWATER FOR FUTURE LAND USE SCENARIO

Chemical-of-Interest	Concentration Irrigated Soil (mg/Kg)	Concentration Air from Irrigated Soil (mg/m3)	Concentration Showerroom Air (mg/m3)	Concentration Groundwater (mg/L)	Concen in Air from Groundwater during Irrigation (mg/m3)
1,1-Dichloroethene	1.56E-02	1.04E-07	1.91E-02	1.20E-02	5.36E-05
1,1-Dichloroethane	1.50E-03	9.96E-09	3.95E-03	2.50E-03	1.11E-05
1,2-Dichloroethene (total)	7.00E-04	4.65E-09	3.46E-03	2.50E-03	9.73E-06
1,2-Dichloroethane	2.95E-03	1.96E-08	3.89E-03	2.50E-03	1.09E-05
1,1,1-Trichloroethane	1.15E-01	7.66E-07	5.37E-02	3.80E-02	1.51E-04
Trichloroethene	1.13E+00	7.52E-06	6.34E-01	4.50E-01	1.78E-03

NOTES:
na - Compound is not a compound of interest for this media at this location.

TABLE 4-1
COMPOUNDS OF INTEREST FOR TOXICITY ASSESSMENT

PARAMETERS
VOLATILE ORGANICS
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethene
1,1,1-Trichloroethane
Trichlorethene
Xylene
PCB - Arochlor 1254

TABLE 4-2
NONCARCINOGENIC TOXICITY DATA FOR COMPOUNDS OF INTEREST

COMPOUND	REFERENCE DOSES CHRONIC Oral mg/Kg-day	REFERENCE DOSES CHRONIC Inhalation mg/Kg-day	UNCERTAINTY FACTORS Oral	UNCERTAINTY FACTORS Inhalation	SOURCE
VOLATILE ORGANICS					
1,1-Dichloroethane	0.1	0.1	1000	1000	HEAST
1,2-Dichloroethane					
1,1-Dichloroethene	0.009	ND	1000	NA	HEAST
1,2-Dichloroethene	0.02	ND	1000	NA	IRIS
1,1,1-Trichloroethane	0.09	0.3	1000	1000	HEAST
Trichloroethene					
Xylene	2	0.085	100	100	HEAST
PCB - Arochlor 1254					

ABBREVIATIONS

IRIS - Integrated Risk Information System

HEAST - Health Effects Assessment Summary Tables Fourth Quarter 1990

ND - Not Determined

NA - Not Applicable

* Verified RfDs for water (0.0005) and food (0.001)

TABLE 4-3
HEALTH ADVISORIES

COMPOUND	MG/L ONE DAY	MG/L TEN DAY
VOLATILE ORGANICS		
1,1-Dichloroethane	0.74	0.74
1,2-Dichloroethane		
1,1-Dichloroethene		
1,2-Dichloroethene		
1,1,1-Trichloroethane		
Trichloroethene		
Xylene		
PCB – Arochlor 1254		

TABLE 4-4
CARCINOGENIC TOXICITY DATA

COMPOUND	Carcinogen Classification	Source	CANCER SLOPE FACTOR Oral (mg/Kg-day)-1	CANCER SLOPE FACTOR Inhalation (mg/Kg-day)-1	Source
VOLATILE ORGANICS					
1,1-Dichloroethane	C	HEAST	ND	ND	HEAST
1,2-Dichloroethane	B2	IRIS	0.091	0.091	IRIS
1,1-Dichloroethene	C	IRIS	1.2	0.6	IRIS
1,2-Dichloroethene					
1,1,1-Trichloroethane					
Trichloroethene	B2	HEAST	0.011	0.017	HEAST
Xylene					
PCB - Arochlor 1254	B2	HEAST	7.7	ND	IRIS

ABBREVIATIONS
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables Fourth Quarter 1990
ND - Not Determined
NA - Not Applicable

TABLE 4-5
TOXICITY DATA FOR COMPOUNDS OF INTEREST

COMPOUND	CHRONIC REFERENCE DOSES ORAL mg/Kg-day	CHRONIC REFERENCE DOSES INHALATION mg/Kg-day	UNCERTAINTY FACTORS ORAL	UNCERTAINTY FACTORS INHALATION	CANCER SLOPE FACTORS ORAL (mg/Kg-day)-1	CANCER SLOPE FACTORS INHALATION (mg/Kg-day)-1
VOLATILE ORGANICS						
1,1-Dichloroethane	0.1	0.1	1000	1000	ND	ND
1,2-Dichloroethane					0.091	0.091
1,1-Dichloroethene	0.009	ND	1000	NA	1.2	0.6
1,2-Dichloroethene	0.02	ND	1000	NA		
1,1,1-Trichloroethane	0.09	0.3	1000	1000		
Trichloroethene					0.011	0.017
Xylene	2	0.085	100	100		
PCB - Arochlor 1254					7.7	ND

ND Not Determined
NA Not Applicable

(Red)

TABLE 4-6
ARARS FOR THE PLANT SITE

ARARs FOR COMPOUNDS OF INTEREST IN GROUNDWATER

Compounds-of-Interest	MCLGs (mg/L)	MCLs (mg/L)	ARAR (mg/L)	
1,1-Dichloroethene	0.007	0.007	0.007	(a)
1,1-Dichloroethane	nf	nf	nf	
1,2-Dichloroethene (total)	0.07	0.07	0.07	(b)
1,2-Dichloroethane	0	0.005	0.005	(c)
1,1,1-Trichloroethane	0.2	0.2	0.2	(a)
Trichloroethene	0	0.005	0.005	(c)

NOTES:

(a) - current MCLG.

(b) - Current MCLG for cis-1,2-DCE. Current MCLG for trans-1,2-DCE is 0.1 mg/L.

(c) - Current MCL, current MCLG equals zero.

TABLE 5-1
COMPARISON OF ARARS FOR THE PLANT SITE TO EXPOSURE POINT CONCENTRATIONS FOR COMPOUNDS OF INTEREST IN GROUNDWATER

Compounds-of-Interest	Groundwater ARAR (mg/L)	Exposure Point Concentrations for Nearsite Groundwater (a) (mg/L)	Exposure Point Concentrations for Distant Off-site Groundwater	
			Current Scenario (mg/L)	Future Scenario (mg/L)
1,1-Dichloroethene	0.007 (b)	0.0120 (e)	0.0060	0.0120 (e)
1,1-Dichloroethane	nf	0.0025	0.0025	0.0025
1,2-Dichloroethene (total)	0.07 (c)	0.0025	0.0025	0.0025
1,2-Dichloroethane	0.005 (d)	0.0025	0.0025	0.0025
1,1,1-Trichloroethane	0.2 (b)	0.0380	0.0070	0.0380
Trichloroethene	0.005 (d)	0.4500 (e)	0.2300 (e)	0.4500 (e)

NOTES:

(a) - Concentration for nearsite groundwater is applicable for both current and future scenario.

(b) - Current MCLG.

(c) - Current MCLG for cis-1,2-DCE. Current MCLG for trans-1,2-DCE is 0.1 mg/L.

(d) - Current MCL, current MCLG equals zero.

(e) - Concentration exceeds ARAR.

TABLE 5-2
CANCER RISK BY PATHWAY BY CHEMICAL FOR
ON-SITE MAINTENANCE WORKERS - CURRENT AND FUTURE SCENARIO

Chemical-of-Interest	Incidental Ingestion of Pumphouse Area Soils	Incidental Ingestion of Railroad Dock Area Soils	Dermal Contact with Pumphouse Area Soils	Dermal Contact with Railroad Dock Area Soils	Total Oral	Total Inhal	Total
1,1-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylenes (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PCB-1254	9.37E-08	0.00E+00	6.05E-08	0.00E+00	1.54E-07	0.00E+00	1.54E-07
	9.37E-08	0.00E+00	6.05E-08	0.00E+00	1.54E-07	0.00E+00	1.54E-07
	PERCENT OF RISK BY PATHWAY BY CHEMICAL						
1,1-Dichloroethane	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	0.00%
1,1,1-Trichloroethane	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	0.00%
Xylenes (total)	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	0.00%
PCB-1254	60.7526%	< 0.0001%	39.2474%	< 0.0001%	100.0000%	< 0.0001%	100.00%
	60.75%	0.00%	39.25%	0.00%	100.00%	0.00%	

TABLE 5-3
CHRONIC HAZARD INDEX BY PATHWAY AND CHEMICAL FOR ON-SITE MAINTENANCE WORKERS - CURRENT AND FUTURE SCENARIO

Chemical-of-Interest	Incidental Ingestion of Pumphouse Area Soils	Incidental Ingestion of Railroad Dock Area Soils	Dermal Contact with Pumphouse Area Soils	Dermal Contact with Railroad Dock Area Soils	Total Oral	Total Inhal	Total
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xylenes (total)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB-1254	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERCENT OF RISK BY PATHWAY BY CHEMICAL							
1,1-Dichloroethane	6.5507%	< 0.0001%	4.2319%	< 0.0001%	10.7827%	< 0.0001%	10.78%
1,1,1-Trichloroethane	35.3298%	< 0.0001%	22.8238%	< 0.0001%	58.1536%	< 0.0001%	58.15%
Xylenes (total)	< 0.0001%	18.8720%	< 0.0001%	12.1917%	31.0637%	< 0.0001%	31.06%
PCB-1254	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	< 0.0001%	0.00%
	41.88%	18.87%	27.06%	12.19%	100.00%	0.00%	

TABLE 5-4
CANCER RISK BY PATHWAY BY CHEMICAL FOR
NEARSITE RESIDENT ADULTS - CURRENT AND FUTURE SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	4.87E-08	1.14E-08	1.56E-05	1.62E-08	3.41E-07	1.76E-04	1.77E-04	1.56E-05	1.92E-04
1,1-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethene (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethane	6.98E-10	3.26E-10	4.81E-07	5.01E-10	5.39E-09	2.79E-06	2.79E-06	4.82E-07	3.27E-06
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloroethene	3.24E-08	2.34E-08	1.46E-05	1.52E-08	1.17E-07	6.06E-05	6.08E-05	1.47E-05	7.54E-05
	8.18E-08	3.51E-08	3.07E-05	3.19E-08	4.64E-07	2.40E-04	2.40E-04	3.07E-05	2.71E-04
	PERCENT OF RISK BY PATHWAY BY CHEMICAL								
1,1-Dichloroethene	0.02%	0.00%	5.74%	0.01%	0.13%	65.06%	65.21%	5.75%	70.96%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethane	0.00%	0.00%	0.18%	0.00%	0.00%	1.03%	1.03%	0.18%	1.21%
1,1,1-Trichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Trichloroethene	0.01%	0.01%	5.40%	0.01%	0.04%	22.37%	22.42%	5.41%	27.83%
	0.03%	0.01%	11.32%	0.01%	0.17%	88.46%	88.66%	11.34%	100.00%

TABLE 5-5
CHRONIC HAZARD INDEX BY PATHWAY AND CHEMICAL FOR NEARSITE RESIDENT ADULTS - CURRENT AND FUTURE SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.04
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethene (total)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
Trichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.06
	PERCENT OF RISK BY PATHWAY BY CHEMICAL								
1,1-Dichloroethene	0.02%	0.00%	0.00%	0.00%	0.13%	68.93%	69.09%	0.00%	69.09%
1,1-Dichloroethane	0.00%	0.00%	0.23%	0.00%	0.00%	1.29%	1.30%	0.23%	1.52%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.01%	6.46%	6.48%	0.00%	6.48%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,1,1-Trichloroethane	0.01%	0.00%	1.03%	0.00%	0.04%	21.83%	21.89%	1.03%	22.92%
Trichloroethene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.03%	0.00%	1.25%	0.00%	0.19%	98.52%	98.74%	1.26%	100.00%

TABLE 5-6
CANCER RISK BY PATHWAY BY CHEMICAL FOR
NEARSITE RESIDENT CHILDREN - CURRENT AND FUTURE SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	1.13E-07	1.24E-08	1.69E-05	1.76E-08	2.32E-07	1.44E-04	1.44E-04	1.70E-05	1.61E-04
1,1-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethene (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethane	1.61E-09	3.55E-10	5.24E-07	5.45E-10	3.66E-09	2.27E-06	2.28E-06	5.24E-07	2.80E-06
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloroethene	7.49E-08	2.55E-08	1.59E-05	1.66E-08	7.96E-08	4.95E-05	4.96E-05	1.60E-05	6.56E-05
	1.89E-07	3.82E-08	3.34E-05	3.47E-08	3.15E-07	1.96E-04	1.96E-04	3.34E-05	2.30E-04
	PERCENT OF RISK BY PATHWAY BY CHEMICAL								
1,1-Dichloroethene	0.05%	0.01%	7.37%	0.01%	0.10%	62.68%	62.83%	7.38%	70.21%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethane	0.00%	0.00%	0.23%	0.00%	0.00%	0.99%	0.99%	0.23%	1.22%
1,1,1-Trichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Trichloroethene	0.03%	0.01%	6.93%	0.01%	0.03%	21.55%	21.61%	6.95%	28.57%
	0.08%	0.02%	14.53%	0.02%	0.14%	85.21%	85.43%	14.57%	100.00%

TABLE 5-7
CHRONIC HAZARD INDEX BY PATHWAY AND CHEMICAL FOR NEARSITE RESIDENT CHILDREN - CURRENT AND FUTURE SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.06
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethene (total)	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
1,2-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.02
Trichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.08
	PERCENT OF RISK BY PATHWAY BY CHEMICAL								
1,1-Dichloroethene	0.05%	0.00%	0.00%	0.00%	0.11%	68.63%	68.79%	0.00%	68.79%
1,1-Dichloroethane	0.00%	0.00%	0.30%	0.00%	0.00%	1.29%	1.29%	0.30%	1.59%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.01%	6.43%	6.45%	0.00%	6.45%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,1,1-Trichloroethane	0.04%	0.00%	1.36%	0.00%	0.03%	21.73%	21.81%	1.37%	23.17%
Trichloroethene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.09%	0.00%	1.66%	0.00%	0.16%	98.08%	98.33%	1.67%	100.00%

TABLE 5-8
CANCER RISK BY PATHWAY BY CHEMICAL FOR
NEARSITE RESIDENT YOUNG CHILDREN - CURRENT AND FUTURE SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation of Volatiles from Irrigation	Dermal Contact Groundwater in Bath	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	4.13E-08	6.03E-09	8.58E-09	8.51E-08	8.77E-05	8.78E-05	1.46E-08	8.78E-05
1,1-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethene (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethane	5.93E-10	1.73E-10	2.65E-10	1.34E-09	1.38E-06	1.39E-06	4.39E-10	1.39E-06
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloroethene	2.75E-08	1.24E-08	8.08E-09	2.92E-08	3.01E-05	3.02E-05	2.05E-08	3.02E-05
	6.95E-08	1.86E-08	1.69E-08	1.16E-07	1.19E-04	1.19E-04	3.56E-08	1.19E-04
	PERCENT OF RISK BY PATHWAY BY CHEMICAL							
1,1-Dichloroethene	0.03%	0.01%	0.01%	0.07%	73.42%	73.52%	0.01%	73.54%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	1.16%	1.16%	0.00%	1.16%
1,1,1-Trichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Trichloroethene	0.02%	0.01%	0.01%	0.02%	25.24%	25.28%	0.02%	25.30%
	0.06%	0.02%	0.01%	0.10%	99.82%	99.97%	0.03%	100.00%

TABLE 5-9
CHRONIC HAZARD INDEX BY PATHWAY AND CHEMICAL FOR
NEARSITE RESIDENT YOUNG CHILDREN - CURRENT AND FUTURE SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation of Volatiles from Irrigation	Dermal Contact Groundwater in Bath	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.11
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethene (total)	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
1,2-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.04
Trichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.16	0.16	0.00	0.16
	PERCENT OF RISK BY PATHWAY BY CHEMICAL							
1,1-Dichloroethene	0.03%	0.00%	0.00%	0.07%	69.86%	69.96%	0.00%	69.96%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	1.31%	1.31%	0.00%	1.31%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.01%	6.55%	6.56%	0.00%	6.56%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,1,1-Trichloroethane	0.02%	0.00%	0.00%	0.02%	22.12%	22.17%	0.00%	22.17%
Trichloroethene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.06%	0.00%	0.00%	0.10%	99.84%	100.00%	0.00%	100.00%

TABLE 5-10
CANCER RISK BY PATHWAY BY CHEMICAL FOR
DISTANT OFF-SITE RESIDENT ADULTS - CURRENT SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	2.43E-08	5.69E-09	7.78E-06	8.09E-09	1.71E-07	8.82E-05	8.84E-05	7.79E-06	9.61E-05
1,1-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethene (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethane	6.98E-10	3.26E-10	4.81E-07	5.01E-10	5.39E-09	2.79E-06	2.79E-06	4.82E-07	3.27E-06
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloroethene	1.66E-08	1.20E-08	7.48E-06	7.78E-09	5.99E-08	3.10E-05	3.11E-05	7.50E-06	3.86E-05
	4.16E-08	1.80E-08	1.57E-05	1.64E-08	2.36E-07	1.22E-04	1.22E-04	1.58E-05	1.38E-04
	PERCENT OF RISK BY PATHWAY BY CHEMICAL								
1,1-Dichloroethene	0.02%	0.00%	5.64%	0.01%	0.12%	63.90%	64.04%	5.65%	69.69%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethane	0.00%	0.00%	0.35%	0.00%	0.00%	2.02%	2.02%	0.35%	2.37%
1,1,1-Trichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Trichloroethene	0.01%	0.01%	5.42%	0.01%	0.04%	22.45%	22.51%	5.43%	27.94%
	0.03%	0.01%	11.40%	0.01%	0.17%	88.37%	88.57%	11.43%	100.00%

TABLE 5-11
CHRONIC HAZARD INDEX BY PATHWAY AND CHEMICAL FOR DISTANT OFF-SITE RESIDENT ADULTS - CURRENT SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.02
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethene (total)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.03
PERCENT OF RISK BY PATHWAY BY CHEMICAL									
1,1-Dichloroethene	0.02%	0.00%	0.00%	0.00%	0.14%	73.71%	73.87%	0.00%	73.87%
1,1-Dichloroethane	0.00%	0.00%	0.48%	0.00%	0.01%	2.76%	2.77%	0.48%	3.25%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.03%	13.82%	13.85%	0.00%	13.85%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,1,1-Trichloroethane	0.01%	0.00%	0.40%	0.00%	0.02%	8.60%	8.62%	0.41%	9.03%
Trichloroethene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.03%	0.00%	0.89%	0.00%	0.19%	98.89%	99.11%	0.89%	100.00%

TABLE 5-12
CANCER RISK BY PATHWAY BY CHEMICAL FOR
DISTANT OFF-SITE RESIDENT CHILDREN - CURRENT SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatilization from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	5.63E-08	6.19E-09	8.46E-06	8.81E-09	1.16E-07	7.20E-05	7.21E-05	8.48E-06	8.06E-05
1,1-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethene (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethane	1.61E-09	3.55E-10	5.24E-07	5.45E-10	3.66E-09	2.27E-06	2.28E-06	5.24E-07	2.80E-06
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloroethene	3.83E-08	1.30E-08	8.14E-06	8.47E-09	4.07E-08	2.53E-05	2.54E-05	8.16E-06	3.35E-05
	9.62E-08	1.96E-08	1.71E-05	1.78E-08	1.60E-07	9.95E-05	9.98E-05	1.72E-05	1.17E-04
	PERCENT OF RISK BY PATHWAY BY CHEMICAL								
1,1-Dichloroethene	0.05%	0.01%	7.24%	0.01%	0.10%	61.54%	61.68%	7.25%	68.93%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethane	0.00%	0.00%	0.45%	0.00%	0.00%	1.94%	1.95%	0.45%	2.40%
1,1,1-Trichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Trichloroethene	0.03%	0.01%	6.96%	0.01%	0.03%	21.62%	21.69%	6.98%	28.67%
	0.08%	0.02%	14.64%	0.02%	0.14%	85.10%	85.32%	14.68%	100.00%

TABLE 5-13
CHRONIC HAZARD INDEX BY PATHWAY AND CHEMICAL FOR DISTANT OFF-SITE RESIDENT CHILDREN - CURRENT SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.03
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethene (total)	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
1,2-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.04
	PERCENT OF RISK BY PATHWAY BY CHEMICAL								
1,1-Dichloroethene	0.06%	0.00%	0.00%	0.00%	0.12%	73.48%	73.65%	0.00%	73.65%
1,1-Dichloroethane	0.00%	0.00%	0.64%	0.00%	0.00%	2.76%	2.76%	0.64%	3.41%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.02%	13.78%	13.80%	0.00%	13.80%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,1,1-Trichloroethane	0.02%	0.00%	0.54%	0.00%	0.01%	8.57%	8.60%	0.54%	9.14%
Trichloroethene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.08%	0.00%	1.18%	0.00%	0.16%	98.58%	98.82%	1.18%	100.00%

TABLE 5-14
CANCER RISK BY PATHWAY BY CHEMICAL FOR
DISTANT OFF-SITE RESIDENT YOUNG CHILDREN - CURRENT SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Bath	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	2.07E-08	3.02E-09	4.29E-09	4.25E-08	4.38E-05	4.39E-05	7.31E-09	4.39E-05
1,1-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethene (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethane	5.93E-10	1.73E-10	2.65E-10	1.34E-09	1.38E-06	1.39E-06	4.39E-10	1.39E-06
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloroethene	1.41E-08	6.35E-09	4.13E-09	1.49E-08	1.54E-05	1.54E-05	1.05E-08	1.54E-05
	3.53E-08	9.54E-09	8.69E-09	5.88E-08	6.06E-05	6.07E-05	1.82E-08	6.07E-05
	PERCENT OF RISK BY PATHWAY BY CHEMICAL							
1,1-Dichloroethene	0.03%	0.00%	0.01%	0.07%	72.17%	72.28%	0.01%	72.29%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	2.28%	2.28%	0.00%	2.28%
1,1,1-Trichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Trichloroethene	0.02%	0.01%	0.01%	0.02%	25.36%	25.41%	0.02%	25.43%
	0.06%	0.02%	0.01%	0.10%	99.81%	99.97%	0.03%	100.00%

TABLE 5-15
CHRONIC HAZARD INDEX BY PATHWAY AND CHEMICAL FOR
DISTANT OFF-SITE RESIDENT YOUNG CHILDREN - CURRENT SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Bath	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.06
1,1-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethene (total)	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
1,2-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
Trichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.08
	PERCENT OF RISK BY PATHWAY BY CHEMICAL							
1,1-Dichloroethene	0.04%	0.00%	0.00%	0.07%	74.43%	74.53%	0.00%	74.53%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	2.79%	2.79%	0.00%	2.79%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.01%	13.95%	13.97%	0.00%	13.97%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,1,1-Trichloroethane	0.01%	0.00%	0.00%	0.01%	8.68%	8.70%	0.00%	8.70%
Trichloroethene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.05%	0.00%	0.00%	0.10%	99.85%	100.00%	0.00%	100.00%

TABLE 5-16
CANCER RISK BY PATHWAY BY CHEMICAL FOR
DISTANT OFF-SITE RESIDENT ADULTS - FUTURE SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	4.87E-08	1.14E-08	1.56E-05	1.62E-08	3.41E-07	1.76E-04	1.77E-04	1.56E-05	1.92E-04
1,1-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethene (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2-Dichloroethane	6.98E-10	3.26E-10	4.81E-07	5.01E-10	5.39E-09	2.79E-06	2.79E-06	4.82E-07	3.27E-06
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloroethene	3.24E-08	2.34E-08	1.46E-05	1.52E-08	1.17E-07	6.06E-05	6.06E-05	1.47E-05	7.54E-05
	8.18E-08	3.51E-08	3.07E-05	3.19E-08	4.64E-07	2.40E-04	2.40E-04	3.07E-05	2.71E-04
	PERCENT OF RISK BY PATHWAY BY CHEMICAL								
1,1-Dichloroethene	0.02%	0.00%	5.74%	0.01%	0.13%	65.06%	65.21%	5.75%	70.96%
1,1-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,2-Dichloroethane	0.00%	0.00%	0.18%	0.00%	0.00%	1.03%	1.03%	0.18%	1.21%
1,1,1-Trichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Trichloroethene	0.01%	0.01%	5.40%	0.01%	0.04%	22.37%	22.42%	5.41%	27.83%
	0.03%	0.01%	11.32%	0.01%	0.17%	88.46%	88.66%	11.34%	100.00%

TABLE 5-17
CHRONIC HAZARD INDEX BY PATHWAY AND CHEMICAL FOR DISTANT OFF-SITE RESIDENT ADULTS - FUTURE SCENARIO

Chemical-of-Interest	Dermal Contact Irrigated Soils	Inhalation Air from Irrigated Soil	Inhalation Showerroom Air	Inhalation Volatiles from Irrigation	Dermal Contact Groundwater in Shower	Ingestion Groundwater	Total Oral	Total Inhal	Total
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.04
1,1-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethene (total)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,2-Dichloroethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,1,1-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
Trichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.06
PERCENT OF RISK BY PATHWAY BY CHEMICAL									
1,1-Dichloroethene	0.02%	0.00%	0.00%	0.00%	0.13%	68.93%	69.09%	0.00%	69.09%
1,1-Dichloroethane	0.00%	0.00%	0.23%	0.00%	0.00%	1.29%	1.30%	0.23%	1.52%
1,2-Dichloroethene (total)	0.00%	0.00%	0.00%	0.00%	0.01%	6.46%	6.48%	0.00%	6.48%
1,2-Dichloroethane	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1,1,1-Trichloroethane	0.01%	0.00%	1.03%	0.00%	0.04%	21.83%	21.89%	1.03%	22.92%
Trichloroethene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.03%	0.00%	1.25%	0.00%	0.19%	98.52%	98.74%	1.26%	100.00%