

Appendix GG
Human Health Risk Assessment

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BASELINE HUMAN HEALTH RISK ASSESSMENT FINAL REPORT

Text, Tables & Attachments

**Pownal Tannery Superfund Site
Pownal, Vermont**

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EXECUTIVE SUMMARY

Potential noncarcinogenic and carcinogenic human health risks were quantitatively estimated for the central tendency (CT) and reasonably maximum exposure (RME) cases for soil/sludge and surface water at the five lagoon areas, soil at the Warehouse Area, surface water and sediment in the Hoosic River and associated wetlands and groundwater from off-site private wells as well as on-site monitoring wells. Soil/sludge and/or surface water risks at the five lagoon areas and the Warehouse Area, as well as surface water and sediment risks associated with the river and wetlands, were estimated for the current adolescent trespasser and future adult and young child park visitors. In addition, the Warehouse Area was evaluated for future residential use by risk estimation for young child and adult residential receptors while the lagoon areas were evaluated for future commercial use via a future commercial worker scenario. Future risks were estimated for a utility worker performing invasive trenching activities in the lagoon areas. Current and future groundwater risks associated with the drinking water ingestion pathway were also estimated.

When risks were estimated for a young child and adult receptor (i.e., residents and park visitors), the young child noncarcinogenic risks (hazard indices; HIs) have been presented as the most conservative, while carcinogenic risks (incremental lifetime cancer risks; ILCRs) presented represent the sum of the young child and adult risks (i.e., a total receptor risk). Soil/sludge and surface water risks, presented for the lagoon areas, have been summed together under the assumption that each receptor is exposed to both media during recreational activities. Surface water and sediment risks, presented for the Hoosic River/wetlands, have also been summed together. For the utility worker, soil/sludge, surface water and air risks were summed. In addition, HIs, segregated by systemic effects, are presented. In cases where the total HI exceeded 1, COPCs having similar systemic effects were summed for each pathway and medium. For those receptors with estimated ILCRs greater than the target range of 10^{-6} to 10^{-4} and target organ-specific HIs greater than 1, primary risk contributors have been discussed. The risk findings have been summarized and presented in the following table.

Risks Under Current Condition. ILCRs and HIs estimated for the current older child trespasser exposure scenarios (lagoon soil/sludge, Hoosic River surface water and sediment) were below an ILCR of 10^{-4} and an HI of 1 for each of the exposure areas, except for Lagoon 5. The HI for the current adolescent trespasser exceeded 1 for Lagoon 5 due to the presence of chromium in lagoon soil/sludge.

ILCRs and HIs for the current resident drinking water ingestion scenario exceeded an ILCR of 10^{-4} and/or an HI of 1 for each of the following private wells (primary risk contributors in parentheses): RW-003 (arsenic); RW-006 (thallium); RW-008 (arsenic and manganese); and RW-010 (manganese).

An evaluation of lead in soil/sludge at Lagoons 1, 3, 4 and 5 indicated that exposures to lead, under current land-use conditions, did not result in blood lead levels in excess of the blood lead level goal for an older child trespasser.

Potential Risks Under Future Conditions. For the future park visitor, ILCRs and HIs for Lagoons 2 and 4 were below an ILCR of 10^{-4} and an HI of 1. HIs exceeded 1 and/or ILCRs exceeded 10^{-4} for soil/sludge exposures at Lagoons 1, 3 and 5. The exceedances were due primarily to the presence of dioxins and chromium in soil/sludge. In addition, the ILCR exceeded 10^{-4} for future park visitor exposures to sediment within the Hoosic River. The exceedance was due primarily to the presence of PCBs in sediment.

For the future commercial worker, the ILCR exceeded 10^{-4} and an HI of 1 for soil/sludge exposure at Lagoons 1, 3 and 5, due primarily to the presence of dioxins and chromium at Lagoon 1 and chromium at Lagoons 3 and 5. For the future utility worker, the HI exceeded 1 for soil/sludge exposure at Lagoons 1 and 3 due primarily to the presence of chromium.

ILCRs and HIs for the future resident drinking water ingestion scenario exceeded an ILCR of 10^{-4} and/or an HI of 1 for each of the following on-site monitoring wells: MW-104U; MW-106U; MW-107R; MW-107U; MW-109U; MW-110R; MW-110U; MW-111U; MW-113R; MW-114U; MW-B-7; MW-L-3; and MW-L-10. The primary risk contributors for the on-site monitoring wells include 1,4-dichlorobenzene, carbon tetrachloride, methylene chloride, tetrachloroethene, atrazine, pentachlorophenol, heptachlor epoxide, dioxins, arsenic, manganese and thallium.

An evaluation of lead in soil/sludge at Lagoons 1, 3, 4 and 5 indicated that exposures to lead only at Lagoon 1, under future assumed land-use conditions, were estimated to result in blood lead levels in excess of the blood lead level goal for a young child park visitor.

SUMMARY OF RECEPTOR RISKS, HAZARDS, AND LIMITATIONS
HUMAN HEALTH RISK ASSESSMENT
POWNAI TANNERY

Location	High Lead	Scenario/Receptor	RME or CT	Total Cancer Risks	Total Noncancer Risks	Media > 1E-04 or HI > 1	Major contributors to risk (> 1E-06, HI > 1)
Lagoon 1	No	Current Adolescent Trespasser	RME CT	4E-06 3E-07	6E-01 6E-02		NA
	Yes	Future Park Visitor	RME	1E-03	5E+01	soil/sludge	(C) - Dioxins, benzo(a)anthracene, benzo(a)pyrene, pentachlorophenol, As
		Young Child / Adult	CT	2E-05	1E+01		(NC) - Hg, Cr
		Future Adult Commercial Worker	RME CT	7E-04 2E-05	1E+01 5E+00	soil/sludge	(C) - Dioxins, benzo(a)pyrene, pentachlorophenol, As
		Future Adult Utility Worker	RME CT	1E-05 8E-07	6E+00 2E+00		(NC) - Cr
Lagoon 2	No	Current Adolescent Trespasser	RME CT	4E-06 6E-07	1E-01 4E-02		NA
	No	Future Park Visitor	RME	2E-05	1E+00		NA
		Young Child / Adult	CT	2E-06	3E-01		NA
		Future Adult Commercial Worker	RME CT	1E-05 2E-06	2E-01 1E-01		NA
		Future Adult Utility Worker	RME CT	3E-07 9E-08	1E-01 5E-02		NA
Lagoon 3	No	Current Adolescent Trespasser	RME CT	2E-06 1E-07	7E-02 9E-03		NA
	No	Future Park Visitor	RME	2E-04	3E+01	soil/sludge	(C) - Dioxins, As
		Young Child / Adult	CT	2E-06	2E+00		(NC) - Cr
		Future Adult Commercial Worker	RME CT	1E-04 3E-06	6E+00 8E-01		(NC) - Cr
		Future Adult Utility Worker	RME CT	3E-06 1E-07	3E+00 3E-01		(NC) - Cr
Lagoon 4	No	Current Adolescent Trespasser	RME CT	9E-06 5E-07	8E-01 2E-01		NA
	No	Future Park Visitor	RME	7E-05	4E-01		NA
		Young Child / Adult	CT	2E-06	9E-02		NA
		Future Adult Commercial Worker	RME CT	5E-05 2E-06	8E-02 3E-02		NA
		Future Adult Utility Worker	RME CT	1E-06 9E-08	5E-02 1E-02		NA
Lagoon 5	No	Current Adolescent Trespasser	RME CT	2E-05 2E-06	2E+00 1E-01		(NC) - Cr
	No	Future Park Visitor	RME	2E-04	1E+01	soil/sludge	(C) - Dioxins, As, N-nitroso-di-n-propylamine, benzo(a)pyrene
		Young Child / Adult	CT	2E-05	3E+00		(NC) - Cr
		Future Adult Commercial Worker	RME CT	1E-04 2E-05	3E+00 1E+00		(NC) - Cr
		Future Adult Utility Worker	RME CT	2E-06 8E-07	2E+00 5E-01		(NC) - Cr

SUMMARY OF RECEPTOR RISKS, HAZARDS, AND LIMITATIONS
HUMAN HEALTH RISK ASSESSMENT
POWNAI TANNERY

Location	High Lead	Scenario/Receptor	RME or CT	Total Cancer Risks	Total Noncancer Risks	Media > 1E-04 or HI > 1	Major contributors to risk (> 1E-06, HI > 1)
Warehouse Area	No	Current Adolescent Trespasser	RME CT	2E-06 2E-07	3E-02 7E-03		NA
		Future Park Visitor Young Child / Adult	RME CT	1E-05 9E-07	5E-01 1E-01		NA
	Future Resident Young Child / Adult	RME CT	1E-05 2E-06	7E-01 3E-01		NA	
Hoosic River	No	Current Adolescent Recreational Visitor	RME CT	3E-05 7E-06	3E-02 6E-03		NA
	No	Future Park Visitor Young Child / Adult	RME CT	2E-04 2E-05	2E-01 3E-02	Sediment	(C) - PCBs, Dioxins, As
Tap Water RW-001	No	Current Resident Young Child / Adult	RME CT	N/A N/A	4E-01 1E-01		NA
Tap Water RW-002	No	Current Resident Young Child / Adult	RME CT	8E-05 1E-05	1E+00 4E-01		NA
Tap Water RW-003	No	Current Resident Young Child / Adult	RME CT	1E-04 3E-05	3E+00 2E+00	Ground-water	(NC) - As
Tap Water RW-004	No	Current Resident Young Child / Adult	RME CT	N/A N/A	9E-01 5E-01		NA
Tap Water RW-006	No	Current Resident Young Child / Adult	RME CT	9E-06 9E-07	2E+00 1E+00	Ground-water	(NC) - TI
Tap Water RW-007	No	Current Resident Young Child / Adult	RME CT	1E-05 2E-06	6E-01 2E-01		NA
Tap Water RW-008	No	Current Resident Young Child / Adult	RME CT	8E-05 1E-05	3E+00 1E+00	Ground-water	(NC) - As, Mn
Tap Water RW-010	No	Current Resident Young Child / Adult	RME CT	4E-05 8E-06	3E+00 2E+00	Ground-water	(NC) - Mn
All On-Site Monit. Wells	No	Future Resident Young Child / Adult	RME CT	4E-03 3E-05	1E+02 4E+00	Ground-water	(C) - 1,4-Dichlorobenzene, carbon tetrachloride, methylene chloride, tetrachloroethylene, atrazine, pentachlorophenol, heptachlor epoxide, dioxins, As (NC) - Methylene chloride, As, Mn, TI

BASELINE HUMAN HEALTH RISK ASSESSMENT

1.0 INTRODUCTION

This appendix contains the baseline human health risk assessment conducted for the Remedial Investigation/Feasibility Study (RI/FS) for the Pownal Tannery Superfund Site. The risk assessment evaluates current and potential future human health risks associated with exposures to on-site soil/sludge and surface water at the Lagoon Area, on-site soil at the Warehouse Area, sediment and surface water from the nearby Hoosic River and associated wetlands, and on-site as well as off-site groundwater potentially impacted by the site. Risks are estimated assuming no remedial actions have been performed, other than those completed as part of the Non-Time-Critical Removal Action (NTCRA). The results of the risk assessment will be used to provide a basis for decisions as to whether additional remedial actions are necessary at the site.

This baseline human health risk assessment has been conducted consistent with guidance presented in *Risk Assessment Guidance for Superfund (RAGS) Part D* (USEPA, 1998a) using the Technical Approach for Risk Assessment (TARA) Standard Tables.

According to USEPA guidelines (USEPA, 1989), the baseline risk assessment generally consists of four basic steps summarized below:

Hazard Identification. Determination of the nature and amount of chemicals that could potentially be encountered at a site, and selection of those chemicals that are of potential concern for the assessment of the impact on human health.

Exposure Assessment. Quantification of the extent, frequency, and duration of actual or potential exposure to chemicals by pathways relevant to a site and the activities of potential receptors.

Toxicity Assessment. Identification of the types of health effects that could be associated with exposure to these chemicals, determination of the relationship between exposure (dose) and the probability of occurrence of the health impact (response).

Risk Characterization. Estimation of the probability that an adverse health impact may occur as a result of exposure to chemicals in the amount and by the pathways identified and the uncertainty in those estimates.

The baseline human health risk assessment for the site was conducted using methodologies required by USEPA guidelines (USEPA, 1989; 1992; 1994c; 1995; 1996a; 1997a; 1998a; and 2000a). A baseline risk assessment is intended to be site-specific; therefore, site-specific information was incorporated into the evaluation whenever available. In the absence of site-specific information, default assumptions, as specified by USEPA guidance, were used.

The baseline human health risk assessment provides estimates of risk, under both current use and hypothetical future use scenarios, to both the central tendency (CT) receptor and the reasonably maximum exposed (RME) receptor. Potential contaminant migration pathways are selected that represent reasonable contaminant migration routes. Exposure assessments model human exposure by these pathways according to algorithms in relevant guidelines. In the risk assessment for this site, exposures were estimated for CT and RME cases. Variables contributing most to estimates of risk or to the uncertainty in the risk assessment have been identified. Each of these steps is discussed in more detail in the following sections.

1.1. Organization

This baseline human health risk assessment consists of several sections. Section 2.0, Hazard Identification, describes the environmental samples used for the risk assessment, the selection of chemicals of potential concern (COPCs) from among the chemicals identified at the site, and the determination of exposure point concentrations (EPCs). Section 3.0, Exposure Assessment, describes

the selection of receptors and exposure pathways to be evaluated and the calculation of dose to the receptors selected. Section 4.0, Toxicity Assessment, summarizes the toxicity of the COPCs including both potential carcinogens and noncarcinogens. Section 5.0, Risk Characterization, includes a summary of site risks and an uncertainty analysis.

Table 1 (Selection of Exposure Pathways) provides a conceptual model for the site, identifying the exposure media, exposure points, receptors, and routes of exposure quantitatively evaluated as part of the baseline human health risk assessment.

2.0 HAZARD IDENTIFICATION

The purpose of this section is the determination of the type and amount of chemicals present at the site and the selection of the COPCs with regard to human health. In addition, this section summarizes the methodology used to determine EPCs for COPCs in each medium. Environmental data used in this hazard identification were collected during two sampling events. The first sampling event, conducted by M&E as part of the EE/CA, occurred in 1995 and included sampling for soil/sludge and surface water at the Lagoon Area, and sediment and surface water from the Hoosic River. The second sampling event, conducted by TRC and M&E as part of this RI for the site, occurred in 2000 and included sampling for soil/sludge and surface water at the Lagoon Area, soil at the Warehouse Area, sediment and surface water in the Hoosic River and wetlands, and groundwater from on-site monitoring wells and off-site private wells. A detailed reporting of the 1995 data can be found in the *Technical Summary of Field Activities* (M&E, 1997) and in Appendices of the RI for samples collected in 2000.

2.1 Background and Reference Samples

Background samples for soil and reference samples for surface water and sediment were collected as part of investigational activities conducted for the site. Background locations for soil are identified as samples SS-003, SS-008 through SS-013 and SS-015. For sediment and surface water, reference locations are identified as samples SW/SD-003 and SD-004 (collected from a reference pond), SD-044 and SD-045 (collected from a reference wetland area), and SD-001, SD-002, SW/SD-005, SD-006, SD-007, SW/SD-008 and SW/SD-026 (collected from the Hoosic River, upgradient of the site). Their locations, relative to the site, and sample-specific analytical results are presented in the RI. These samples were collected from areas not considered to be affected by site activities and not displaying visual evidence of contamination. Background and reference data were not used quantitatively in the human health risk assessment.

2.2 Data Used in Risk Assessment

Detailed discussions of sampling approaches and the quality assurance and control activities implemented during the collection of the data are provided in the RI. The sampling data were validated according to USEPA's Contract Laboratory Program (CLP) procedures and guidelines, as described in the RI. The analytical results are discussed in the Nature and Extent Section of the RI. The following process used to summarize the analytical data is in accordance with *Risk Assessment Guidance for Superfund (RAGS)* (USEPA, 1989) and supplemental guidance (USEPA, 1992).

The analytical data were summarized by environmental medium and grouped into exposure areas. For the baseline human health risk assessment, the following media and exposure areas were selected for quantitative evaluation:

- Soil/sludge and surface water at the Lagoon Area (Lagoons 1 through 5)
- Soil at the Warehouse Area
- Surface water and sediment in the Hoosic River and wetlands
- Off-site private residential wells (individual wells as exposure points)
- On-site monitoring wells

The following sections summarize the environmental data available for use in the quantitative risk assessment for each of the exposure areas.

Lagoon Area. Surface water samples and surface and subsurface soil/sludge samples were collected from the five lagoon areas. Analytical results of compounds detected in surface water for the individual lagoons in 2000 are presented in the RI. Sampling locations are also shown in the RI. Samples collected and analyzed in 1995 are presented in the *Technical Summary of Field Activities Report* (M&E, 1997). Even though both surface water and soil/sludge samples were collected in 1995, only the soil/sludge samples have been quantitatively used in the risk assessment since historical surface water results are unlikely to represent current on-site conditions. Samples collected in 1995 are designed LAG- samples while those collected in 2000 are designed SBL-, SDOL- or TP- samples.

Surface water samples from ponded water were collected in 2000 from Lagoons 1, 2, 4 and 5. A single surface water sample was collected from each of Lagoons 1 (SW-OL1), 2 (SW-OL2) and 5 (SW-OL5). Three surface water samples were collected from Lagoon 4 (SW-OL4A, SW-OL4B and SW-OL4C). No surface water sample was collected from Lagoon 3.

Because human exposures are likely to occur only to soil/sludge located below one foot or less of standing water, depth of surface water in the lagoons at the soil/sludge sampling locations was measured in August, a time of the year when human exposures are likely to occur. All surface water

depths were less than or equal to one foot. Therefore, no soil/sludge samples were excluded from quantitative use in the human health risk assessment due to standing water depth.

Surface soil/sludge samples are defined as the most surficial interval of material. The most surficial interval was typically the 0-0.5' interval. However, the 0-1' and 0-2' interval were also included as surface soil/sludge since these may represent contaminant concentrations that humans currently encounter. Surface soil/sludge samples collected from below a surface water depth of less than or equal to one foot include:

- Lagoon 1** SBL1-01 (0-0.5'), SBL1-02 (0-0.5'), SBL1-03 and its duplicate (0-0.5'), SBL1-08 (0-0.5'), SBL1-09 (0-0.5'), SBL1-11 (0-0.5'), SBL1-12 (0-0.5'), TP-500 (0-1'), TP-501 (0-1') and TP-508 (0-1');
- Lagoon 2** SBL2-01 (0-0.5'), SBL2-02 (0-0.5'), SBL2-03 (0-0.5'), SBL2-04 (0-0.5'), SBL2-05 and its duplicate (0-0.5'), SBL2-06 (0-0.5'), SBL2-07 (0-0.5'), SBL2-08 (0-0.5') and SBL2-09 (0-0.5');
- Lagoon 3** SBL3A-01 (0-0.5'), SBL3A-02 (0-0.5'), SBL3A-03 (0-0.5'), SBL3AB-01 (0-0.5'), SBL3B-01 (0-0.5'), SBL3B-02 (0-0.5') and SBL3B-03 (0-0.5');
- Lagoon 4** SBL4-01 (0-0.5'), SBL4-04 and its duplicate (0-0.5'), SBL4-05 (0-0.5' and 0-0.6'), SBL4-07 (0-2'), SBL4-08 (0-0.5' and 0.0.6'), SBL4-09 (0-0.5'), SBL4-10 (0-0.5'), SBL4-11 and its duplicate (0-0.5'), SBL4-12 (0-0.5'), SBL4-13 (0-2'), SBL4-14 (0-0.5'), SBL4-15 (0-0.5'), SBL4-16 (0-0.5' and 0-2'), SBL4-17 (0-0.5'), SBL4-18 (0-0.5'), SBL4-19 and its duplicate (0-0.5'), SBL4-20 (0-2'), SBL4-21 (0-0.5'), SBL4-22 (0-1'), SBL4-23 (0-2'), SBL4-24 (0-0.5' and 0-2'), SBL4-25 (0-2'), SBL4-26 (0-0.5' and 0-2'), SBL4-27 (0-2'), SBL4-28 (0-0.5'), SDOL-4B, SDOL-4C, TP-503 (0-1'), TP-504 (0-1'), TP-505 (0-1') and TP-506 (0-1'); and

Lagoon 5 SBL5-01 (0-0.5'), SBL5-07 (0-0.5'), SBL5-08 and its duplicate (0-0.5'), SBL5-09 (0-0.5'), SBL5-10 and its duplicate (0-0.5'), SBL5-11 (0-0.5'), TP-502 (0-1') and TP-507 (0-1').

Subsurface soil/sludge samples were also collected from the Lagoon Area. Subsurface soil/sludge samples are representative of the deeper interval which human receptors may encounter under future site reuse conditions. The subsurface interval includes soil/sludge at depths up to 10' below ground surface for the shallower collection interval. However, because a small number of dioxin results were available for this subsurface interval, dioxin results from deeper soils were also quantitatively used in the risk assessment. These deeper dioxin results are likely indicative of dioxin concentrations within the subsurface interval of interest. Subsurface soil/sludge samples collected include:

Lagoon 1 SBL1-01 (3-5' and 9-12'), SBL1-02 (2-4' [and its duplicate] and 7-10'), SBL1-03 (4-7'), SBL1-04 (5-8'), SBL1-05 (5-8'), SBL1-07 (4-7'), SBL1-08 and its duplicate (2-4'), SBL1-09 (5-7'), SBL1-10 (6-8'), SBL1-11 (8-11'), SBL1-12 and its duplicate (5-8'), SBL1-13 (6-8'), SBL1-14 (8-11'), SBL1-15 (8-10'), TP-500 (7-8'), TP-501 and its duplicate (6-7'), TP-508 (5-6'), LAG-01-00-L100 (8'), LAG-01-50-L200 (3'), LAG-01-50-L200 (8'), LAG-01-100-L150 (2'), LAG-01-100-L200 (8'), LAG-01-150-L100 (2'), LAG-01-150-L100 (8') and LAG-01-250-L150 (8');

Lagoon 2 SBL2-01 (2-4'), SBL2-03 (9-12'), SBL2-05 (3-5'), SBL2-06 (6-8'), LAG-02-150-R100 (8'), LAG-02-150-R50 (8'), LAG-02-150-R200 (1'), LAG-02-200-R50 (1'), LAG-02-200-R50 (8') and LAG-02-200-R100 (8');

Lagoon 3 SBL3A-01 (6-8'), SBL3A-02 (6-9'), SBL3A-03 (5-7'), SBL3B-01 (7-10'), SBL3B-02 (8-10'), SBL3B-03 (14-16' for dioxins only), LAG-3A-350-R250 (2'), LAG-3A-350-R250 (8'), LAG-3A-350-R300 (8'), LAG-3A-400-R200 (8'), LAG-3A-400-R300 (2'), LAG-3A-400-R300 (8'), LAG-3B-250-R50

(1'), LAG-3B-250-R50 (8'), LAG-3B-300-R50 (8'), LAG-3B-300-R250 (1') and LAG-3B-350-R100 (1');

Lagoon 4 SBL4-02 (0.5-1'), SBL4-05 (2-4'), SBL4-07 (6-8'), SBL4-08 (2-4' and 4-6'), SBL4-09 (2-4'), SBL4-10 (2-4'), SBL4-11 (2-4'), SBL4-12 (2-3'), SBL4-13 (4-6'), SBL4-14 (2-4'), SBL4-15 (8-10'), SBL4-16 (7-8'), SBL4-17 (6-8'), SBL4-18 (8-10'), SBL4-19 (2-4'), SBL4-21 (6-8'), SBL4-22 (3-5'), SBL4-23 (4-6'), SBL4-24 and its duplicate (4-6'), SBL4-25 (4-6'), SBL4-26 (4-6'), SBL4-27 (3-4'), SBL4-29 (5-7'), TP-503 (6-7'), TP-504 (5-6'), TP-505 (5-6'), TP-506 (5-6'), LAG-04-550-R125 (1'), LAG-04-650-R100 (8'), LAG-04-800-R70 (1'), LAG-04-800-R360 (1'), LAG-04-800-R70 and its duplicate (8'), LAG-04-800-R825 and its duplicate (8') and LAG-04-870-R825 (1'); and

Lagoon 5 SBL5-2 and its duplicate (0.5-1'), SBL5-03 (3-4'), SBL5-4 and its duplicate (0.5-1'), SBL5-05 (0.5-1' [and its duplicate] and 2-4'), SBL5-06 (0.5-1'), SBL5-08 (2-4'), SBL5-10 (2-4'), TP-502 (6-7'), TP-507 (5-6'), LAG-05-450-L100 (2'), LAG-05-450-L150 (2'), LAG-05-550-L100 (1'), LAG-05-550-L150 (1'), LAG-05-600-L150 (2') and LAG-05-650-L100 (1').

The surface soil/sludge data and all combined data (surface and subsurface results) are summarized in Tables 2.1 and 2.2, respectively, for Lagoon 1, Tables 2.3 and 2.4 for Lagoon 2, Tables 2.5 and 2.6 for Lagoon 3, Tables 2.7 and 2.8 for Lagoon 4, and Tables 2.9 and 2.10 for Lagoon 5. For lagoon surface water, analytical results are summarized in Tables 2.11 through 2.14 for Lagoons 1, 2, 4 and 5, respectively. Each of the summary tables (Tables 2.1 through 2.14) for chemicals detected in soil/sludge and surface water provide the frequency of detection, range of detection limits, range of detected concentrations and location of maximum detected result.

Warehouse Area. Soil samples were collected from various depths in the vicinity of the warehouse building as well as from beneath the footprint of the building. Analytical results of compounds detected

in soil for the Warehouse Area in 2000 are presented in the RI. Sampling locations are also shown in the RI. Surface soil samples were defined as those samples collected from depths of less than 1 foot below ground surface from the area outside the building. Subsurface soil samples were defined as those samples collected from depths between 1-10' below ground surface from the area outside the building, or from shallower depths (i.e., 0-1') if collected from beneath the footprint of the building. Subsurface soil samples are representative of the deeper interval which human receptors may encounter under future site reuse conditions, which assumes removal of the existing warehouse building. The surface and subsurface soil samples available for use in the risk assessment include:

Surface Soil SS-001 (0-0.5'), SS-002 (0-0.5'), SS-004 and its duplicate (0-0.5'), SS-005 (0-0.5'), SS-007 (0-0.5'), SBW-2 (0-0.5'), SBW-3 and its duplicate (0-0.5') and SBW-5 (0-0.5');

Subsurface Soil SBW-1 (2-4' and 6-8'), SBW-2 (2-4' and 6-8'), SBW-3 (2-4' and 6-8'), SBW-4 (2-4' and 6-8'), SBW-5 (2-4' and 6-8'), SBW-6 (2-4' and 6-8'), SBW-7 (0-2' and 4-5'), SBW-8 (0-2' [and its duplicate] and 4-5'), SBW-9 (0-2' and 4-6'), SBW-10 (0-2' and 4-5'), SBW-11 (0-2' and 3-4') and SBW-12 (4-6').

Surface soil analytical results for the Warehouse Area are summarized in Table 2.15 while all soil data combined (surface and subsurface results) are summarized in Table 2.16. The summary tables for chemicals detected in soil provide the frequency of detection, range of detection limits, range of detected concentrations and location of maximum detected result.

Hoosic River and Wetlands. Surface water and sediment samples were collected in 2000 from the Hoosic River and associated wetland areas. Analytical results of compounds detected in surface water from the river and wetlands are presented in the RI. Sampling locations are also shown in the RI. Surface water and sediment samples from the Hoosic River were also collected in 1995. However,

these samples have not been quantitatively used in the risk assessment since historical surface water and sediment results are unlikely to represent current on-site conditions.

Because human exposures are likely to occur only to sediments located below one foot or less of standing water, depth of surface water in the river and wetlands at the sediment sampling locations was measured in August, a time of the year when human exposures are likely to occur. All surface water depths were less than or equal to one foot except for sampling locations SD-027, SD-028 and SD-029. Therefore, these three sediment samples were excluded for quantitative use in the human health risk assessment due to standing water depth.

Surface water and sediment samples available for quantitative use in the risk assessment include:

Surface Water SW-009, SW-011, SW-012, SW-013, SW-020, SW-021, SW-030, SW-034 and its duplicate, SW-036, SW-038, SW-050 and OF-1 and its duplicate;

Sediment SD-009, SD-010, SD-011, SD-012, SD-013, SD-014, SD-015, SD-016, SD-017, SD-018, SD-019, SD-020, SD-021, SD-022, SD-023, SD-024 and its duplicate, SD-025, SD-030, SD-031 and its duplicate, SD-032 and its duplicate, SD-033, SD-034, SD-035, SD-036, SD-037, SD-038, SD-039, SD-040, SD-041, SD-042 and SD-043.

Surface water and sediment analytical results for the river and wetlands are summarized in Tables 2.17 and 2.18, respectively. The summary tables for chemicals detected in surface water and sediment provide the frequency of detection, range of detection limits, range of detected concentrations and location of maximum detected result.

Private Wells. Private well water samples were collected twice in 2000 from 10 residential wells (RW-001 through RW-010) in the vicinity of the site. Analytical results of compounds detected in these private wells are presented in the RI. Sampling locations are also shown in the RI. Groundwater analytical results for the two rounds of sampling for each of the private wells are summarized in Tables 2.19 through 2.28, except for private well RW-010. This well was resampled in August after removal of the filtration system which was in poor condition and likely contributing elevated levels of inorganics noted during the May round of sampling. Therefore, only the August analytical results have been quantitatively used in the risk assessment. The summary tables for chemicals detected in private wells provide the frequency of detection, range of detection limits and range of detected concentrations.

On-Site Monitoring Wells. On-site monitoring well samples were collected between one and three times in 2000 from 24 overburden and bedrock wells (MW-101U through MW-104U, MW-106U, MW-107U, MW-109U through MW-112U, MW-114U, MW-B-7, MW-L-3 through MW-L-7, MW-L-9 through MW-L-11, MW-103-R, MW-107R, MW-110R and MW-113R) across the site. Analytical results of compounds detected in these monitoring wells are presented in the RI. Sampling locations are also shown in the RI. Groundwater analytical results for the rounds of sampling for each of the monitoring wells are summarized in Tables 2.29 through 2.52. The summary tables for chemicals detected in each monitoring well provide the frequency of detection, range of detection limits and range of detected concentrations. Table 2.53 provides a summary of detected contaminants in all monitoring wells combined in the form of frequency of detection, range of detection limits, range of detected concentrations and location of maximum detected result.

Data were qualified by the analytical laboratory and validated as described in RI. The qualification and validation of the analytical data included a comparison of the site data to corresponding blank (laboratory, field, equipment, and trip) concentration data. Data rejected by the validation ("R" qualified) were not used. Estimated values (e.g., J qualified) were used in the risk assessment without modification. Analytical data from duplicate samples were combined as described in Attachment 1.

Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples analyzed after the exclusion of rejected ("R" qualified) data.

2.3 Identification of COPCs

The scope of the baseline human health risk assessment includes identification of COPCs based on the chemical substances found at the site. This list was developed using the simple screening process described below. For each medium evaluated, all available and appropriate data from each exposure area were used to select COPCs for the exposure area.

2.3.1 Selection Criteria. The maximum detected concentration of a chemical in groundwater, soil/sludge, surface water or sediment was compared to preliminary remedial goals (PRGs) published by USEPA Region 9 (USEPA, 2000b). PRGs are chemical concentrations back-calculated using toxicity criteria and either a 1×10^{-6} target risk level for potential carcinogens or a hazard quotient (HQ) of 1 for noncarcinogens. For purposes of this screening analysis, a HQ of 0.1 was used to add a ten-fold measure of safety to reduce the chance of omitting chemicals from the list of COPCs that could contribute to a total hazard index (HI) of 1. To accomplish this, PRGs for noncarcinogenic chemicals were divided by 10 prior to comparison to maximum detected values. Tap water PRGs were used for comparison to maximum detected groundwater and surface water concentrations for each exposure area, and residential soil PRGs were used for comparison to the maximum detected soil/sludge and sediment concentrations for each exposure area. The comparison of surface water concentrations to tap water PRGs provides a conservative screening evaluation. Ambient Water Quality Criteria (AWQCs) (USEPA, 1998b) developed to be protective of human health following the ingestion of water and organisms from fishable surface water bodies, were also used as screening criteria for surface water.

A maximum detected site chemical concentration less than its screening value indicated that the excess lifetime cancer risk associated with exposure to that chemical concentration would be less than one in

one million and the HQ associated with exposure would be less than 0.1. Chemicals detected at concentrations below their screening criteria (and also below AWQCs for surface water) were, therefore, eliminated from further evaluation. All chemicals with maximum concentrations greater than the relevant screening criteria (or relevant AWQCs for surface water) were selected as COPCs. Comparisons of maximum concentrations to screening criteria are presented in the data summary tables for each medium by exposure area (Tables 2.1 through 2.52). For certain analytes lacking compound-specific screening criteria (e.g., endrin aldehyde), a surrogate compound was selected (e.g., endrin) and its screening criteria was used for COPC screening. Specific instances where surrogate assignments were made are identified in footnotes on Tables 2.1 through 2.52.

For four essential human nutrients that lacked screening criteria (i.e., calcium, magnesium, potassium and sodium), the maximum detected concentrations were compared to concentrations in drinking water and soil that would not significantly increase the dietary Allowable Daily Intakes (ADIs), as follows: for calcium (400,000 µg/l water; 4,000,000 mg/kg soil); for magnesium (805,000 µg/l water; 8,050,000 mg/kg soil); for potassium (100,000 µg/l water; 1,000,000 mg/kg soil); and for sodium (100,000 µg/l water; 1,000,000 mg/kg soil). Derivations of these ADIs are provided in Attachment 2. If no concentrations exceeded the ADIs, these chemicals were not further evaluated.

Since PRGs were not available for lead, the maximum detected lead concentration in soil/sludge and sediment for each exposure area was evaluated relative to the residential soil screening level of 400 mg/kg (USEPA, 1994a). The maximum lead concentration in groundwater and surface water was evaluated relative to a drinking water concentration of 15 µg/l, a criterion protective of blood lead levels in children (USEPA, 1996b).

In addition, four other inorganic chemicals, aluminum, cobalt, copper and iron, were eliminated as COPCs because the PRGs were based on provisional toxicity criteria provided by the Superfund Technical Support Center. USEPA Region I does not concur with the use of these values. These

metals are abundant in the earth's crust and are unlikely to cause substantial toxicity at concentrations commonly encountered.

2.3.2 Chemicals Selected as COPCs. This subsection describes the chemicals selected as COPCs and refers to lists of the selected chemicals.

COPCs in Lagoon Soil/Sludge. Surface soil/sludge and soil/sludge (all soil/sludge combined) analytical results for the five lagoon areas quantitatively evaluated are summarized in Tables 2.1 through 2.10. The specific samples summarized and evaluated are listed in Section 2.2. Tables 2.1 through 2.10 list all chemicals detected in soil/sludge samples from the lagoons as well as the chemicals selected as COPCs in soil/sludge based on comparison to residential soil PRGs. COPCs were selected independently for each of the lagoon areas as well as for surface soil/sludge and all soil/sludge combined. The maximum detected results for the following compounds exceed their respective PRGs and were selected as soil/sludge COPCs:

Lagoon 1 Surface Soil/Sludge	benzo(a)pyrene, dioxins, antimony, arsenic, cadmium, chromium, manganese, mercury and thallium;
Lagoon 1 Soil/Sludge	dichlorobenzenes, 1,2-dichloroethane, benzene, bromodichloromethane, carbon tetrachloride, chlorobenzene, chloroform, tetrachloroethene, trichloroethene, xylenes, 2-methylnaphthalene, 4-methylphenol, benzo(a)anthracene, benzo(a)pyrene, naphthalene, pentachlorophenol, dieldrin, dioxins, antimony, arsenic, barium, cadmium, chromium, cyanide, lead, manganese, mercury and thallium;
Lagoon 2 Surface Soil/Sludge	dioxins, arsenic, cadmium, chromium, cyanide, manganese, mercury and thallium;
Lagoon 2 Soil/Sludge	acetophenone, dioxins, arsenic, cadmium, chromium, cyanide, manganese, mercury and thallium;

Lagoon 3 Surface Soil/Sludge	dioxins, arsenic, chromium, manganese and mercury.
Lagoon 3 Soil/Sludge	dioxins, antimony, arsenic, chromium, lead, manganese, mercury and thallium;
Lagoon 4 Surface Soil/Sludge	benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,1,3-cd)pyrene, dioxins, arsenic, cadmium, chromium, lead, manganese, mercury and thallium;
Lagoon 4 Soil/Sludge	benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, naphthalene, pentachlorophenol, dioxins, arsenic, cadmium, chromium, lead, manganese, mercury and thallium;
Lagoon 5 Surface Soil/Sludge	benzo(a)pyrene, pentachlorophenol, dioxins, antimony, arsenic, cadmium, chromium, lead, manganese and thallium; and
Lagoon 5 Soil/Sludge	benzo(a)pyrene, bis(2-chloroethoxy)methane, bis(2-chloroethyl)ether, N-nitroso-di-n-propylamine, nitrobenzene, pentachlorophenol, Aroclor 1248, dioxins, antimony, arsenic, cadmium, chromium, lead, manganese, mercury and thallium.

No essential nutrients were detected at maximum concentrations in excess of their respective ADIs for soil.

COPCs in Lagoon Surface Water. Surface water analytical results for Lagoons 1, 2, 4 and 5 are summarized in Tables 2.11 through 2.14. No surface water samples were collected for Lagoon 3. The specific samples summarized and evaluated are listed in Section 2.2. Tables 2.11 through 2.14 list all chemicals detected in surface water samples from the lagoons as well as the chemicals selected as COPCs in surface water based on comparison to tap water PRGs. COPCs were selected independently for each of the lagoon areas. The maximum detected results for the following compounds exceed their respective PRGs and were selected as surface water COPCs:

- Lagoon 1** arsenic, manganese, mercury and thallium;
- Lagoon 2** dioxins and manganese;
- Lagoon 4** dioxins, manganese and mercury; and
- Lagoon 5** dioxins, trivalent chromium, manganese and mercury.

No essential nutrients were detected at maximum concentrations in excess of their respective ADIs for water.

COPCs in Warehouse Soil. Surface soil and soil (surface and subsurface soil combined) analytical results for the Warehouse Area are summarized in Tables 2.15 and 2.16. The specific samples summarized and evaluated are listed in Section 2.2. Tables 2.15 and 2.16 list all chemicals detected in soil samples from this area as well as the chemicals selected as COPCs in soil based on comparison to residential soil PRGs. COPCs were selected independently for surface soil and all soil combined. The maximum detected results for the following compounds exceed their respective PRGs and were selected as soil COPCs:

- Surface Soil** benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, dioxins, arsenic, chromium and manganese; and
- Soil** acetophenone, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, dioxins, arsenic, chromium, manganese, mercury, thallium and vanadium.

No essential nutrients were detected at maximum concentrations in excess of their respective ADIs for soil.

COPCs in River Surface Water. Surface water analytical results from the Hoosic River and wetlands are summarized in Table 2.17. Table 2.17 lists all chemicals detected in surface water from the river as well as the chemicals selected as COPCs in surface water based on comparison to tap

water PRGs and human health AWQCs. The maximum detected results for dioxins, manganese and mercury exceed their respective PRGs and/or AWQCs and were selected as surface water COPCs. No essential nutrients were detected at maximum concentrations in excess of their respective ADIs for water.

COPCs in River Sediment. Sediment analytical results from the Hoosic River and wetlands quantitatively evaluated are summarized in Table 2.18. The specific samples summarized and evaluated are listed in Section 2.2. Table 2.18 lists all chemicals detected in sediment samples from the river as well as the chemicals selected as COPCs in sediment based on comparison to residential soil PRGs. The maximum detected results for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, Aroclor 1254, Aroclor 1260, dioxin-like PCBs, dioxins, arsenic, chromium, manganese and mercury exceed their respective PRGs and were selected as sediment COPCs. No essential nutrients were detected at maximum concentrations in excess of their respective ADIs for sediment.

COPCs in Private Wells. Groundwater analytical results from ten private wells are summarized in Tables 2.19 through 2.28. Table 2.19 through 2.28 list all chemicals detected in groundwater from the private wells as well as the chemicals selected as COPCs in drinking water based on comparison to tap water PRGs. COPCs were selected independently for each of the private wells. The maximum detected results for the following compounds exceed their respective PRGs and were selected as groundwater COPCs:

RW-001	antimony;
RW-002	arsenic;
RW-003	bis(2-ethylhexyl)phthalate, antimony, arsenic and manganese;
RW-004	manganese;
RW-005	no COPCs selected;
RW-006	methyl tert-butyl ether, bis(2-ethylhexyl)phthalate and thallium;

- RW-007** antimony and arsenic;
- RW-008** arsenic and manganese;
- RW-009** no COPCs selected; and
- RW-010** arsenic and manganese.

No essential nutrients, except sodium, were detected at maximum concentrations in excess of their respective ADIs for water. For sodium, the maximum detected concentration in RW-010 (177,000 µg/l) exceeded its ADI (100,000 µg/l). However, due to a lack of toxicity values, sodium has not been further evaluated in the risk assessment.

COPCs in Monitoring Wells. Groundwater analytical results from thirteen on-site monitoring wells are summarized in Tables 2.29 through 2.52. Table 2.53 summarizes all on-site monitoring wells combined. Tables 2.29 through 2.53 list all chemicals detected in groundwater from these monitoring wells as well as the chemicals selected as COPCs in groundwater based on comparison to tap water PRGs. COPCs were selected independently for each of the private wells. The maximum detected results for the following compounds exceed their respective PRGs and were selected as groundwater COPCs:

- MW-101U** methylene chloride, antimony, arsenic, trivalent chromium, manganese and thallium;
- MW-102U** arsenic;
- MW-103R** antimony, arsenic and manganese;
- MW-103U** arsenic;
- MW-104U** arsenic and manganese;
- MW-106U** arsenic and manganese;
- MW-107R** dioxins, arsenic and manganese;
- MW-107U** antimony, arsenic and manganese;
- MW-109U** carbon tetrachloride, heptachlor epoxide, arsenic, manganese and thallium;
- MW-110R** arsenic and manganese;

MW-110U	methylene chloride, pentachlorophenol, antimony, arsenic and manganese;
MW-111U	antimony, arsenic and manganese;
MW-112U	antimony and arsenic;
MW-113R	arsenic and manganese;
MW-114U	1,3-dichlorobenzene, 1,4-dichlorobenzene, chlorobenzene, tetrachloroethene, arsenic, trivalent chromium and manganese;
MW-B-7	methylene chloride;
MW-L-3	1,4-dichlorobenzene, hexavalent chromium, arsenic and manganese;
MW-L-4	methylene chloride;
MW-L-5	arsenic and thallium;
MW-L-6	no COPCs selected;
MW-L-7	methylene chloride, arsenic and manganese;
MW-L-9	methylene chloride and cyanide;
MW-L-10	methylene chloride, arsenic and manganese; and
MW-L-11	atrazine.

No essential nutrients, except sodium, were detected at maximum concentrations in excess of their respective ADIs for water. For sodium, the maximum detected concentrations in MW-110R and MW-110U (129,000 µg/l and 276,000 µg/l) exceeded its ADI (100,000 µg/l). However, due to a lack of toxicity values, sodium has not been further evaluated in the risk assessment.

2.4 Determination of Exposure Point Concentrations

To evaluate the magnitude of potential human exposures, the concentration of each COPC in each exposure medium must be estimated. An estimate of this concentration is referred to as an EPC. EPCs were determined for the COPCs in each medium for each exposure area.

USEPA requires the use of the 95% UCL on the arithmetic mean concentration for the estimation of both the CT and RME risk (USEPA 1989; 1992; and 1994c). Therefore, whenever possible, the 95% UCL has been calculated and used as the EPC for both the RME and CT exposure cases. For data sets with only one sample (e.g., Lagoon 1 surface water), the detected COPC concentrations were used as the EPCs for both the CT and RME exposure cases. For data sets with a small sample size (e.g., Lagoon 4 surface water) or for larger data sets with high variability, the 95% UCL value for a COPC frequently exceeded the maximum detected concentration. For these cases, the maximum detected value was used as the EPC for the RME scenario, and the arithmetic mean value was used as the EPC for the CT exposure case (USEPA 1989 and 1994c). In cases where the arithmetic mean value exceeded the maximum detected value, the maximum detected value was used as the EPC for both the RME and CT cases. Attachment 1 describes the treatment of analytical data including the calculation of average and 95% UCL values.

For lagoon soil/sludge, each of the lagoons was quantitatively evaluated as a separate exposure location using COPCs which were selected using 1995 and 2000 data combined. In addition, surface soil/sludge and soil/sludge (combined surface and subsurface data) were evaluated as separate exposure points as noted in subsection 2.2. Only soil/sludge samples collected from below a surface water depth of less than or equal to one foot were used in the human health risk assessment. Tables 3.1 through 3.10 list the soil/sludge COPCs detected, by lagoon, along with their maximum detected concentrations, arithmetic mean concentrations and 95% UCL values. Arithmetic mean and 95% UCL values have been provided because multiple samples of appropriate depth were collected from each lagoon.

For lagoon surface water, each of the lagoons was quantitatively evaluated as a separate exposure location using COPCs which were selected using 2000 data. No surface water sample was collected from Lagoon 3. Tables 3.11, 3.12 and 3.14 list, for Lagoons 1, 2 and 5, respectively, the surface water COPCs detected and their maximum detected concentrations. Since only one surface water sample was collected from each of these lagoons, the arithmetic mean and 95% upper confidence limit

(UCL) values were not calculated. However, for Lagoon 4, where three samples were collected, Table 3.13 lists the surface water COPCs detected along with their maximum detected concentrations, arithmetic mean concentrations and 95% UCL values.

For Warehouse Area soil, surface soil and all soil combined were quantitatively evaluated as separate exposure points using COPCs which were selected using 2000 data. Tables 3.15 and 3.16 list the surface soil and soil (combined surface and subsurface data) COPCs, along with their maximum detected concentrations, arithmetic mean concentrations and 95% UCL values. Arithmetic mean and 95% UCL values have been provided because multiple samples of appropriate depth were collected from this area.

For the river and wetlands, sediment collected within the entire reach was quantitatively evaluated as an exposure location using COPCs which were selected using 2000 data from the area combined. Only sediment samples collected from below a surface water depth of less than or equal to one foot were used in the human health risk assessment. For surface water, samples collected within the entire river and wetland area were also evaluated as an exposure location using COPCs selected using 2000 data from the area combined. Tables 3.17 and 3.18 list the sediment and surface water COPCs detected, respectively, along with their maximum detected concentrations, arithmetic mean concentrations and 95% UCL values.

For groundwater from private wells and on-site monitoring wells, each of the wells was quantitatively evaluated as a separate exposure point using COPCs which were selected using 2000 data. Tables 3.19 through 3.26 list, for the private wells, the groundwater COPCs detected along with their maximum detected concentrations and arithmetic mean concentrations. Tables 3.27 through 3.49 list, for the on-site monitoring wells, the groundwater COPCs detected along with their maximum detected concentrations and arithmetic mean concentrations. No COPCs were selected for wells RW-005, RW-009 and MW-L-6. Since between one and three groundwater samples were collected from each of the wells, the 95% UCL values were not calculated. In addition, Table 3.50 lists, for all

groundwater COPCs, their average and maximum detected concentrations. The maximum detected COPC concentrations were used as the EPCs for the RME exposure case and the arithmetic average concentrations were used as EPCs for the CT exposure case. If an arithmetic mean concentration could not be calculated (i.e., only one sample was collected) or if the average concentration exceeded the maximum detected concentration, the maximum detected value was used as the EPC for both RME and CT exposure cases.

For air, concentrations of volatile COPCs detected in lagoon soil or overburden groundwater were modeled to estimate airborne concentrations a utility worker may be exposed to during trenching activities in the Lagoon Area. Attachment 3 documents the assumptions used in the modeling as well as the inputs to the model. Table 3.51 lists the groundwater and soil COPCs detected along with their modeled maximum air concentrations. Because only one set of air concentrations were modeled, these concentrations were used as EPCs for both the RME and CT exposure scenarios.

3.0 EXPOSURE ASSESSMENT

The purpose of the exposure assessment is the quantification of the extent, frequency and duration of actual or potential exposure to chemicals by pathways relevant to the site and activities of the potential receptors.

3.1 Identification of Potentially Exposed Populations and Potential Exposure Pathways

As part of the exposure assessment, potential current and future exposure pathways were determined through which identified populations may be exposed to the COPCs at the site. A detailed historical account and physical description of the site can be found in the RI.

An exposure pathway describes the course a chemical follows while moving through environmental media from its source to the receptor. An exposure pathway may consist of the following elements: 1) a source; 2) a mechanism of release from the source into the environment; 3) an environmental transport medium (e.g., surface soil); 4) an exposure route (e.g., ingestion); and 5) a receptor. An exposure pathway is considered complete when all five elements are present. For purposes of this risk assessment, only potentially complete exposure pathways were quantitatively evaluated.

USEPA (1989 and 1991) guidance requires that plausible exposures under both current and future land-use scenarios be evaluated in a baseline risk assessment. Accordingly, potential human exposure pathways were identified for both current and potential future land-use scenarios at the site. The current land-use scenario examines the potential for human exposure under current site conditions, while the future land-use scenario evaluates potential exposures following possible changes in site use (assuming no additional remedial action occurs). Table 1 presents a summary of the exposure routes quantitatively evaluated in the baseline human health risk assessment as well as the human health exposure points and receptors.

3.1.1 Potential Exposure Pathways and Receptors Under Current Land-Use Conditions. The site, located in the village of North Pownal, Vermont, was historically used to operate a cow and sheep hide tanning operation. On-site areas of interest for this assessment include the wastewater lagoon system (Lagoons 1 through 5) and the area near the warehouse building. The site is currently abandoned. However, a residential area lies to the east of the site, with the nearest residence located approximately 75 feet from the site. In addition, an agricultural area is located to the north of the site, and the Hoosic River borders the site to the west. The Hoosic River historically received wastewater discharge from the lagoons and other process areas.

Because of the rural nature of the area, many residences have private wells. Due to the proximity of the site to residences that use groundwater as a potable supply, nearby young child (ages 1 to 6) and adult residents may be exposed to site-related contaminants in impacted groundwater through ingestion.

Exposures through the dermal and inhalation pathways are likely to be negligible due to the low levels of volatile and other organic compounds detected in groundwater. Most contaminants detected in residential well water are inorganics which do not penetrate into the skin or volatilize with ease.

Local residents near the site could potentially contact contaminants in surface soil/sludge and standing surface water (in the lagoons) while trespassing on-site. The most likely receptor to trespass onto the site is an adolescent (ages 9 to 18). The adolescent trespasser is likely to be exposed to contaminants in surface soil/sludge by incidental ingestion and dermal contact, and to contaminants in standing surface water by dermal contact during wading. Ingestion of standing surface water is unlikely to occur during wading activities. Inhalation of contaminants from surface soil/sludge and surface water is also assumed to be an incomplete exposure pathway because the levels of volatile compounds and airborne particulates are low, and would be further diluted and dispersed into ambient air.

The Hoosic River is classified by the State of Vermont as Class B (i.e., suitable for fishing, boating and irrigation). Adolescent trespassers at the site may also contact contaminants in surface water and sediment in the Hoosic River while engaging in recreational activities in the river such as wading and boating. Because of the rapid flow of the river waters, swimming is unlikely to occur. Exposure to contaminants in river surface water and sediments is assumed to occur via incidental ingestion and dermal contact. Even though ingestion of surface water during wading is unlikely, this exposure pathway is assumed to be complete due to the rapid flowing of the river and the other activities engaged in (i.e., boating) which might result in incidental ingestion of surface water during to occasional accidental immersion. Inhalation of contaminants from sediment and surface water is assumed to be an incomplete exposure pathway because the levels of volatile compounds are low, and would be further diluted and dispersed into ambient air.

No fish tissue from the Hoosic River has been collected. The Vermont Department of Health has issued a special advisory that individuals not consume any fish caught from the Hoosic River due to the potentially harmful effects from PCBs (VTDH, 2000).

3.1.2 Potential Receptors and Exposure Pathways Under Future Land-Use Conditions. To evaluate potential future exposures, it was assumed that no further remedial action was taken, and that the levels of contamination currently existing at the site would remain the same in the future. Should no land-use change occur, the exposures described under current land-use conditions for nearby residents and adolescent trespassers would continue in the future. However, for the purposes of this baseline risk assessment, it was assumed that site development will occur in the future which might include future park, commercial and/or residential land uses. Future site development also assumes that disturbances of site soil/sludge results in the movement of contaminants currently at depth (up to 10 feet below ground surface) to a surficial location where exposures could occur. Should portions of the site undergo development for park use, the site would become more attractive to children and adults. Therefore, future park visitors to the site (young children and adults) would be exposed to contaminated media via the same pathways as assumed for the current adolescent trespasser, but with an increased exposure frequency and intensity. Residential groundwater use is also assumed to continue in the future, but migration of on-site groundwater contamination to off-site residential wells is assumed. Furthermore, it was assumed that future land-use conditions would result in uses of the site resulting in exposures of additional human receptors as described below.

Under future land-use conditions, portions of the lagoons may be developed for commercial use. Under this assumption, commercial workers would likely be exposed to contaminants in soil/sludge by incidental ingestion and dermal contact. This scenario assumes that disturbances of site soil/sludge has resulted in the movement of contaminants currently at depth (up to 10 feet below ground surface) to a surficial location where exposure could occur. Contact with standing water in the lagoons would be unlikely, but if it were to occur, would be similar to exposures received by the adolescent trespasser. Therefore, exposures to surface water have not been quantitatively evaluated for the commercial worker. Inhalation of contaminants from soil/sludge and surface water is assumed to be an incomplete exposure pathway because the levels of volatile compounds and airborne particulates are low, and would be further diluted and dispersed into ambient air.

During commercial development of the Lagoon Area, utility workers may be exposed to surface and subsurface soil/sludge and standing surface water during trenching activities. Utility workers would likely be exposed to soil/sludge via ingestion and dermal contact, and to volatile contaminants in the subsurface via inhalation. Dermal contact with standing surface water would also be likely. However, ingestion of surface water is unlikely to occur to a significant extent during these excavation activities.

As a worst-case scenario, the Warehouse Area has been assumed to be developed for future residential use. Under this scenario, future young child (ages 1 to 6) and adult residents would be exposed to soils by incidental ingestion and dermal contact. This scenario assumes that disturbances of site soil has resulted in the movement of contaminants currently at depth (up to 10 feet below ground surface) to a surficial location where exposure would occur. Inhalation of contaminants from soils is assumed to be an incomplete exposure pathway because the levels of volatile compounds and airborne particulates are low, and would be further diluted and dispersed into ambient air. On-site residents may also be exposed to impacted on-site groundwater through the ingestion pathway as described above for off-site residents.

3.1.3 Summary of Pathways and Receptors Selected for Consideration. The following items summarize the pathways quantitatively evaluated for each exposure scenario:

- Off-site child/adult resident scenario, current
Ingestion pathway: groundwater from private wells

- On-site adolescent trespasser scenario, current
Ingestion pathways: surface soil/sludge
Dermal contact pathways: surface soil/sludge, surface water

- Hoosic River adolescent recreational user scenario, current
Ingestion pathways: surface water, sediment
Dermal contact pathways: surface water, sediment

- On-site adult and young child park visitor scenario, future
 Ingestion pathways: soil/sludge
 Dermal contact pathways: soil/sludge, surface water

- Hoosic River adult and young child park user scenario, future
 Ingestion pathways: surface water, sediment
 Dermal contact pathways: surface water, sediment

- On-site commercial worker scenario, future
 Ingestion pathways: soil/sludge
 Dermal contact pathways: soil/sludge

- On-site utility worker scenario, future
 Ingestion pathways: soil/sludge
 Dermal contact pathways: soil/sludge, surface water
 Inhalation pathways: volatiles from soil/sludge and groundwater

- On-site child/adult resident scenario, future
 Ingestion pathway: soil, groundwater
 Dermal pathway: soil

3.2 Calculation of Dose

The purpose of the exposure assessment is to identify exposure equations to be used in the risk assessment and to document assumptions made for each of the parameters used in these equations. USEPA Region 1 *Risk Updates, No. 2* (USEPA, 1994c) requires the calculation of CT exposure and RME estimates and provides a number of default exposure parameters for each of these estimations. The risk assessment used the default CT exposure parameters to evaluate average exposures and high-end exposure parameters to calculate RME estimates. For exposure parameters that are not available from this source, other USEPA guidance or documents were used, including *RAGS* (USEPA, 1989); *Exposure Factors Handbook* (USEPA, 1997a); and updated dermal equations and parameters provided by USEPA Region 1 (USEPA, 2000a).

3.2.1 Selection of Exposure Equations. Equations are presented for the calculation of chronic daily intake (CDI) values for the ingestion, dermal and inhalation pathways of exposure. The equations are used for calculating a lifetime average daily dose (LADD) relevant to cancer risk (i.e., cancer intake) or for calculating an average daily dose (ADD) relevant to noncancer risk (i.e., noncancer intake). The medium-specific equations used for the calculation of carcinogenic and noncarcinogenic intakes of the COPCs are presented in Tables 4.1 through 4.24. Additional equations used in calculating dose following dermal exposure to organics in surface water are contained in Attachment 4.

3.2.2 Exposure Parameters. The exposure parameters used for each of the receptors evaluated in the risk assessment are described below and are presented in Tables 4.1 through 4.24. Since exposure parameters vary depending on the exposure pathway and receptors being evaluated, the exposure parameters are presented by pathway in the tables and are discussed by receptor.

Adolescent Trespasser/Recreational Visitor Exposure Parameters. The exposure parameters for the adolescent receptor (9 to 18 years of age) are shown in Tables 4.1 (surface soil/sludge; current trespasser), 4.2 (lagoon surface water; current trespasser), 4.13 (river surface water; current recreational visitor) and 4.14 (river sediment; current recreational visitor). These exposure parameters rely partially on default CT and RME parameters presented in *Exposure Factors Handbook* (USEPA, 1997a) and updated dermal parameters provided by USEPA Region 1 (USEPA, 2000a).

It was assumed that the current trespasser may venture onto the site and engage in activities resulting in surface soil/sludge exposure 30 days/year and 60 days/year for the CT and RME cases, respectively. Exposure frequency values for the current trespasser for lagoon surface water were assumed to be 24 days/year and 36 days/year for the CT and RME cases, respectively. The fraction of soil ingested from the site was conservatively assumed to be 100% for both the CT and RME cases. The adolescent ingestion rate for soil was set at 100 mg/day for the RME receptor and 50 mg/day for the CT receptor (USEPA, 1997a).

The default high-end exposure duration of 10 years was used for the RME case, while an average exposure duration of 5 years was used for the CT exposure case (USEPA, 1997a). The value of 45 kg for an adolescent body weight was used for both CT and RME exposures (USEPA, 1997a). The averaging time for noncarcinogens was set equal to the exposure duration, and the averaging time for carcinogens was the standard USEPA lifetime duration (70 years; USEPA, 1989).

For Hoosic River surface water and sediment, exposure frequencies of 24 days/year and 36 days/year were assumed for the CT and RME scenarios, respectively. Incidental ingestion of surface water was assumed to occur during recreational activities. A surface water ingestion rate of 50 mls/hour (USEPA, 1989) was used to evaluate both CT and RME exposures. Surface water exposure time was set at 0.5 hours/day for the CT case, and 2.5 hour/day for the RME case. For the sediment ingestion pathway, the default CT and RME soil ingestion rates (50 mg/kg and 100 mg/kg, respectively; USEPA, 1997a) for adolescents were used to provide a conservative evaluation of sediment exposure.

For the dermal pathway, adolescent skin surface areas were calculated for the body parts that could contact surface soil/sludge, surface water and sediment, using statistical distributions of surface areas provided in the *Draft Dermal Guidance* (USEPA, 2000a). Adolescents were assumed to contact environmental media with 4,700 cm² of body surface area for both the CT and RME cases (50th percentile value; USEPA, 2000a). To be conservative, a soil-to-skin adherence factor of 0.23 mg/cm² was used for the CT and RME cases for soil and sediment exposures (USEPA, 2000a). Cadmium, arsenic, pentachlorophenol, dioxins, PCBs and PAHs were assessed for dermal exposures to sediment through the use of chemical-specific dermal absorption factors. Dermal absorption factors of 0.1%, 3%, 25%, 3%, 14% and 13% for cadmium, arsenic, pentachlorophenol, dioxins, PCBs and B(a)P, respectively, were used in both the CT and RME cases. In the absence of recommended dermal absorption factors, dermal exposures to the remaining soil COPCs were not assessed. For the surface water dermal exposure pathway, absorbed doses were calculated for each chemical using equations and chemical-specific factors described in Attachment 4. The remaining exposure parameters used for

the dermal exposure pathway (i.e., exposure frequency, exposure duration, body weight, and averaging time) were the same as the values described for the surface soil/sludge ingestion pathways.

Adult Park Visitor Exposure Parameters. The exposure parameters for the adult park visitor are shown in Tables 4.3 (soil/sludge; future), 4.4 (lagoon surface water; future), 4.15 (river surface water; future) and 4.16 (river sediment; future). These exposure parameters rely partially on default CT and RME parameters presented in *Risk Updates, No. 2* (USEPA, 1994c), *Exposure Factors Handbook* (USEPA, 1997a) and updated dermal parameters provided by USEPA Region 1 (USEPA, 2000a).

Since the weather in the area is cold and not conducive to outdoor activities for about 6 months of the year, it was assumed that the adult park visitor would engage in activities resulting in soil/sludge exposures 112 days/year for the RME scenario and 56 days/year for the CT scenario. Exposure frequency values for the future park visitor for lagoon surface water were assumed to be 30 days/year and 60 days/year for the CT and RME cases, respectively. The fraction of soil ingested from the site was conservatively assumed to be 100% for both the CT and RME cases. The adult ingestion rate for soil was set at 100 mg/day for the RME receptor and 50 mg/day for the CT receptor (USEPA, 1997a).

For Hoosic River surface water and sediment, exposure frequencies of 30 days/year and 60 days/year were assumed for the CT and RME scenarios, respectively. Incidental ingestion of surface water was assumed to occur during recreational activities. A surface water ingestion rate of 50 mls/hour (USEPA, 1989) was used to evaluate both CT and RME exposures. Surface water exposure time was set at 0.5 hours/day for the CT case, and 2.5 hour/day for the RME case. For the sediment ingestion pathway, the default CT and RME soil ingestion rates (50 mg/kg and 100 mg/kg, respectively; USEPA, 1997a) for adults were used to provide a conservative evaluation of sediment exposure.

The default high-end exposure duration of 24 years was used for the RME case, while an average exposure duration of 7 years was used for the CT exposure case (USEPA, 1997a). The default value

of 70 kg for an adult body weight was used for both CT and RME exposures (USEPA, 1997a). Finally, as recommended in *RAGS* (USEPA, 1989), the averaging time for noncarcinogens was set equal to the exposure duration, and the averaging time for carcinogens was the standard USEPA lifetime duration (70 years).

For the dermal pathway, skin surface areas were calculated for the body parts that could contact soil/sludge, sediment and surface water, using statistical distributions of surface areas provided in the *Draft Dermal Guidance* (USEPA, 2000a). Adult park visitors were assumed to contact soil/sludge, sediment and surface water during outdoor activities with 5,700 cm² of body surface area for both the CT and RME cases (50th percentile value; USEPA, 2000a). A soil-to-skin adherence factor of 0.07 mg/cm² was used for both the CT and RME cases (USEPA, 2000a). Cadmium, arsenic, dioxins, pentachlorophenol, PCBs and PAHs were assessed for dermal exposures to soil and sediment as previously described. The remaining exposure parameters used for the dermal exposure pathway (i.e., exposure frequency, exposure duration, body weight and averaging time) were the same as the values described for the soil ingestion pathway.

Young Child Park Visitor Exposure Parameters. The exposure parameters for the young child park visitor are shown in Tables 4.5 (soil/sludge; future), 4.6 (lagoon surface water; future), 4.17 (river surface water; future) and 4.18 (river sediment; future). As with the adult park visitor, these exposure parameters rely partially on default CT and RME parameters presented in *Risk Updates, No. 2* (USEPA, 1994c), *Exposure Factors Handbook* (USEPA, 1997a) and updated dermal parameters provided by USEPA Region 1 (USEPA, 2000a).

As with the adult park visitor, it was assumed that the young child park visitor engages in activities resulting in soil/sludge exposures 112 days/year for the RME scenario and 56 days/year for the CT scenario. The fraction of soil ingested from the site was conservatively assumed to be 100% for both the CT and RME cases. The young child ingestion rate for soil was set at 200 mg/day for the RME receptor and 100 mg/day for the CT receptor (USEPA, 1997a).

For Hoosic River surface water and sediment, exposure frequencies of 30 days/year and 60 days/year were assumed for the CT and RME scenarios, respectively. Incidental ingestion of surface water was assumed to occur during recreational activities. A surface water ingestion rate of 50 mls/hour (USEPA, 1989) was used to evaluate both CT and RME exposures. Surface water exposure time was set at 0.5 hours/day for the CT case, and 2.5 hour/day for the RME case. For the sediment ingestion pathway, the default CT and RME soil ingestion rates (100 mg/kg and 200 mg/kg, respectively; USEPA, 1997a) for young children were used to provide a conservative evaluation of sediment exposure.

The default high-end exposure duration of 6 years was used for the RME case, while an average exposure duration of 2 years was used for the CT exposure case (USEPA, 1994c). The default value of 15 kg for a young child body weight was used for both CT and RME exposures (USEPA, 1997a). Finally, as recommended in *RAGS* (USEPA, 1989), the averaging time for noncarcinogens was set equal to the exposure duration, and the averaging time for carcinogens was the standard USEPA lifetime duration (70 years).

For the dermal pathway, skin surface areas were calculated for the body parts that could contact soil/sludge, sediment and surface water, using statistical distributions of surface areas provided in the *Draft Dermal Guidance* (USEPA, 2000a). Young child residents were assumed to contact surface soil during outdoor activities with 2,900 cm² of body surface area for both the CT and RME cases (50th percentile value; USEPA, 2000a). A soil-to-skin adherence factor of 0.3 mg/cm² was used for both the CT and RME cases (USEPA, 2000a). The same dermal absorption factors used for the adult were also used for the child. The remaining exposure parameters used for the dermal exposure pathway (i.e., exposure frequency, exposure duration, body weight and averaging time) were the same as the values described for the soil ingestion pathway.

Adult Resident Exposure Parameters. The exposure parameters for the adult resident are shown in Tables 4.11 (soil; future land use), 4.19 (groundwater; current land use) and 4.21 (groundwater; future

land use). These exposure parameters rely partially on default CT and RME parameters presented in *Risk Updates, No. 2* (USEPA, 1994c), *Exposure Factors Handbook* (USEPA, 1997a) and updated dermal parameters provided by USEPA Region 1 (USEPA, 2000a).

Drinking water ingestion rates of 2 liters/day and 1.4 liters/day were assumed for the RME and CT receptors, respectively (USEPA, 1994c). Exposures were assumed to occur 350 days/year for both the CT and RME cases (USEPA, 1994c).

Since the weather in the area is cold and not conducive to outdoor activities for about 6 months of the year, it was assumed that the adult resident engages in activities resulting in soil exposures 150 days/year for both the RME and CT scenarios (USEPA, 1994c). The fraction of soil ingested from the site was conservatively assumed to be 100% for both the CT and RME cases. The adult ingestion rate for soil was set at 100 mg/day for the RME receptor and 50 mg/day for the CT receptor (USEPA, 1997a).

The default high-end exposure duration of 24 years was used for the RME case, while an average exposure duration of 7 years was used for the CT exposure case (USEPA, 1997a). The default value of 70 kg for an adult body weight was used for both CT and RME exposures (USEPA, 1997a). Finally, as recommended in *RAGS* (USEPA, 1989), the averaging time for noncarcinogens was set equal to the exposure duration, and the averaging time for carcinogens was the standard USEPA lifetime duration (70 years).

For the soil dermal pathway, skin surface areas were calculated for the body parts that could contact soil, using statistical distributions of surface areas provided in the *Draft Dermal Guidance* (USEPA, 2000a). Adult residents were assumed to contact soil during outdoor activities with 5,700 cm² of body surface area for both the CT and RME cases (50th percentile value; USEPA, 2000a). A soil-to-skin adherence factor of 0.07 mg/cm² was used for both the CT and RME cases (USEPA, 2000a).

Cadmium, arsenic, dioxins, pentachlorophenol, PCBs and PAHs were assessed for dermal exposures

to soil as previously described. The remaining exposure parameters used for the dermal exposure pathway (i.e., exposure frequency, exposure duration, body weight and averaging time) were the same as the values described for the soil ingestion pathway.

Young Child Resident Exposure Parameters. The exposure parameters for the young child resident are shown in Tables 4.12 (soil; future land use), 4.20 (groundwater; current land use) and 4.22 (groundwater; future land use). As with the adult resident, these exposure parameters rely partially on default CT and RME parameters presented in *Risk Updates, No. 2* (USEPA, 1994c), *Exposure Factors Handbook* (USEPA, 1997a) and updated dermal parameters provided by USEPA Region 1 (USEPA, 2000a).

Drinking water ingestion rates of 1.5 liters/day and 0.87 liters/day were assumed for the RME and CT receptors, respectively (USEPA, 1997a). Exposures were assumed to occur 350 days/year for both the CT and RME cases (USEPA, 1994c).

As with the adult resident, it was assumed that the young child resident engages in activities resulting in soil exposures 150 days/year for both the RME and CT scenarios (USEPA, 1994c). The fraction of soil ingested from the site was conservatively assumed to be 100% for both the CT and RME cases. The young child ingestion rate for soil was set at 200 mg/day for the RME receptor and 100 mg/day for the CT receptor (USEPA, 1997a).

The default high-end exposure duration of 6 years was used for the RME case, while an average exposure duration of 2 years was used for the CT exposure case (USEPA, 1994c). The default value of 15 kg for a young child body weight was used for both CT and RME exposures (USEPA, 1997a). Finally, as recommended in *RAGS* (USEPA, 1989), the averaging time for noncarcinogens was set equal to the exposure duration, and the averaging time for carcinogens was the standard USEPA lifetime duration (70 years).

For the soil dermal pathway, skin surface areas were calculated for the body parts that could contact soil, using statistical distributions of surface areas provided in the *Draft Dermal Guidance* (USEPA, 2000a). Young child residents were assumed to contact soil during outdoor activities with 2,900 cm² of body surface area for both the CT and RME cases (50th percentile value; USEPA, 2000a). A soil-to-skin adherence factor of 0.3 mg/cm² was used for both the CT and RME cases (USEPA, 2000a). The same dermal absorption factors used for the adult were also used for the child. The remaining exposure parameters used for the dermal exposure pathway (i.e., exposure frequency, exposure duration, body weight and averaging time) were the same as the values described for the soil ingestion pathway.

Commercial Worker Exposure Parameters. The exposure parameters for the commercial worker are shown in Table 4.7 (lagoon soil/sludge; future). The exposure parameters rely partially on default CT and RME exposure parameters presented in *Exposure Factors Handbook* (USEPA, 1997a) and updated dermal parameters provided by USEPA Region 1 (USEPA, 2000a).

For the soil ingestion pathway, the default CT and RME soil ingestion rates (50 mg/kg and 100 mg/kg, respectively; USEPA, 1997a) for adult residents were used to provide a conservative evaluation of exposure. It was assumed that commercial workers may be exposed to soil on-site for 250 days/year for the RME scenario and 219 days/year for the CT scenario (USEPA, 2000a). The fraction of soil ingested from the site was conservatively assumed to be 100% for both the CT and RME cases.

The default high-end exposure duration of 25 years was used for the RME case, while an average exposure duration of 9 years was used for the CT exposure case (USEPA, 2000a). The default value of 70 kg for an adult body weight was used for both CT and RME exposures (USEPA, 1997a). Finally, as recommended in *RAGS* (USEPA, 1989), the averaging time for noncarcinogens was set equal to the exposure duration, and the averaging time for carcinogens was the standard USEPA lifetime duration (70 years).

For the dermal pathway, skin surface areas were calculated for the body parts that could contact soil/sludge, using statistical distributions of surface areas provided in the *Draft Dermal Guidance* (USEPA, 2000a). Commercial workers were assumed to contact soils with 3,300 cm² of body surface area for both the CT and RME cases (50th percentile value; USEPA, 2000a). A soil-to-skin adherence factor of 0.07 mg/cm² was used for both the CT and RME cases (USEPA, 2000a).

Cadmium, arsenic, pentachlorophenol, dioxins, PCBs and PAHs were assessed for dermal exposures as previously described. The remaining exposure parameters used for the dermal exposure pathway (i.e., exposure frequency, exposure duration, body weight and averaging time) were the same as the values described for the soil ingestion pathway.

Utility Worker Exposure Parameters. The exposure parameters for the utility worker are shown in Table 4.8 (lagoon soil/sludge; future), 4.9 (inhalation of volatiles from soil/sludge and groundwater; future) and 4.10 (lagoon surface water; future). The exposure parameters rely partially on default CT and RME exposure parameters presented in *Exposure Factors Handbook* (USEPA, 1997a) and updated dermal parameters provided by USEPA Region 1 (USEPA, 2000a).

For the soil ingestion pathway, the default contact intensive soil ingestion rate of 200 mg/kg (USEPA, 1996d) was used for both the CT and RME cases to provide a conservative evaluation of exposure. It was assumed that utility workers may be exposed to soil on-site for 22 days/year for the CT scenario (a one-month project) or 66 days/year for the RME scenario (a three-month project). The fraction of soil ingested from the site was assumed to be 100% for both the CT and RME cases. For lagoon surface water, exposure frequencies of 22 days/year and 66 days/year were assumed for the CT and RME scenarios, respectively. Surface water exposure time was set at 0.5 hours/day for the CT case, and 1 hour/day for the RME case.

An assumed exposure duration of 1 year was used for both the CT and RME cases. The default value of 70 kg for an adult body weight was used for both CT and RME exposures (USEPA, 1997a).

Finally, as recommended in *RAGS* (USEPA, 1989), the averaging time for noncarcinogens was set

equal to the exposure duration, and the averaging time for carcinogens was the standard USEPA lifetime duration (70 years).

For the dermal pathway, skin surface areas were calculated for the body parts that could contact surface soil/sludge, using statistical distributions of surface areas provided in the *Draft Dermal Guidance* (USEPA, 2000a). Utility workers were assumed to contact soils with 3,300 cm² of body surface area for both the CT and RME cases (50th percentile value; USEPA, 2000a). A soil-to-skin adherence factor of 0.2 mg/cm² was used for both the CT and RME cases (USEPA, 2000a).

Cadmium, arsenic, pentachlorophenol, dioxins, PCBs and PAHs were assessed for dermal exposures as previously described. For the surface water dermal exposure pathway, absorbed doses were calculated for each chemical using equations and chemical-specific factors previously described for the adult resident. The remaining exposure parameters used for the dermal exposure pathway (i.e., exposure frequency, exposure duration, body weight and averaging time) were the same as the values described for the soil ingestion pathway.

For the inhalation pathway, utility workers were assumed to be involved in activities resulting in the inhalation of volatile compounds from the subsurface for 8 hours/day. Air EPCs were modeled from soil and groundwater volatile COPC concentrations as described in Attachment 3. The remaining exposure parameters used for the inhalation pathway (i.e., exposure frequency, exposure duration and averaging time) were the same as the values described for the soil ingestion pathway.

4.0 TOXICITY ASSESSMENT

The toxicity assessment presented here was conducted in accordance with USEPA guidance (1989). The methodology used for classifying health effects from exposure to chemicals is recommended by USEPA (1989). The health effects analysis considers chronic (long-term) exposures. For potentially carcinogenic chemicals, less than chronic exposures would result in less risk than chronic exposure;

therefore, if chronic risk is below a regulatory limit, risk from subchronic exposures will also be below the regulatory limit. For noncarcinogenic chemicals, acute and subchronic hazards could be assessed; however, only irritating substances such as sulfur dioxide would likely present an acute hazard. Chronic exposures would result in higher hazards than subchronic exposures; therefore, again, if chronic risks are below a regulatory limit, subchronic risks are also below the regulatory limit.

The chronic toxicity criteria were obtained from USEPA's Integrated Risk Information System (IRIS) (USEPA, 2001) and Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b). These sources list the most recent toxicity values recommended by USEPA for use in human health risk assessments. In addition, some toxicity criteria values were obtained from the National Center for Environmental Assessment (NCEA), a division of USEPA.

4.1 Toxicity Information for Noncarcinogenic Effects

Systemic toxic effects other than cancer can be associated with exposures to chemicals. The reference doses (RfDs) and reference concentrations (RfCs) are the toxicity values that are used to evaluate the potential of developing noncarcinogenic effects as a result of exposure to potentially toxic chemicals. RfDs and RfCs have been developed on the premise that there are protective mechanisms that must be overcome before an appreciable risk of adverse health effects is manifested during a defined exposure period. It is assumed that there is a threshold dose that must be exceeded before adverse effects can occur.

Chemicals classified as carcinogens may also produce other systemic effects. These chemicals were also evaluated for potential noncarcinogenic toxic effects and were included in the determination of chronic toxicity HQs, which characterize noncancer hazards. Carcinogenic effects, however, are usually manifested at levels that are significantly lower than those associated with systemic toxic effects; thus, cancer is usually the predominant adverse effect for contaminants that may elicit carcinogenic as well as noncarcinogenic responses.

Table 5.1 summarize the oral noncarcinogenic toxicity values (i.e., RfDs) and the corresponding critical effects for the COPCs at the site. Table 5.2 summarizes the inhalation noncarcinogenic toxicity values (i.e., RfCs) and the corresponding critical effects for volatile COPCs at the site. Oral RfDs for manganese were developed based on USEPA Region I guidance (USEPA, 1996a). These RfDs were based on a total allowable manganese intake of 10 mg/day (USEPA, 2001). After adjusting for background intake (the average dietary manganese intake in the U.S. population; 5 mg/day), the remaining intake (5 mg/day) was then normalized for body weight (70 kg) to arrive at the manganese RfD for soil/sludge and sediment exposures (0.07 mg/kg-day). An additional uncertainty factor of 3 was applied for surface water and groundwater exposures resulting in a water RfD of 0.024 mg/kg-day. For mercury, the RfD for inorganic mercury was used to evaluate surface water and groundwater exposures. However, since mercury in soil/sludge and sediments is likely to exist as organic mercury compounds, the RfD for organic mercury was used to evaluate soil/sludge and sediment exposures. Due to a lack of reliable chromium speciation data for soils and sediments, all chromium in these media was evaluated using the hexavalent chromium RfD. For groundwater and surface water, all chromium was evaluated using the trivalent chromium RfD, except in cases where hexavalent chromium was detected. In these cases, the hexavalent chromium RfD was used. Additional information on the noncarcinogenic effects for each COPC is presented in the toxicity profiles in Attachment 5. Chemical-specific permeability coefficients (K_p s), used to evaluate the surface water dermal pathway, are listed on the bottom of Table 5.1 and in Attachment 4.

4.2 Toxicity Information for Carcinogenic Effects

The potential for human carcinogenic effects is evaluated based on the chemical-specific slope factors (SFs) and unit risk (UR) values along with the weight-of-evidence classification of the USEPA. The SF and UR values are the toxicity values that quantitatively defines the dose-response relationship of a known or suspected carcinogen. The SF and UR are an estimate of an upper-bound lifetime probability of an individual developing cancer following exposure to a potential cancer-causing agent over his or her lifetime. The SFs and URs for chemicals are generally expressed as the 95% UCL of

the slope of the dose-response curve and are derived by assuming low-dose linearity and applying a computer model to extrapolate from the relatively high doses administered to animals (or the exposures observed in epidemiological studies) to the lower environmental exposure levels that generally occur in humans. The USEPA has developed SFs and URs for chemicals classified as carcinogens, based on the premise that there is no threshold, i.e., there is no level of exposure below which there is no risk of a carcinogenic effect.

Because the SF and UR are generally the 95% UCL of the probability of a response per unit intake of a chemical over a lifetime exposure, the use of such SFs and URs is expected to result in a conservative (i.e., upper-bound) estimate of potential cancer risk. The true risk to humans is not likely to exceed the upper-bound estimate but could be lower and may even be zero. Further, because the dose-response curve is assumed to be linear in the low-dose region, the accuracy of the SF and UR may be limited if this region should, in reality, exhibit nonlinearity.

Table 6.1 summarizes the oral carcinogenic toxicity values (i.e., SFs) and the corresponding weight-of-evidence classifications. Table 6.2 summarizes the inhalation carcinogenic toxicity values (URs) for volatile COPCs. For PAHs, the SF for benzo(a)pyrene, along with the appropriate relative potency factors (USEPA, 1993), have been used to evaluate the potency of the individual carcinogenic PAHs.

Prior to carcinogenic evaluation, the detected concentrations of dioxins, dibenzofurans and dioxin-like PCBs were adjusted to Toxic Equivalent (TEQ) concentrations using methodology and Toxicity Equivalency Factors (TEFs) provided by USEPA (2000c) and Van den Berg *et al.* (1998). The concept of TEFs has been developed and introduced to facilitate risk assessment and regulatory control of exposure to complex environmental mixtures of classes of compounds. TEFs are used to represent the toxicity of isomers, congeners and homologues of dioxins, dibenzofurans and dioxin-like PCBs relative to 2,3,7,8-TCDD, which is assigned a TEF of unity. For example, an isomer assigned a TEF of 0.1 indicates that the isomer is approximate 10-fold less potent than 2,3,7,8-TCDD. The environmental concentrations of the isomers and congeners are multiplied by their respective TEFs and

then summed together to derive an adjusted environmental concentration (the TEQ) which factors in the relative toxicity of the compounds. The TEQ is then used, along with the slope factor for 2,3,7,8-TCDD, to estimate cancer risk for dioxins, dibenzofurans and dioxin-like PCBs as a group. Because the Scientific Advisory Board is currently re-evaluating the carcinogenic potency of 2,3,7,8-TCDD, the draft dioxin slope factor has also been used in risk estimation. Additional discussion on each carcinogenic COPC is provided in toxicity profiles presented in Attachment 5.

4.3 Adjustment of Toxicity Factors

No RfDs or SFs are available for evaluating dermal exposure. Therefore, cancer risks and HIs associated with dermal exposure may be evaluated using an oral SF or RfD, adjusted such that the toxicity value is appropriate for the dermal pathway. As detailed by USEPA (1989), for purposes of evaluating dermal exposure, it is generally necessary to adjust an oral toxicity factor (i.e., RfD or SF) from an administered (i.e., applied) dose to an absorbed (i.e., internal) dose. Because the toxicity values for the COPCs at the site are expressed as orally administered doses (i.e., applied or intake-based), it is necessary to adjust both the RfDs and SFs for these substances in estimating exposure on an absorbed-dose basis when assessing dermal exposure.

The oral RfDs and oral SFs for each COPC were modified according to the following equations (USEPA, 1989) for use in assessing dermal exposure:

$$ERfD_o = RfD_o \times BF_{o,a}$$

$$ESF_o = SF_o / BF_{o,a}$$

where:

$ERfD_o$ = effective absorbed-dose oral RfD for each chemical (i.e., adjusted dermal RfD)

RfD_o = oral RfD for each chemical

- $BF_{o,a}$ = absolute oral bioavailability factor for each chemical (i.e., oral to dermal adjustment factor)
- ESF_o = effective absorbed-dose oral SF for chemical (i.e., adjusted dermal SF)
- SF_o = oral SF for each chemical

Tables 5.1 and 6.1 present the oral to dermal adjustment factors used to adjust the oral toxicity criteria for the COPCs evaluated in the dermal exposure pathways. Oral bioavailability values were derived from data presented in peer-reviewed scientific journals for antimony (ATSDR, 1997), barium (ATSDR, 1997), cadmium (McLellan *et al.*, 1978), chromium (Donaldson and Barreras, 1996), manganese (Davidsson *et al.*, 1989), vanadium (Conklin *et al.*, 1982) and from information presented in the IRIS profile for inorganic mercury (USEPA, 2001). No adjustment for oral absorption efficiency has been applied to any COPC with an absorption efficiency of greater than 50%. These COPCs include all VOCs, PAH compounds, pesticides, PCBs, arsenic, cyanide, organic mercury and thallium. Additional information on compound-specific oral to dermal adjustment factors is provided in Attachment 5.

4.4 Toxicity of Lead

Lead was selected as a COPC at Lagoons 1, 3, 4 and 5 where the RME EPC for lead in soil/sludge exceeded the residential soil screening value of 400 mg/kg (USEPA, 1994a). No RfD or SF is available for lead. Therefore, USEPA has recommended some alternative approaches to evaluate lead exposures. For the lagoons where lead was selected as a COPC, future potential childhood lead exposures were evaluated through the use of the Integrated Exposure Uptake Biokinetic (IEUBK) Model (USEPA, 1994b). Attachment 6 contains summary information showing the IEUBK model inputs. This model uses algorithms to calculate a soil lead concentration protective of a childhood blood lead level of 10 µg/dL. Attachment 6 specifies the assumptions used in the calculation of the site-specific soil lead concentration protective of childhood exposures should the area be used as parkland in the future.

Because future use in the Lagoon Area may include industrial uses, future adult commercial exposures were evaluated through the use of methodology provided in *Interim Approach to Assessing Risk Associated with Adult Exposures to Lead in Soil* (USEPA, 1996d). This methodology uses algorithm to relate soil lead intake to blood lead concentrations in women of childbearing age; this group is assumed to be the most sensitive to lead exposure, among adults. The model calculates a soil lead concentration protective of a site-specific maternal blood lead level that will be protective of a 95th percentile fetal blood level of 10 µg/dL. Attachment 6 documents the calculation of a site-specific maternal blood lead level of 4.2 µg/dL, using a geometric standard deviation (GSD) in intake and biokinetics of 1.8, which is typical of populations in small areas dominated by a single source of lead exposure. A typical blood lead concentration in women of child-bearing age in the absence of site exposures was assumed to be 2.0 µg/dL, which is a mid-range default assumption (USEPA, 1996d). All other model inputs are presented in Attachment 6.

5.0 RISK CHARACTERIZATION

Risk characterization combines estimates of exposure with toxicity data to develop estimates of the probability that an adverse effect will occur under the specified conditions of exposure. The risk characterization was divided into three phases: 1) risk estimation; 2) risk description; and 3) uncertainty analysis.

Risk estimation is undertaken by combining the toxicity factors and exposure assessment equations to calculate estimates of risks. Noncarcinogenic risks are reported as pathway-specific HIs, which are the sum of pathway-specific HQs. Only HQs from COPCs that affect the same target organ are summed to generate HIs. Estimates of carcinogenic risks are reported as incremental (above background) lifetime cancer incidence risks (ILCRs). Risk description entails several discussions, including the relative contributions of individual exposure pathways to the total risk for each medium.

The significance of the risk estimates are relative to action levels set forth in USEPA policy. USEPA's risk management cancer risk range for site-related exposures is 10^{-6} to 10^{-4} . Current practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances. A HI of 1 or less indicates that noncarcinogenic effects are unlikely. When the total HI for an exposed individual or group of individuals exceeds 1, there may be concern for potential noncarcinogenic health effects. The uncertainty analysis describes and quantifies, where possible, the impact of data, assumptions, and parameter values on estimates of risk.

5.1 Risk Estimation

Noncancer risk is estimated by means of a HQ. To calculate noncarcinogenic HQs, the ADDs, calculated as described in subsection 3.2, were divided by the RfDs as follows:

$$HQ = ADD / RfD$$

The sum of this ratio for all chemicals within an area and pathway that have the same target organ or type of toxicity is termed the HI. The HI is useful as a reference point for gauging potential effects of environmental exposures to complex mixtures. In general, HIs that are less than 1 are not of regulatory concern; however, a HI of greater than 1 does not automatically indicate that an adverse effect will occur and should not automatically be interpreted as posing a hazard to the exposed population.

The total pathway HI for each exposure area was calculated by summing the HQs for COPCs having similar systemic effects for noncancer risks. Total HIs for each receptor, by medium, were calculated by summing the total pathway HIs across pathways within the media (e.g., summing dermal and ingestion soil risks). Within each medium and pathway, as a first approximation, all COPCs are assumed to have additive effects. The HIs, assuming additivity of effects, are presented in Tables 7.1 through 7.117. However, in cases where the HI exceeded 1, only COPCs having similar systemic

effects (i.e., target organs) were summed for each pathway and medium. HIs, segregated by target organ, are presented in Tables 9.1 through 9.57.

The cancer risk of each receptor is estimated for each medium by means of an ILCR. USEPA (1991) states that where the cumulative incremental current or future carcinogenic risk to an individual is less than 10^{-4} , and where the noncarcinogenic HI is less than 1, action generally is not warranted unless there are adverse environmental impacts. To calculate ILCR, the chemical- and pathway-specific LADDs, calculated as described in subsection 3.2, were multiplied by SFs as follows:

$$\text{ILCR} = \text{SF} \times \text{LADD}$$

The resulting value represents the upper-bound probability that an individual could develop cancer over his or her lifetime due to exposure to potential carcinogens under the conditions specified in the exposure scenario. For example, a carcinogenic risk level of 1×10^{-6} represents a one in one million chance that an individual could contract cancer over a lifetime. Total excess cancer risks for each pathway were calculated by summing the risks from each chemical in each area within the pathway, while total risks for each medium for each receptor were calculated by summing ILCRs for each pathway within the medium. For example, total cancer risk to a resident from exposure to soil in the Warehouse Area was determined by adding the risk from soil ingestion to the risk from dermal contact with soil from this location. These summed ILCRs are presented in Tables 8.1 through 8.117. ILCRs were further summed for young child and adult receptors to derive a total lifetime risk for the resident and park visitor receptors. The total receptor cancer risks, summed for the adult and child receptors, are presented in Table 9s.

Risks were not summed across exposure areas within the site since the parameter values used assume maximal exposure within each exposure area. It is assumed that an individual would not be maximally exposed to soil/sludge at more than one area (e.g., Lagoon 1 and Lagoon 5).

5.2 Risk Description

This subsection summarizes the human health risks potentially associated with exposures to environmental media (soil/sludge, surface water, sediment, groundwater and air). Individual chemical-specific carcinogenic risks are expressed as probabilities of contracting cancer, while noncarcinogenic risks are expressed as HIs. All carcinogenic and noncarcinogenic risks were calculated using both CT and RME methods. The RME represents the reasonable maximum exposure and risk an individuals can receive from a site. The CT represents the average exposure and risk at a site.

The risk description for the site is provided below in two parts. First, the relative contributions of the various exposure pathways and media are analyzed for each receptor. Second, the relative contributions of each contaminant are analyzed for each receptor. The noncarcinogenic risks associated with each medium for the various exposure scenarios evaluated are presented in Tables 7.1 through 7.117 for the RME and CT cases (e.g., 7.1.RME and 7.1.CT). The corresponding RME and CT cancer risks are presented in Tables 8.1 through 8.117 (e.g., 8.1.RME and 8.1.CT).

Table 9s present target-organ specific HIs, which are discussed if a medium-specific HI exceeds 1, and summed ILCRs. For the resident and park visitor scenarios, the young child and adult ILCRs have been summed to present the total receptor cancer risk. However, because the young child receptor is the most sensitive receptor for the estimation of noncarcinogenic risk, only the young child receptor HIs have been presented on Tables 9s for the resident and park visitor scenarios.

5.2.1 Description of HI Estimates. Estimates of HIs represent the risk of health effects other than cancer from exposure to contaminants within the site, as described in subsection 5.1. Table 7s present the noncarcinogenic risks by receptor and medium. When a receptor-specific HI for an exposure medium exceeded 1, HIs were segregated by target organ and discussed as to whether target organ-specific HIs exceed risk management criteria. These target organ-specific HIs are presented on Table 9s.

Current Adolescent Trespasser/Recreational User Receptor. The estimated HIs for each pathway and medium, presented by exposure area (Lagoons 1 through 5, Warehouse Area and Hoosic River/wetlands), are listed for the current adolescent trespasser/recreational user receptor in Tables 7.1 through 7.12. The summed risks for the media evaluated are presented in Tables 9.1 through 9.7. HIs for surface soil/sludge, surface water and sediment ingestion and/or dermal contact were all less than the target risk range of 1 to 10 for all exposure areas, except for Lagoon 5 which had an HI of 2 for the RME receptor from contact with soil/sludge (Table 7.5.RME; Table 9.5.RME). The largest contributor to the HI in excess of 1 for soil/sludge in Lagoon 5 was chromium.

Future Adult Park Visitor Receptor. The estimated HIs for each pathway and medium, presented by exposure area (Lagoons 1 through 5, Warehouse Area and Hoosic River/wetlands), are listed for the future adult park visitor receptor in Tables 7.13 through 7.24. HIs for surface/subsurface soil/sludge, surface water and sediment ingestion and/or dermal contact were less than the target risk range of 1 to 10 for all exposure areas, except for Lagoons 1 and 3 for contact with soil/sludge. The HIs for the RME receptors from contact with surface and subsurface soil/sludge were 5 for Lagoon 1 and 3 for Lagoon 3 (Tables 7.13.RME and 7.15.RME, respectively). The largest contributor to the HIs in excess of 1 for soil/sludge in Lagoons 1 and 3 was chromium.

Future Young Child Park Visitor Receptor. The estimated HIs for each pathway and medium, presented by exposure area (Lagoons 1 through 5, Warehouse Area and Hoosic River/wetlands), are listed for the future young child park visitor receptor in Tables 7.25 through 7.36. The summed risks for the media evaluated are presented in Tables 9.8 through 9.14. HIs for surface/subsurface soil/sludge, surface water and sediment ingestion and/or dermal contact were less than or within the target risk range of 1 to 10 for all exposure areas except for Lagoons 1, 3 and 5 for contact with soil/sludge. The HIs for the RME receptor from contact with surface and subsurface soil/sludge were 50 for Lagoon 1, 30 for Lagoon 3 and 10 for Lagoon 5 (Tables 7.25.RME, 7.27.RME and 7.29.RME). The largest contributors to the HI for Lagoon 1 were mercury and chromium. Chromium

was the largest risk contributor for Lagoons 3 and 5. HIs for all other exposure areas and media were less than or equal to 1.

Current Adult Resident Receptor. The estimated HIs for the groundwater ingestion pathway, presented by private well, are listed for the current adult resident receptor in Tables 7.37 through 7.44. HIs for the drinking water ingestion pathway were less than the target risk range of 1 to 10 for each of the private wells evaluated. The private wells with the highest HIs were private wells RW-003, RW-008 and RW-010, each with an HI of 0.9 for the RME individual (Tables 7.39.RME, 7.43.RME and 7.44.RME, respectively).

Current Young Child Resident Receptor. The estimated HIs for the groundwater ingestion pathway, presented by private well, are listed for the current young child resident receptor in Tables 7.45 through 7.52. The risks, segregated by target organ, are presented in Tables 9.15 through 9.22. HIs for the drinking water ingestion pathway were less than or within the target risk range of 1 to 10 for each of the private wells evaluated. However, HIs for four of the private wells exceeded 1. The private wells with the highest HIs were private wells RW-003, RW-008 and RW-010, each with an HI of 3 for the RME individual (Tables 7.47.RME, 7.51.RME and 7.52.RME, respectively). For these same wells, estimated HIs for the CT receptor were between 1 and 2 (Tables 7.47.CT, 7.51.CT and 7.52.CT). In addition, the drinking water ingestion HI for well RW-006 was 2 for the RME receptor (Table 7.49.RME). The HIs for these wells exceeded 1 even when HIs were summed only for COPCs with similar target organs (Tables 9.17.RME, 9.19.RME, 9.21.RME and 9.22.RME). The largest contributor to the HI for RW-003 was arsenic, while thallium was the largest contributor for RW-006. For RW-008 and RW-101, manganese was the primary contributor to the HI. All other drinking water ingestion HIs were less than or equal to 1.

Future Adult Resident Receptor. The estimated HIs for each pathway and medium (soil and groundwater), presented for the Warehouse Area and each on-site monitoring well, are listed for the future adult resident receptor in Tables 7.53 through 7.77. HIs for soil ingestion and dermal contact at

the Warehouse Area were less than the target risk range of 1 to 10. HIs for the drinking water ingestion pathway were less than or within the target risk range of 1 to 10 for each of the monitoring wells evaluated. However, HIs for a number of the monitoring wells exceeded 1. In addition, for all monitoring wells combined, the HIs for the RME and CT receptors were 30 and 1, respectively (Table 7.77). The monitoring wells with the highest HIs were wells MW-109U, MW-114U and MW-L-3, each with an HI of 10 for the RME individual (Tables 7.62.RME, 7.68.RME and 7.70.RME, respectively). For these same wells, estimated HIs for the CT receptor were 5, 8 and 7, respectively (Tables 7.62.CT, 7.68.CT and 7.70.CT). HIs were 5 and 2 for the RME and CT receptor, respectively, at MW-107U (Tables 7.61.RME and 7.61.CT), 3 and 2 for MW-110R (Tables 7.63.RME and 7.63.CT), 7 and 5 for MW-113R (Tables 7.67.RME and 7.67.CT) and 9 and 2 for MW-B-7 (Tables 7.69.RME and 7.69.CT). In addition, the drinking water ingestion HI for wells MW-107R, MW-110U and MW-L-10 were 3, 2 and 3 for the RME receptor (Tables 7.60.RME, 7.64.RME and 7.75.RME). All other drinking water ingestion HIs were less than or equal to 1.

The largest contributor to the HIs in excess of 1 for the monitoring wells were: MW-107R (manganese); MW-107U (manganese); MW-109U (arsenic, manganese and thallium); MW-110R (manganese); MW-110U (manganese); MW-113R (arsenic and manganese); MW-114U (manganese); MW-B-7 (methylene chloride); MW-L-3 (arsenic and manganese); and MW-L-10 (manganese).

Future Young Child Resident Receptor. The estimated HIs for each pathway and medium (soil and groundwater), presented for the Warehouse Area and each on-site monitoring well, are listed for the future young child resident receptor in Tables 7.78 through 7.102. The risks, segregated by target organ, are presented in Tables 9.23 through 9.47. HIs for soil ingestion and dermal contact at the Warehouse Area were less than the target risk range of 1 to 10. For all monitoring wells combined, the HIs for the RME and CT receptors were 100 and 4, respectively. Drinking water ingestion HIs exceeded the target risk range of 1 to 10 for six wells, MW-107U (HIs of 20 and 7; Table 7.86. RME and CT), MW-109U (HIs of 30 and 10; Table 7.87.RME and CT), MW-113R (HIs of 20 and 10;

Table 7.92.RME and CT), MW-114U (HIs of 40 and 20; Table 7.93.RME and CT), MW-B-7 (HI of 30 and 6; Table 7.94.RME and CT) and MW-L-3 (HIs of 50 and 20; Table 7.95.RME and CT). HIs for the drinking water ingestion pathway were less than or within the target risk range of 1 to 10 for each of the remaining monitoring wells evaluated. However, HIs for a number of additional monitoring wells exceeded 1. The monitoring wells with HIs within the target risk range were wells MW-104U, MW-107R, MW-110R, MW-110U, MW-111U and MW-L-10 with HIs of 5, 9, 9, 7 and 10 for the RME individual (Tables 7.83.RME, 7.85.RME, 7.88.RME, 7.89.RME and 7.100.RME, respectively). Estimated HIs for the CT receptor for these same wells were 2, 4, 5, 3 and 4, respectively (Tables 7.83.CT, 7.85.CT, 7.88.CT, 7.89.CT and 7.100.CT). In addition, the drinking water ingestion HI for wells MW-101U and MW-111U were 3 for the RME receptor (Tables 7.79.RME and 7.90.RME) and, for wells MW-103R and MW-106U, was 2 for the RME receptor (Tables 7.81.RME and 7.84.RME). All other drinking water ingestion HIs were less than or equal to 1.

When HIs were summed only for COPCs with similar target organs, segregated HIs for monitoring wells MW-101U and MW-103R were less than 1 (Tables 9.24.RME and 9.26.RME). HIs for wells MW-104U, MW-106U, MW-107R, MW-107U, MW-109U, MW-110R, MW-110U, MW-111U, MW-113R, MW-114U, MW-B-7, MW-L-3 and MW-L-10 exceeded 1 even when HIs were summed only for COPCs with similar target organs (Tables 9.28.RME through 9.35.RME, 9.37.RME through 9.40.RME, and 9.45.RME). The largest contributor to the HIs for the monitoring wells were: MW-104U (manganese); MW-106U (manganese); MW-107R (arsenic and manganese); MW-107U (manganese); MW-109U (arsenic, manganese and thallium); MW-110R (arsenic and manganese); MW-110U (manganese); MW-111U (manganese); MW-113R (arsenic and manganese); MW-114U (manganese); MW-B-7 (methylene chloride); MW-L-3 (arsenic and manganese); and MW-L-10 (manganese).

Future Commercial Worker Receptor. The estimated HIs for soil exposure pathways, presented by exposure area (Lagoons 1 through 5), are listed for the future commercial worker receptor in Tables 7.103 through 7.107. The risks, segregated by target organ, are presented in Tables 9.48

through 9.52. HIs for surface/subsurface soil/sludge ingestion and dermal contact were less than the target risk range of 1 to 10 for Lagoons 2 and 4. However, HIs were within the target risk range for Lagoons 1, 3 and 5. The HIs for the REM receptor from contact with surface and subsurface soil/sludge were 10 for Lagoon 1, 6 for Lagoon 3 and 3 for Lagoon 5 (Tables 7.103.RME, 7.105.RME and 7.107.RME, respectively). The largest contributor to the HIs in excess of 1 for soil/sludge in Lagoons 1, 3 and 5 was chromium.

Future Utility Worker Receptor. The estimated HIs for each pathway and medium, presented by exposure area (Lagoons 1 through 5), are listed for the future utility worker receptor in Tables 7.108 through 7.117. The risks, segregated by target organ, are presented in Tables 9.53 through 9.57. HIs for surface/subsurface soil/sludge ingestion and dermal contact, surface water dermal contact and inhalation of volatiles were less than the target risk range of 1 to 10 for Lagoons 2 and 4. However, HIs were within the target risk range for Lagoons 1, 3 and 5. The HIs for the RME receptor from contact with surface and subsurface soil/sludge were 6 for Lagoon 1, 3 for Lagoon 3 and 2 for Lagoon 5 (Tables 7.108.RME, 7.110.RME and 7.112.RME, respectively). The largest contributor to the HI in excess of 1 for soil/sludge in Lagoons 1, 3 and 5 was chromium.

5.2.2 Description of ILCR Estimates. Estimates of ILCR represent the risk of cancer from the site, as described in subsection 5.1. Table 8s present the cancer risks by receptor and medium. ILCRs were summed for young child and adult receptors to derive a total lifetime risk for the resident and park visitor receptors. The total receptor cancer risks, summed for the adult and child receptors, are presented in Table 9s.

Current Adolescent Trespasser/Recreational User Receptor. The estimated ILCRs for each pathway and medium, presented by exposure area (Lagoons 1 through 5, Warehouse Area and Hoosic River/wetlands), are listed for the current adolescent trespasser/recreational user receptor in Tables 8.1 through 8.12. ILCRs for surface soil/sludge, surface water and sediment ingestion and/or dermal contact were estimated to be below or within the target risk range of 10^{-4} to 10^{-6} for all exposure areas.

The lagoon area with the highest ILCR from contact with surface soil/sludge was Lagoon 5, with an ILCR of 2×10^{-5} for the RME individual (Table 8.5.RME; Table 9.5.RME). Contact with Hoosic River/wetland sediment resulted in an estimated ILCR of 3×10^{-5} for the RME individual (Table 8.12.RME; Table 9.7.RME).

Future Young Child/Adult Park Visitor Receptor. The estimated ILCRs for each pathway and medium, presented by exposure area (Lagoons 1 through 5, Warehouse Area and Hoosic River/wetlands), are listed for the future park visitor receptor in Tables 8.13 through 8.24 for the adult and in Tables 8.25 through 8.36 for the young child. The total receptor ILCRs (child and adult risks combined) are presented in Tables 9.8 through 9.14. ILCRs for soil/sludge ingestion and dermal contact were estimated to exceed the target risk range of 10^{-4} to 10^{-6} for Lagoons 1, 3 and 5. The total receptor ILCRs from contact with soil/sludge at these lagoons were 1×10^{-3} for the RME individual at Lagoon 1 (Table 9.8.RME), 2×10^{-4} for the RME individual at Lagoon 3 (Table 9.10.RME) and 2×10^{-4} for the RME individual at Lagoon 5 (Table 9.12.RME). In addition, ingestion and dermal contact with Hoosic River/wetland sediment resulted in an estimated ILCR of 2×10^{-4} for the RME individual (Table 9.14.RME). The largest contributors to the RME ILCRs in excess of 10^{-4} were: Lagoon 1 (dioxins, PAHs, pentachlorophenol and arsenic); Lagoon 3 (dioxins and arsenic); Lagoon 5 (dioxins, PAHs, n-nitroso-di-n-propylamine and arsenic); and Hoosic River (PCBs, dioxins and arsenic).

Current Young Child/Adult Resident Receptor. The estimated ILCRs for the groundwater ingestion pathway, presented by private well, are listed for the current resident receptor in Tables 8.37 through 8.44 for the adult and in Tables 8.45 through 8.52 for the young child. The total receptor ILCRs (child and adult risks combined) are presented in Tables 9.15 through 9.22. ILCRs for the drinking water ingestion pathway were within or below the target risk range of 10^{-4} to 10^{-6} for each of the private wells evaluated. The private well with the highest total receptor ILCR was private well RW-003, with an ILCR of 1×10^{-4} for the RME individual (Table 9.17.RME).

Future Young Child/Adult Resident Receptor. The estimated ILCRs for each pathway and medium (soil and groundwater), presented for the Warehouse Area and each on-site monitoring well, are listed for the future resident receptor in Tables 8.53 through 8.77 for the adult and in Tables 8.78 through 8.102 for the young child. The total receptor ILCRs (child and adult risks combined) are presented in Tables 9.23 through 9.47. Total receptor ILCRs for soil ingestion and dermal contact at the Warehouse Area were within the target risk range of 10^{-4} to 10^{-6} (Table 9.23). Total receptor ILCRs for the drinking water ingestion pathway exceeded the target risk range of 10^{-4} to 10^{-6} for monitoring wells MW-107R (2×10^{-4} for the RME individual; Table 9.30.RME), MW-109U (6×10^{-4} for the RME individual; Table 9.32.RME), MW-113R (2×10^{-3} for the RME individual and 3×10^{-4} for the CT individual; Tables 9.37.RME and 9.37.CT), MW-B-7 (3×10^{-3} for the RME individual and 2×10^{-4} for the CT individual; Tables 9.39.RME and 9.39.CT) and MW-L-3 (5×10^{-4} for the RME individual; Table 9.40.RME). Total receptor ILCRs for all monitoring wells combined were 4×10^{-3} and 3×10^{-5} for the RME and CT receptor, respectively (Tables 9.47.RME and CT). The largest contributors to the ILCRs in excess of 10^{-4} were: MW-107R (dioxins and arsenic); MW-109U (carbon tetrachloride, heptachlor epoxide and arsenic); MW-113R (arsenic); MW-B-7 (methylene chloride); and MW-L-3 (arsenic). Total receptor ILCRs were within or below the target risk range for all other monitoring wells.

Future Commercial Worker Receptor. The estimated ILCRs for soil exposure pathways, presented by exposure area (Lagoons 1 through 5), are listed for the future commercial worker receptor in Tables 8.103 through 8.107. ILCRs for soil/sludge ingestion and dermal contact were estimated to exceed the target risk range of 10^{-4} to 10^{-6} for Lagoon 1. The ILCR from contact with soil/sludge at Lagoon 1 was 7×10^{-4} for the RME individual (Table 8.103.RME; Table 9.48.RME). The largest contributor to the RME ILCR in excess of 10^{-4} were dioxins. ILCRs were within the target risk range for the other lagoon areas.

Future Utility Worker Receptor. The estimated ILCRs for each pathway and medium, presented by exposure area (Lagoons 1 through 5), are listed for the future utility worker receptor in Tables

8.108 through 8.117. ILCRs for soil/sludge ingestion and dermal contact, surface water dermal contact and inhalation of volatiles were estimated to be below or within the target risk range of 10^{-4} to 10^{-6} for all exposure areas. The lagoon area with the highest ILCR from contact with soil/sludge was Lagoon 1, with an ILCR of 1×10^{-5} for the RME individual (Table 8.108.RME; Table 9.53.RME).

5.2.3 Risks Associated with Exposure to Lead. Lead is a COPC for surface soil/sludge at Lagoons 4 and 5 (current scenarios) and for surface and subsurface soil sludge combined at Lagoons 1, 3, 4 and 5 (future scenarios). Childhood lead exposures at these stations were evaluated through use of the IEUBK model (USEPA, 1994b). Adult commercial worker lead exposures were evaluated using interim methodology provided by USEPA (1996d). Childhood lead exposures at Lagoons 3, 4 and 5 (RME EPCs of between 37 mg/kg and 620 mg/kg) were not estimated to result in an exceedance of the blood lead level goal of 10 $\mu\text{g}/\text{dL}$. However, childhood exposures to soil/sludge at Lagoon 1 (RME EPC of 1,100 mg/kg) were estimated to result in an exceedance of the blood lead level goal. For adult commercial worker exposures, the calculated central estimate of the blood lead concentration in women of childbearing age did not exceed the goal of 4.2 $\mu\text{g}/\text{dL}$ for Lagoons 1, 3, 4 or 5. The results of the lead evaluation for these lagoons are contained in Attachment 6.

5.3 Description of Uncertainties

Estimation of risks to human health that may result from exposure to chemicals in the environment is a complex process that often requires the combined efforts of multiple disciplines. Each assumption, whether regarding the toxicity value to use for a particular chemical or the value of a parameter in an exposure equation, has a degree of variability and uncertainty associated with it. In each step of the risk assessment process, beginning with the data collection and analysis and continuing through the toxicity assessment, exposure assessment, and risk characterization, conservative assumptions are made that are intended to be protective of human health and to ensure that risks are not underestimated. The following subsection provides a discussion of the key uncertainties that may affect the final estimates of human health risk in this risk assessment. Uncertainties are arranged by topic.

5.3.1 Environmental Sampling and Analysis. The process of environmental sampling and analysis results in uncertainties from several sources, including errors inherent in sampling procedures or analytical methods. One area of uncertainty is sampling procedures. Since it is not possible to sample the entire area of interest at a given site, several samples are taken from each medium within each area of a site, and the results are considered to be representative of the chemicals present throughout the area. This approach may result in an overestimate or underestimate of risk. Analytical methods also involved uncertainties. Due to uncertainty of quantification, individual chemicals were sometimes listed as detected, but with the value qualified as estimated by laboratory qualification or validation procedures. The estimated value was used in the risk assessment. In some cases, analytical errors or sampling errors resulted in the rejection of data, which decreased the amount of data available and increased uncertainty associated with the representativeness of the detected chemical concentrations.

With respect to determining exposure point concentrations for this evaluation, one assumption was that the concentrations of chemicals in the medium evaluated would remain constant over time. Depending on the properties of the chemical and the medium in which it was detected, this assumption may overestimate risks, depending on the degree of chemical degradation or transport to other media. Conversely, biodegradation of chemicals to more toxic chemicals was also not considered.

5.3.2 Selection of Chemicals for Evaluation. A comparison of maximum detected chemical concentrations to USEPA Region 9 PRGs was conducted. Chemicals whose maximum concentrations were below their respective cancer screening value or 10% of their noncancer screening value were not carried through the assessment. It is unlikely that this risk-based screening excluded chemicals that would be of concern, based on the conservative exposure assumptions and conservatively derived toxicity criteria that are the basis of the screening criteria. Although following this methodology does not provide a quantitative risk estimate for all chemicals, it focuses the assessment on the chemicals accounting for the greatest risks (i.e., chemicals whose maximum concentrations exceeded their respective PRGs), and, although the overall risk estimates are uncertain, it is not expected that actual risks will be significantly greater than estimated risks.

5.3.3 Toxicological Data. Uncertainty is associated with the toxicity values and toxicity information available to assess potential adverse effects. For the site, there is a probability of overestimating health risks or hazards for a number of reasons, which are discussed in the following sections.

One of the major contributors to uncertainty is the accuracy of the toxicity values used. Until the present, the assumptions used by the USEPA in the dose-response extrapolation model for carcinogens were based on a 95% UCL of the maximum likelihood estimate. Other assumptions include the following: 1) the extrapolation of data from high-dose exposures in human and animal studies to the low-dose exposure region of the general population is linear and does not have a threshold; 2) there is an interspecies (i.e., animal to man) correlation, based on body surface area; and 3) there is a conditional probability that cancer incidence demonstrated in animal studies will be similar to the incidence in potentially exposed humans. To the extent that any of these assumptions are incorrect, the extrapolated risks may be over- or underestimates. One COPC for which there is some evidence of a nonlinear dose-response is arsenic (Chen *et al.*, 1992; Tseng, 1977; Tseng *et al.*, 1968). Since arsenic is a primary contributor to potential cancer risks to residents from the ingestion of drinking water, the interpretation of whether there is a non-toxic threshold for arsenic could affect whether arsenic levels in groundwater are considered allowable. The quantitative estimates of risk presented in this risk assessment assumes no threshold for carcinogenicity from arsenic, which may overestimate risk.

One COPC currently undergoing re-evaluation for carcinogenic potency is 2,3,7,8-TCDD (dioxin). An interim revised cancer slope factor for dioxin indicates that the cancer risk associated with dioxin exposure may be as much as 6.2 times greater than the risks estimated in this risk assessment. Footnotes on Table 8s present revised cancer risk estimates, using the interim revised slope factor.

5.3.4 Exposure Assessment. The primary areas of uncertainty affecting exposure parameter estimation involve the assumptions regarding exposure pathways, the estimation of exposure point

concentrations, and the parameters used to estimate chemical doses. The uncertainties associated with these various sources are discussed below.

The bioavailability of the COPCs from the oral exposure route through the ingestion of soil and sediment is uncertain. The animal bioassays on which the RfDs and oral SFs are based do not involve feeding of chemicals in a soil/sediment matrix. Oral absorption of chemicals from soil/sediment may be diminished due to the matrix effect of these media. This is particularly true for the inorganics that may be a component of the mineral structure of these media and, thus, may not be available for uptake.

For dermal exposure pathways, the absence of dermal toxicity criteria necessitated the use of oral toxicity data. To calculate risk estimates for the dermal pathway, absolute oral bioavailability factors that reflect the toxicity study conditions were used to modify the oral toxicity criteria. For the chemicals with oral absorption exceeding 50% (e.g., the PAHs), a default oral absorption factor of 100% was used. The risk estimates for the dermal pathways may be over- or underestimated depending on how closely these values reflect the difference between the oral and dermal routes.

The exposure assumptions selected for this evaluation were based on central tendency and RME case exposures. For example, it was assumed that park visitors would engage in recreational activities in the site at frequent intervals (up to 112 times a year) under future land-use conditions that would result in exposures to COPCs (i.e., contact with soil/sludge). This assumption is likely conservative since it is expected that the activities assumed in this analysis would likely occur less frequently.

The parameter values used to describe the extent, frequency, and duration of exposure are associated with some uncertainty. Actual risks for some individuals within an exposed population may vary from those predicted depending upon their actual intake rates (e.g., soil ingestion rates) or body weights. The exposure assumptions were selected to produce an upper-bound estimate of exposure in accordance with USEPA guidelines regarding evaluation of potential exposures at Superfund sites.

Therefore, exposures and estimated potential risks for the majority of the evaluated receptors are likely to be overestimated.

Because a small number of environmental samples were collected from each lagoon for surface water, the maximum detected level of a COPC was used as the RME EPC. Use of the maximum detected result instead of the 95% UCL value for the RME EPC most likely results in an overestimate of risk. In addition, only sediment samples collected from below one foot or less of standing water were used in the human health risk assessment. This approach eliminated a small number of samples from those available to calculate sediment EPCs. Depending on the representativeness of the available samples to the site as a whole, this approach may have resulted in an over- or underestimation of risk.

5.3.5 Risk Characterization. Cancer risks and HIs for each receptor were not summed across all media. For example, the risks to the park visitor from surface water and sediment ingestion and dermal contact in the Hoosic River were not summed with those from soil/sludge and surface water ingestion and/or dermal contact. In addition, risks from a given medium were not summed across exposure areas. That is, for the park visitor, risks from ingestion of and dermal contact with soil/sludge were assumed to occur within a given exposure area, such as Lagoon 1. This assumption is uncertain since a given park visitor may spend half his/her time in one exposure area and half in another. Risks to such an individual would be intermediate between the risks to individuals exposed solely within each exposure area.

5.3.6 Overall Uncertainty. This risk assessment contains many layers of conservative assumptions. For example, in the RME case, the value selected for each parameter in each equation used to calculate risks to the RME individual is a maximum or upper-bound assumption. Therefore, the estimated risk is likely to be greater than the 95% UCL of all potential risks. If the risk assessment was able to capture the uncertainty and variability associated with each parameter, it is likely that the actual potential risk to the RME individual would be less than the risks estimated in this assessment.

5.4 Summary of Human Health Risks

An overall summary of cancer and noncancer risk estimates for the current older child trespasser, future adult/young child park visitor, current adult/young child resident, future adult/young child resident, future commercial worker and future utility worker scenarios are presented in Tables 9.1 through 9.57. In these tables, risks are summarized for both the RME and CT receptors. When risks were estimated for a young child and adult receptor (i.e., residents and park visitors), the young child HIs are presented as the most conservative, while ILCRs presented are the sum of the young child and adult risks (i.e., a total receptor risk). Soil/sludge and surface water risks, presented for the lagoon areas, have been summed together under the assumption that each receptor is exposed to both media during recreational activities. Surface water and sediment risks, presented for the Hoosic River/wetlands, have also been summed together. For the utility worker, soil/sludge, surface water and air risks were summed. In addition, HIs, segregated by systemic effects, are presented. In cases where the total HI exceeded 1, COPCs having similar systemic effects were summed for each pathway and medium. Tables 10.1 through 10.28 summarize the primary risk contributors for those receptors with estimated ILCRs greater than the target range of 10^{-6} to 10^{-4} and target organ-specific HIs greater than 1.

Risks Under Current Condition. ILCRs and HIs estimated for the current older child trespasser exposure scenarios (lagoon soil/sludge, Hoosic River surface water and sediment) were below an ILCR of 10^{-4} and an HI of 1 for each of the exposure areas, except for Lagoon 5. The HI for the current adolescent trespasser exceeded 1 due to the presence of chromium in lagoon soil/sludge (Table 10.1.RME).

ILCRs and HIs for the current resident drinking water ingestion scenario exceeded an ILCR of 10^{-4} and/or an HI of 1 for each of the following private wells (primary risk contributors in parentheses): RW-003 (arsenic); RW-006 (thallium); RW-008 (arsenic and manganese); and RW-010 (manganese). Risks and primary risk contributors are presented on Tables 10.6 through 10.9.

An evaluation of lead in soil/sludge at Lagoons 1, 3, 4 and 5 indicated that exposures to lead, under current conditions, do not result in blood lead levels in excess of the blood lead level goal for a young child park visitor.

Potential Risks Under Future Conditions. For the future park visitor, ILCRs and HIs for Lagoons 2 and 4 were below an ILCR of 10^{-4} and an HI of 1. HIs exceeded 1 and/or ILCRs exceeded 10^{-4} for soil/sludge exposures at Lagoons 1, 3 and 5. The exceedances were due primarily to the presence of dioxins and chromium in soil/sludge (Tables 10.2.RME through 10.4.RME). In addition, the ILCR exceeded 10^{-4} for future park visitor exposures to sediment within the Hoosic River. The exceedance was due primarily to the presence of PCBs in sediment (Table 10.5.RME).

For the future commercial worker, the ILCR exceeded 10^{-4} and an HI of 1 for soil/sludge exposure at Lagoons 1, 3 and 5, due primarily to the presence of dioxins and chromium at Lagoon 1 (Table 10.24.RME) and chromium at Lagoons 3 and 5 (Tables 10.25.RME and 10.26.RME).

For the future utility worker, the HI exceeded 1 for soil/sludge exposure at Lagoons 1 and 3 due primarily to the presence of chromium (Tables 10.27.RME and 10.28.RME).

ILCRs and HIs for the future resident drinking water ingestion scenario exceeded an ILCR of 10^{-4} and/or an HI of 1 for each of the following monitoring wells (primary risk contributors in parentheses): MW-104U (manganese); MW-106U (manganese); MW-107R (dioxin, arsenic and manganese); MW-107U (arsenic and manganese); MW-109U (carbon tetrachloride, heptachlor epoxide, arsenic, manganese and thallium); MW-110R (arsenic and manganese); MW-110U (manganese); MW-111U (manganese); MW-113R (arsenic and manganese); MW-114U (manganese); MW-B-7 (methylene chloride); MW-L-3 (arsenic and manganese); and MW-L-10 (manganese). Risks and primary risk contributors are presented on Tables 10.10 through 10.22. Risks and primary risk contributors for all on-site monitoring wells combined are presented on Table 10.23.

An evaluation of lead in soil/sludge at Lagoons 1, 3, 4 and 5 indicated that exposures to lead only at Lagoon 1, under future assumed land-use conditions, were estimated to result in blood lead levels in excess of the blood lead level goal for a young child park visitor.

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TABLE 1.0
SELECTION OF EXPOSURE PATHWAYS

TABLE 1
SELECTION OF EXPOSURE PATHWAYS

POWNAI TANNERY

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Tap Water (Residential Wells)	Resident	Adult	Dermal	Off-Site	Qual	Not likely to be a significant pathway due to low levels of organics in groundwater.
						Inhalation	Off-Site	Qual	Not likely to be a significant pathway due to low levels of VOCs in groundwater.
						Ingestion	Off-Site	Quant	Residents currently live next to the site and have wells.
					Young Child	Dermal	Off-Site	Qual	Not likely to be a significant pathway due to low levels of organics in groundwater.
						Inhalation	Off-Site	Qual	Not likely to be a significant pathway due to low levels of VOCs in groundwater.
						Ingestion	Off-Site	Quant	Residents currently live next to the site and have wells.
	Soils	Surface Soil/Sludge	Lagoons (1-5) and Warehouse Area	Trespasser	Adolescent	Dermal	On-Site	Quant	Evidence of trespassers on-site.
						Inhalation	On-Site	Qual	Air sampling demonstrates that this is not a significant pathway.
						Ingestion	On-Site	Quant	Evidence of trespassers on-site.
	Surface Water	Surface Water	Lagoons (1-5)	Trespasser	Adolescent	Dermal	On-Site	Quant	Evidence of trespassers on-site. Wading in lagoons may occur.
Ingestion						On-Site	None	Wading scenario. Ingestion is unlikely during wading.	
Surface Water		River and Wetlands	Recreational Visitor	Adolescent	Dermal	Off-Site	Quant	Unrestricted access to river.	
					Ingestion	Off-Site	Quant	Unrestricted access to river.	
Sediment	Sediment	River and Wetlands	Recreational Visitor	Adolescent	Dermal	Off-Site	Quant	Unrestricted access to river.	
					Ingestion	Off-Site	Quant	Unrestricted access to river.	
	Animal Tissue	Fish from River and Wetlands	Area Residents	Adult	Ingestion	Off-Site	None	No data collected. Fish advisory from VTDPH.	
Future	Groundwater	Groundwater	On-Site Monitoring Wells	Resident	Adult	Dermal	On-Site/ Off-Site	Qual	Not likely to be a significant pathway due to low levels of organics in groundwater.
						Inhalation	On-Site/ Off-Site	Qual	Not likely to be a significant pathway due to low levels of VOCs in groundwater.
						Ingestion	On-Site/ Off-Site	Quant	On-site groundwater may be used as a source of drinking water or may migrate and impact off-site residential wells.
					Young Child	Dermal	On-Site/ Off-Site	Qual	Not likely to be a significant pathway due to low levels of organics in groundwater.
						Inhalation	On-Site/ Off-Site	Qual	Not likely to be a significant pathway due to low levels of VOCs in groundwater.
Ingestion	On-Site/ Off-Site	Quant	On-site groundwater may migrate and impact off-site residential wells.						

TABLE 1
SELECTION OF EXPOSURE PATHWAYS

POWNA TANNERY

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future (continued)	Soils	Soil/Sludge (0-10 ft deep)	Lagoons (1-5) and Warehouse Area	Park Visitor	Adult	Dermal	On-Site	Quant	Assumes future recreational site use.
						Inhalation	On-Site	Qual	Air sampling demonstrates that this is not a significant pathway.
						Ingestion	On-Site	Quant	Assumes future recreational site use.
		Soil/Sludge (0-10 ft deep)	Lagoons (1-5) and Warehouse Area	Park Visitor	Young Child	Dermal	On-Site	Quant	Assumes future recreational site use.
						Inhalation	On-Site	Qual	Air sampling demonstrates that this is not a significant pathway.
						Ingestion	On-Site	Quant	Assumes future recreational site use.
		Soil/Sludge (0-10 ft deep)	Lagoons (1-5)	Commercial Worker	Adult	Dermal	On-Site	Quant	Assumes future industrial/commercial site use.
Inhalation	On-Site					Qual	Air sampling demonstrates that this is not a significant pathway.		
Ingestion	On-Site					Quant	Assumes future industrial/commercial site use.		
Soil/Sludge (0-10 ft deep)	Lagoons (1-5)	Utility Worker	Adult	Dermal	On-Site	Quant	Assumes future site development.		
				Inhalation	On-Site	Quant	Inhalation of VOCs may occur during trenching activities.		
				Ingestion	On-Site	Quant	Assumes future site development.		
Soil (0-10 ft deep)	Warehouse Area	Resident	Adult	Dermal	On-Site	Quant	Assumes future residential use of warehouse area.		
				Inhalation	On-Site	Qual	Air sampling demonstrates that this is not a significant pathway.		
				Ingestion	On-Site	Quant	Assumes future residential use of warehouse area.		
Soil (0-10 ft deep)	Warehouse Area	Resident	Young Child	Dermal	On-Site	Quant	Assumes future residential use of warehouse area.		
				Inhalation	On-Site	Qual	Air sampling demonstrates that this is not a significant pathway.		
				Ingestion	On-Site	Quant	Assumes future residential use of warehouse area.		

TABLE 1
SELECTION OF EXPOSURE PATHWAYS

POWNAI TANNERY

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future (continued)	Surface Water	Surface Water	Lagoons (1-5)	Park Visitor	Adult	Dermal Ingestion	On-Site On-Site	Quant None	Assumes future recreational site use. Wading scenario. Ingestion is unlikely during wading.
		Surface Water	Lagoons (1-5)	Park Visitor	Young Child	Dermal Ingestion	On-Site On-Site	Quant None	Assumes future recreational site use. Wading scenario. Ingestion is unlikely during wading.
		Surface Water	Lagoons (1-5)	Commercial Worker	Adult	Dermal Ingestion	On-Site On-Site	Qual None	Contact similar to trespasser. Wading scenario. Ingestion is unlikely during wading.
		Surface Water	Lagoons (1-5)	Utility Worker	Adult	Dermal Ingestion	On-Site On-Site	Quant Qual	Assumes future site development. Unlikely to occur to a significant extent during construction activities.
		Surface Water	River and Wetlands	Park Visitor	Adult	Dermal Ingestion	Off-Site Off-Site	Quant Quant	Unrestricted access to river. Unrestricted access to river.
		Surface Water	River and Wetlands	Park Visitor	Young Child	Dermal Ingestion	Off-Site Off-Site	Quant Quant	Unrestricted access to river. Unrestricted access to river.
	Sediment	Sediment	River and Wetlands	Park Visitor	Adult	Dermal Ingestion	Off-Site Off-Site	Quant Quant	Unrestricted access to river. Unrestricted access to river.
		Sediment	River and Wetlands	Park Visitor	Young Child	Dermal Ingestion	Off-Site Off-Site	Quant Quant	Unrestricted access to river. Unrestricted access to river.
		Animal Tissue	Fish from River and Wetlands	Area Residents	Adult	Ingestion	Off-Site	None	No data collected. Fish advisory from VTDH.
					Older Child	Ingestion	Off-Site	None	No data collected. Fish advisory from VTDH.