N83447.AR.000543
NAS FORT WORTH
5090.3a

FINAL RISK ASSESSMENT ASSUMPTIONS DOCUMENT NAS FORT WORTH TX
10/1/2000
HYDROGEOLOGIC

649 0

File: 17G
P.W.

# NAVAL AIR STATION
# FORT WORTH JRB
# CARSWELL FIELD
# TEXAS

# ADMINISTRATIVE RECORD
# COVER SHEET

**AR File Number** 649

HYDRO GeoLogic INC.

# FINAL
# RISK ASSESSMENT ASSUMPTIONS DOCUMENT
# FORMER CARSWELL AFB, TEXAS

Prepared for

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

October 2000

HydroGeoLogic, Inc.
1155 Herndon Parkway
Suite 900
Herndon, Virginia 20170
(703) 478-5186

649 2

NOV 29 REC'D

Alvin Cain
Please return Vol I & II of Report - only one copy per

**CH2MHILL** TRANSMITTAL

**TO:** Ray Risner/TNRCC
Luda Voskov/TNRCC
Gary Miller/US EPA Region 6
Ruben Moya/US EPA Region 6

**TO:** Charles Pringle/AFCEE
Rafael Vasquez/AFBCA
Audrie Medina/Unitech

**CC:** Don Ficklen/AFCEE, w/out attachment
Mike Dodyk/AFCEE, w/out attachment
George Walters/ HQ ASC, w/out attachment

**Date:** November 27, 2000

**Re:** NAS Fort Worth JRB, Area of Concern 2

**We Are Sending You:**

| | | |
|---|---|---|
| ☑ Attached | Under separate cover via | |
| Shop Drawings | ☑ Documents | Tracings |
| Prints | Specifications | Catalogs |
| Copy of letter | Other: | |

| ITEM | Description |
|---|---|
| 1. | Final RCRA Facility Investigation Report, Area of Concern 2, NAS Fort Worth JRB (Version 1.1), Volumes I and II<br>NOTE: This version of the report incorporates AFCEE's response to TNRCC and EPA comments on the January 1999 draft. |

If material received is not as listed, please notify us at once

**NOTE to distribution recipients:**

**This copy is being provided by CH2M HILL at the request of Don Ficklen/ AFCEE.**

NOV 2 9 REC'D

November 27, 2000

Mr Ray Risner
Texas Natural Resource Conservation Commission
Building D – MC127
12100 Park 35 Circle
Austin, Texas 78753

Dear Mr. Risner:

Subject: NAS Fort Worth JRB, Texas (Carswell Field)
Area of Concern 2 RCRA Facility Investigation Report, Version 1.1

AFCEE is pleased to submit the final version of the RCRA Facility Investigation (RFI) Report for Area of Concern 2 (AOC2) at Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB).

AOC2 represents the groundwater affected by trichloroethylene (TCE) at NAS Fort Worth JRB. TCE-related contamination observed at the base generally occurs in the form of three lobes: northern, central, and southern. At the time the AOC2 RFI was being planned, only the northern lobe had not already been well-defined by previous investigative work conducted at the base, and the AOC2 RFI investigation was planned to specifically address data needs remaining for this northern lobe. The AOC2 RFI was conducted by CH2M HILL in accordance with the AOC2 RFI Workplan dated February 1998.

The attached document, designated Version 1.1, incorporates TNRCC and EPA review comments on Version 1.0 (dated January 1999), in accordance with our original response to comments provided to you in January 2000. Based on the RFI activities, the conclusions of the report describe the TCE plume at Air Force Plant 4 (AFP4) as the most likely source of TCE in the northern lobe of AOC2, and provide a description of the nature and extent of the affected groundwater, the potential for natural attenuation, and the potential risks associated with the current and potential future plume. Recommendations for continued monitoring pending the evaluation and selection of remedial alternatives are also provided.

Please let me know if you have any questions or comments.

Sincerely,

Don Ficklen
Restoration Team Chief
Air Force Center for Environmental Excellence

DFW\138681\AOC2RFI\REPORT\VER1 1\00Nov_AOC2 doc

c Ms. Luda Voskov/TNRCC
Mr. Gary Miller/EPA Region 6
Mr. Ruben Moya/EPA Region 6
Mr. Charles Pringle/AFCEE
Mr. Rafael Vasquez/AFBCA
Ms Audrie Medina/Universe Technologies, Inc.

649 4

the IT group

**IT Corporation**
312 Directors Drive
Knoxville, TN 37923-4799
Tel 865 690.3211
Fax 865 690.3626

A Member of The IT Group

Alvin
Cms

November 30, 2000

774802-ITCHOO-0064

Mr. Charles Pringle
HQ AFCEE/RE
3207 North Road, Bldg 532
Brooks AFB, TX 78235-5363

Subject: **Completion Report of Remedial Action Activities at Landfills No.4, No.5, No.8, and Waste Burial Area No. 7.**
**Contract F41624-97-D-8024, Delivery Order Number 03**
**IT Project Number 774902,**
**NAS Fort Worth JRB (former Carswell AFB), Texas**

Dear Mr. Pringle:

Enclosed is the Draft Completion Report of Remedial Action Activities at Landfills No. 4, No. 5, and No. 8, and Waste Burial Area No. 7 for your review and comment. Comments will be appreciated by January 15, 2001 Once comments have been received and incorporated, the report will be issued final.

Contact me if you have any questions

Sincerely,

Willard S. Carter, PMP
Senior Project Manager

Enclosure

cc: Charles Pringle/ HQ AFCEE/RE (1 Copy)
Leslie McPherson/Unitec (2 Copies)
Alvin Brown/ AFBCA (1 Copy)
Mike Dodyk/AFCEE Field (2 Copies)
Todd Harrah/ HGL (1 Copy)

| Site Matrix<br>Naval Air Station Fort Worth Joint Reserve Base, Carswell Field | | | | | |
|---|---|---|---|---|---|
| **SWMU No.** | **AOC/ OU No.** | **Site Name** | **Old Site No.** | **Old IRP No.** | **New IRP No.** |
| 1 | | Pathological Waste Incinerator | | | |
| 2 | | Pathological Waste Storage Shed | | | |
| 3 | | Metal Cans | | | |
| 4 | | Facility Dumpsters | | | |
| 5 | | Bldg 1628, Waste Accumulation Area | | | SS-02 |
| 6 | | Bldg 1628, Wash Rack & Drain | | | SD-16 |
| 7 | | Bldg 1628, Oil/Water Separator | | | SD-00 |
| 8 | | Bldg 1628, Sludge Collection Tank | | | SD-14 |
| 9 | | Bldg 1628, Work Station Waste Accumulation | | | |
| 10 | | Bldg 1617, Work Station Waste Accumulation | | | |
| 11 | | Bldg 1617, Waste Accumulation Area | | | SS-03 |
| 12 | | Bldg 1619, Waste Accumulation Area | | | SS-04 |
| 13 | | Bldg 1710, Waste Accumulation Area | | | SS-05 |
| 14 | | Bldg 1060, Bead Blast Collection Tray | | | |
| 15 | | Bldg 1060, Paint Booth Vault | | | |
| 16 | | Bldg 1060, Waste Accumulation Area | | | SS-06 |
| 17 | | Landfill No 7 | | LF-07 | LF-05 |
| 18 | | Fire Training Area No 1 | 11 | FT-08 | FT-01 |
| 19 | OU-1 | Fire Training Area No. 2 | 12 | FT-09 | FT-01 |
| 20 | | Waste Fuel Storage Tank | | FT-09 | FT-01 |
| 21 | | Waste Oil Tank | | FT-09 | FT-01 |
| 22 | OU-1 | Landfill No 4 | 4 | LF-04 | LF-04 |
| 23 | OU-1 | Landfill No. 5 | 5 | LF-05 | LF-05 |
| 24 | OU-1 | Waste Burial Area (Buried Drums) | 10 | WP-07 | WP-07 |
| 25 | | Landfill No. 8 | | LF-08 | LF-06 |
| 26 | | Landfill No 3 | 3 | LF-03 | LF-03 |
| 27 | | Landfill No. 10 | | LF-10 | LF-08 |
| 28 | OU-2 | Landfill No 1 | 1 | LF-01 | LF-01 |
| 29 | | Landfill No 2 | 2 | LF-02 | LF-02 |
| 30 | | Landfill No. 9 | | LF-09 | LF-07 |
| 31 | | Bldg 1050, Waste Accumulation Area | | | SS-07 |
| 32 | | Bldg 1410, Waste Accumulation Area | | | SS-08 |
| 33 | | Bldg 1420, Waste Accumulation Area | | | SS-09 |
| 34 | | Bldg 1194, Waste Accumulation Area | | | SS-10 |
| 35 | | Bldg 1194, Oil/Water Separator System | | | SD-02 |
| 36 | | Bldg 1191, Waste Accumulation Area | | | SS-11 |
| 37 | | Bldg 1191, Oil/Water Separator | | | SD-03 |
| 38 | | Bldg 1269, PCB Transformer Storage | | | |
| 39 | | Bldg 1643, Waste Accumulation Area | | | SS-12 |
| 40 | | Bldg 1643, Oil/Water Separator | | | SD-04 |
| 41 | | Bldg 1414, Oil/Water Separator | | | SD-05 |
| 42 | | Bldg 1414, Waste Accumulation Area | | | SS-13 |
| 43 | | Bldg 1414, NDI Waste Accumulation Area | | | |
| 44 | | Bldg 1027, Oil/Water Separator | | | SD-06 |
| 45 | | Bldg 1027,Waste Oil Tank | | | SD-15 |
| 46 | | Bldg 1027, Waste Accumulation Area | | | |

| Site Matrix (continued)<br>Naval Air Station Fort Worth Joint Reserve Base, Carswell Field | | | | | |
|---|---|---|---|---|---|
| SWMU No. | AOC/ OU No. | Site Name | Old Site No. | Old IRP No. | New IRP No. |
| 47 | | Bldg 1015, Oil/Water Separator | | | SD-07 |
| 48 | | Bldg 1048, Floor Drains | | | |
| 49 | | Aircraft Washing Area No 1 | | | SD-17 |
| 50 | | Aircraft Washing Area No. 2 | | | SD-18 |
| 51 | | Bldg 1190, Waste Accumulation Area (Central Waste Holding) | | | SS-14 |
| 52 | | Bldg 1190, Oil/Water Separator | | | SD-08 |
| 53 | OU-1 | Storm Water Drainage System (Flightline Drainage Ditch) | 13 | SD-10 | SD-19 |
| 54 | | Storm Water Interceptors | | | SD-20 |
| 55 | | East Gate Oil/Water Separator | | | SD-09 |
| 56 | | Bldg 1405, Waste Accumulation Area | | | |
| 57 | | Bldg 1432/1434, Waste Accumulation Area | | | |
| 58 | | Pesticide Rinse Area | 14 | WP-11 | WP-11 |
| 59 | | Bldg 8503, Waste Accumulation Area | | OT-15 | RW-12 |
| 60 | OU-3 | Bldg 8503, Radioactive Waste Burial Site | | OT-15 | OT-15 |
| 61 | | Bldg 1320, Waste Accumulation Area | | | SS-15 |
| 62 | OU-1 | Landfill No. 6 | 6 | LF-06 | LF-04 |
| 63 | | Entomology Dry Well | 15 | OT-12 | |
| 64 | OU-2 | French Under Drain System (Unnamed Stream) | 16 | SD-13 | ST-03 |
| 65 | | Weapons Storage Area | | OT-15 | |
| 66 | | Sanitary Sewer System | | | WP-01 |
| 67 | | Bldg 1340, Oil/Water Separator | | SD-13 | ST-03 |
| 68 | OU-1 | POL Tank Farm | 17 | ST-14 | ST-01 |
| | AOC 1/ OU-2 | Base Service Station | | ST-16 | ST-04 |
| | AOC 2/ OU-1 | Airfield Groundwater | | OT-18 | WP-02 |
| | AOC 3/ OU-1 | Waste Oil Dump | | DP-17 | |
| | AOC 4/ OU-2 | East Area Groundwater (Fuel Hydrant System) "Spot 35" | | | ST-05 |
| | AOC 5 | Grounds Maintenance Yard | | OT-39 | |
| | AOC 6 | RV Parking Area | | | SS-01 |
| | AOC 7 | Base Refueling Area (Abandoned Gas Station) | | | ST-02 |
| | AOC 8 | SW Aerospace Museum | | OT-38 | |
| | AOC 9 | Golf Course Maint Yard | | WP-11 | |
| | AOC 10 | Bldg 1064, Oil/Water Separator | | | SD-10 |
| | AOC 11 | Bldg 1060, Oil/Water Separator | | | SD-11 |
| | AOC 12 | Bldg 4208/4210, Oil/Water Separator | | | SD-12 |
| | AOC 13 | Bldg 1145, Oil/Water Separator | | | SD-13 |
| | AOC 14 | Base MW | | SD-13 | SD-13 |
| | AOC 15 | OWSA-EOD (Bldg 1190 Storage Shed) | | | SS-16 |
| | AOC 16 | Family Camp | | | |
| | AOC 22 | Rail Right-of-Way | | | |

# FINAL
# RISK ASSESSMENT ASSUMPTIONS DOCUMENT
# FORMER CARSWELL AFB, TEXAS

Prepared for

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Prepared by

HydroGeoLogic, Inc.
1155 Herndon Parkway, Suite 900
Herndon, VA 20170

and

IT Corporation
11499 Chester Road
Cincinnati, OH 45246

October 18, 2000

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# LIST OF TABLES

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AFB | Air Force Base |
| BRAC | Base Realignment and Closure |
| COPC | chemicals of potential concern |
| CSM | conceptual site model |
| EPA | U.S. Environmental Protection Agency |
| FFS | Focused Feasibility Study |
| HI | hazard index |
| HQ | hazard quotient |
| JRB | Joint Reserve Base |
| LOAEL | lowest observed adverse effect level |
| NAS | Naval Air Station |
| NOAEL | no observed adverse effect level |
| PCL | protective concentration level |
| RfD | reference dose |
| RME | reasonable maximum exposure |
| SF | slope factor |
| SQL | sample quantitation limit |
| TCE | trichloroethylene |
| TNRCC | Texas Natural Resource Conservation Commission |
| UCL | upper confidence level |

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE TEXAS



18 October 2000

MEMORANDUM FOR RUBEN MOYA (EPA REGION 6)

FROM: Mr. Don Ficklen
AFCEE ERD
3207 North Road
Brooks AFB, TX 78235

SUBJECT: Former Carswell AFB
Final Risk Assessment Assumption Document

Dear Mr. Moya,

Three copies of the Final Risk Assessment Assumption Document (RAAD) are enclosed for your reference. Please distribute the additional copies to your risk assessors. The RAAD presents the methodology that will be used to complete the risk assessment necessary for the on-going Focused Feasibility Study (FFS). All comments from the Draft RAAD and the two teleconferences following the Draft RAAD have been addressed.

Should you have any questions regarding this report, please contact me at (210) 536-5290.

Sincerely,

Mr. Don Ficklen
HQ AFCEE ERD

cc:

Mr. Gary W. Miller (2 copies)
EPA Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Ms. Luda Voskov (2 copies)
Texas Natural Resource Conservation Commission
Attn: Ms. Voskov (MC 143)
Building D
12100 Park 35 Circle
Austin, TX 78753

Mr. Michael Dodyk (2 copies)
HQ AFCEE/ERD
P.O.BOX27008,
Ft Worth, TX 76127-0008

Mr. Tim Sewell
TNRCC Region IV
1101 E. Arkansas Lane
Arlington, TX 76010-6499

Mr. Mark Weegar (2 copies)
Texas Natural Resource Conservation Commission
Attn: Mr. Mark Weegar (MC 127)
Building D
12100 Park 35 Circle
Austin, TX 78753

George Walters (2 copies)
ASC/EMVR
Bldg. 8
1801 10th Street
Wright-Patterson AFB, OH 45433-7726

Mr. Rafael Vazquez
AFBCA/ROL Bergstrom
3711 Fighter Drive
Austin, TX 78719-2557

Mr. Charles C. Pringle, P.E.
HQ AFCEE/ERB
3207 North Road
Brooks AFB, TX 78235-5363

Ms. Audrie Medina (Unitec)
2100 Bypass Road
Building 580
Brooks AFB, TX 78235

# FINAL
# RISK ASSESSMENT ASSUMPTIONS DOCUMENT
# FORMER CARSWELL AFB, TEXAS

## 1.0 INTRODUCTION

A Focused Feasibility Study (FFS) is currently being conducted to evaluate remedial options associated with the transfer of federal property located adjacent to the Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB) on Former Carswell Air Force Base (AFB) property. This property is approximately 300 acres, and it includes the Carswell Golf Course. The property is being evaluated for transfer under the Base Realignment and Closure (BRAC) program. This document summarizes the proposed approach that will be used to perform a human health and ecological risk assessment for this BRAC property. The risk assessment is being conducted to support the FFS. The objective of this document is to present the methodology that will be used to complete the risk assessment. This will permit input by the Regulatory Agencies prior to the completion of the risk assessment. Hopefully, this will help streamline the risk assessment and FFS process.

Investigations of contaminant source areas at NAS Fort Worth JRB revealed the presence of groundwater contaminants in varying concentrations throughout the area. These contaminants, primarily volatile organic compounds (i.e., predominantly trichloroethylene (TCE) and its degradation products) occur as definable plumes. Because of movement of groundwater under the Base, and the physio-chemical properties of the individual contaminants, contaminants may be transported from one source area through others, commingling contaminants and finally moving into remote portions of the Base or across the Base boundary. This risk assessment will examine the potential for risks posed to human health and the environment by exposure to the contaminants in groundwater, surface water and sediment. The risk assessment will incorporate previous groundwater, surface water, and sediment characterization efforts to allow for the development, evaluation, and selection of appropriate remedial actions for the BRAC property.

Human health risk from exposure to contaminated groundwater will be evaluated quantitatively. Traditionally, the groundwater exposure point concentration is estimated as the maximum concentration for any constituent. However, in situations involving large areas and multiple chemicals of concern, the maximum detected constituent concentration associated with one chemical may be at a different location from the maximum detected constituent concentration associated with a second chemical. Assuming equivalent exposure for both chemicals to any receptor would, therefore, be inaccurate and overly conservative. Since current and future exposures to groundwater occur at particular locations, it would be helpful to estimate risk at all possible locations within the study area based on land use scenarios. For these purposes, a risk assessment that evaluates risk at multiple locations for multiple contaminants of concern is more realistic.

For the NAS Fort Worth JRB groundwater risk assessment, risk contour maps will be developed for the entire study area. These maps will represent total incremental cancer risk and noncancer hazard for all chemicals of potential concern (COPCs) as a function of contaminant concentration and location (i.e., risk isopleths). This approach to risk characterization is not conventional. In most risk assessments, risk is presented for a discrete area in a tabular format. This approach, however, does not present the spatial distribution of risk on a continuous basis. Instead, statistical methods are used to develop conservative risk numbers that are representative of a large discrete area. The risk characterization approach proposed in this document provides a mechanism for presenting quantitative estimates of carcinogenic risk and noncarcinogenic hazard in a fashion that can be easily communicated to all stakeholders and allows the spatial distribution of risk to be presented at every location within the study area.

Surface water and sediment constituent concentrations will also be evaluated to assess potential human health and ecological risk using more traditional methods. Human health risk will be evaluated through the estimation of average surface water and sediment concentrations from which, numerical risk and hazard estimates will be derived. For ecological risk, surface water and sediment constituent concentrations will be evaluated by a tiered approach (Texas Natural Resource Conservation Commission [TNRCC], 2000). The need for a more rigorous ecological evaluation will be based on the results of the initial evaluation.

The risk assessment is intended to reflect appropriate guidance provided by U.S. Environmental Protection Agency (EPA) (1989a, 1995c, and 1998a) for human health risk assessment and guidance provided by TNRCC (2000) for ecological risk assessment. EPA's Part D risk assessment guidance (1998a) provides standardized tables that present data and calculated values that are to be used in the risk assessment. Part D guidance will be used to present the majority of the risk assessment. However, since the groundwater risk characterization will take the form of risk isopleth maps rather than single numerical estimates of risk, the groundwater risk characterization will not specifically conform to Part D risk characterization formats.

The risk assessment consists of the following elements:

- Conceptual Site Model (CSM) for both human and ecological health;
- Data Compilation and Evaluation describing methodologies used to summarize data used in this evaluation;
- Summary of COPCs;
- Exposure Assessment which includes a summary of the unit risk values used in the risk characterization;

- Toxicity Assessment will be used to evaluate carcinogenic risk and noncarcinogenic hazard from groundwater, surface water and sediment exposures. The Toxicity Assessment includes both carcinogenic and noncarcinogenic toxicity values as well as toxicity profiles for potential human health and ecological receptors; and

- Risk Characterization and an Evaluation of Uncertainties in the exposure, toxicity, and risk estimates.

*This page was intentionally left blank.*

# 2.0 CONCEPTUAL SITE MODEL

The CSM for the risk assessment is developed to provide the basis for identifying and evaluating the potential risks to human health in the baseline risk assessment. The conceptual model facilitates consistent and comprehensive evaluation of risks by creating a framework for identifying the paths by which potential human and ecological receptors may be impacted by groundwater, surface water, and/or sediment. The elements necessary to construct a complete exposure pathway and develop the conceptual model include:

- Land use scenarios and potential populations of concern
- COPCs and their sources
- Release mechanisms
- Transport pathways
- Exposure pathway scenarios
- Potential receptors (both current and future)

## 2.1 LAND USE SCENARIOS AND POTENTIAL POPULATIONS OF CONCERN

Land use in the study area ranges from industrial to residential. Although current groundwater supplies in the vicinity of the NAS Fort Worth JRB originate from deep wells, this risk assessment addresses potential future use of groundwater at all depths beneath the site. Also included is an exposure scenario that evaluates current conditions where shallow groundwater is not available for residential use and the only potential exposure to contaminated groundwater would be during construction activities. All receptors will be evaluated for the reasonable maximum exposure (RME).

The potential human groundwater receptor exposure scenarios include:

- Resident - This exposure assumes that adults and children reside within the study area and that these receptors obtain all household water from on-site supply wells.

- Construction Worker - This exposure assumes that a construction worker is exposed through dermal contact, inhalation of volatiles, and incidental ingestion while engaged in construction activities in the study area.

The potential human surface water and sediment receptor exposure scenarios include:

- Recreational User - This exposure assumes that adults frequent the study area and occasionally come in contact with surface water and sediment. Since a portion of the property will remain a golf course, a typical exposure would be a frequent golfer retrieving golf balls from the study area. Although the stream in this area is ephemeral and does not provide a habitat that supports sport fishing, as a conservative measure surface water will be evaluated assuming some limited fishing may be possible.

- Trespasser – This receptor is a young adult that visits the area intermittently. This receptor is exposed to surface water and sediment while exploring and playing in the surface water bodies.

- Site Maintenance Worker - This receptor is an adult that works as a groundskeeper and occasionally performs maintenance activities in the surface water bodies and becomes exposed to surface water and sediment.

The receptor exposure scenarios included in the ecological risk assessment include only exposures to surface water and sediment, but do not include groundwater:

- Ecological Receptors – Ecological receptors include hydric and aquatic organisms, plants, and wildlife that live in or use the habitat provided in the study area.

## 2.2 EXPOSURE PATHWAYS

Exposure pathways relevant to human and ecological exposures to groundwater, surface water and sediment are listed below.

Exposure routes for the resident and construction worker include:

- Ingestion of groundwater
- Inhalation of volatiles from groundwater, surface water, and sediment
- Dermal contact with chemicals in the groundwater
- Incidental ingestion of surface water and sediment
- Inhalation of vapors in basements from groundwater contaminants

Exposure routes for the recreational user, trespasser, and maintenance worker include:

- Incidental ingestion of surface water and sediment
- Dermal contact with chemicals in the surface water and sediment
- Inhalation of volatiles from groundwater, surface water, and sediment
- Limited ingestion of fish

Exposure routes for ecological receptors:

- Direct contact with the surface water and sediment (plants and aquatic organisms)
- Ingestion of food from the surface water and sediment
- Ingestion of prey that may bioaccumulate (or bioconcentrate) contaminants
- Ingestion of surface water
- Incidental ingestion of sediments

# 3.0 DATA COMPILATION AND EVALUATION

Historical groundwater, surface water and sediment data will be compiled and summarized from previous investigations. Groundwater quality data collected during the Data Gaps Investigation, conducted as part of the FFS, will be integrated with historical data. The integrated groundwater quality data set will be used to develop contour maps showing constituent concentrations. These maps will then be used to derive risk isopleth maps using the methods described below. Surface water and sediment data will be statistically summarized to derive exposure point concentrations that can be used in both the human health and ecological risk assessment. The collection of additional surface water and sediment data is not proposed as part of the FFS. Consequently, the risk assessment will be completed using available historical data.

Only data validated to EPA Level III will be used in this risk assessment. Data may be classified as rejected (R), qualified as estimated (J or UJ), or qualified below detection limits (U). Rejected data will not be used in the risk assessment. J-qualified data represent estimated values, but are treated in the same manner as unqualified data and will be included in the exposure estimates. Methods used to include U-qualified data are discussed in Section 5.0.

*This page was intentionally left blank.*

# 4.0 CHEMICALS OF POTENTIAL CONCERN

The objective for selecting COPCs is to identify a set of chemicals that are likely to be site-related and reported concentrations that are of acceptable quality for use in the quantitative risk assessment (EPA, 1989a). The process for selecting COPCs for groundwater, surface water and sediment in the study area are defined below.

## 4.1 COMPARISON OF SITE-RELATED DATA TO BACKGROUND DATA

The initial selection of inorganic constituents for evaluation in the risk assessment is based on a statistical comparison of site-related data to background data. A statistical representation of background concentrations will be calculated for all inorganic constituents (see Section 5.0 that describes statistical methods for the derivation of the 95% Upper Confidence Level [UCL] which will be used to describe the representative concentration of background constituents). The initial list of COPCs will be based on a comparison of detected analyte concentrations to representative background concentrations. Inorganic constituents will be considered to be similar to background concentrations if the UCL concentration of the detected site constituent is less than or equal to the background UCL for the selected inorganic constituent. Those inorganic compounds that are within background levels will be eliminated as COPCs.

## 4.2 RISK-BASED CONCENTRATION SCREEN

After screening out chemicals that are not COPCs on the basis of background comparisons, the remaining chemicals will be screened against risk-based concentrations. The purpose of this screening is to make the baseline risk assessment process more efficient by focusing on the dominant chemicals and routes of exposure at the earliest feasible stage.

The risk-based concentration screen includes the following steps:

- The maximum concentration is identified for each chemical detected in each medium.
- The maximum concentration is compared to the Region 6 Media-Specific Screening Criteria (EPA, 2000).
- If a specific chemical exceeds the risk-based concentration for that medium, the chemical is retained for the risk assessment for all routes of exposure involving that medium.
- If a specific chemical does not exceed its risk-based concentration for any medium, the chemical is eliminated from the COPC list.

In addition to the concentration/toxicity screen described above, additional screens will be applied to the groundwater data to evaluate the potential for significant vapor intrusion to future residential basements. The Johnson and Ettinger Model (EPA, 1989b) will be used to derive inhalation screening criteria for detected groundwater constituents. A comparison of screening criteria to detected groundwater constituents will determine the need for a more quantitative evaluation of this pathway.

In addition, surface water constituent concentrations will be compared to TNRCC screening criteria for non-sustainable fisheries (TNRCC, 2000). This comparison will be used to determine the need for a more quantitative evaluation of this pathway.

## 4.3 DETECTION FREQUENCY

In accordance with EPA guidance (EPA, 1989a), consideration of detection frequency will be applied in the selection of COPCs. Chemicals that are detected infrequently (i.e., in less than 5 percent of 20 or more samples) at less than five times the reporting limit will be eliminated from the COPC list. Exceptions are made for Class A carcinogens which remain on the COPC list.

# 5.0 EXPOSURE POINT CONCENTRATIONS

The exposure point concentration is the concentration of a COPC in an exposure medium that may be contacted by a real or hypothetical receptor. Determination of the exposure point concentration depends on factors such as:

- Availability of data
- Amount of data suitable for statistical analysis
- Location of the potential receptor

Measured groundwater concentrations will be used to evaluate current conditions within the aquifers underlying the BRAC property that is being considered for public transfer.

Historical surface water and sediment data will be statistically evaluated to determine conservative constituent concentrations that will be used in the risk assessment. In Superfund risk assessments, the concentration term in the intake equation is an estimate of the arithmetic average concentration for a contaminant based on a set of site sampling results (EPA 1989a and 1992d). Because of the uncertainty associated with estimating the true average concentration at a site, the UCL of the arithmetic mean will be used in the risk assessment if sufficient data are available. If the data are limited, the maximum detected concentration will be used as the exposure point concentration. The UCL provides reasonable confidence that the true site average will not be underestimated.

The EPA has determined that most large environmental contaminant data sets from soil sampling are lognormally distributed rather than normally distributed (EPA, 1992d).

The W test developed by Shapiro and Wilk (Gilbert, 1987; Equations 12.3 and 12.4) will be used to determine whether or not a data set has been drawn from a population that is normally distributed.

The equation that will be used to calculate the UCL for the lognormal distribution is shown below:

$$UCL = e^{\bar{x} + 0.5\left(s^2\right) + sH/\sqrt{n-1}}$$

where:

| | | |
|---|---|---|
| UCL | = | 95 percent upper confidence limit |
| e | = | constant (base of the natural log, equal to 2.718) |
| $\bar{x}$ | = | arithmetic mean of transformed data |
| s | = | standard deviation of the transformed data |
| H | = | H-statistic (Gilbert, 1987) |
| n | = | number of samples |

The equation that will be used to calculate the UCL for the normal distribution is:

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

where:

| | | |
|---|---|---|
| UCL | = | 95 percent upper confidence limit |
| $\bar{x}$ | = | arithmetic mean of the untransformed data |
| s | = | standard deviation of the untransformed data |
| t | = | Student-t statistic (Gilbert, 1987) |
| n | = | number of samples |

In many cases, analytes are below the applicable detection limit in each sample. Non-detected results (U-qualified) are reported as less than the sample quantitation limit (SQL). The chemical may be present at the concentration just below the reported quantitation limit, or it may not be present in the sample at all. For media in which a chemical has been otherwise detected, non-detected results for that chemical will be treated statistically as one-half the SQL as a proxy concentration. This standard conservative approach is used to determine the concentrations most representative of potential exposures.

The statistical methods described in this section are parametric procedures and are intended for use in cases where the percentage of non-detects in a particular data set is less than 50 percent. In the event that the percentage of non-detects for a particular chemical is greater than 50 percent, non-parametric procedures will be applied as appropriate. Procedures for evaluating and applying non-parametric statistics are described in the guidance document *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance* (EPA, 1992a).

# 6.0 HUMAN INTAKE ASSUMPTIONS AND EXPOSURE QUANTIFICATION

This section describes methods that are used for quantifying chronic exposures for exposure pathways identified in the conceptual model. Exposures are determined to characterize the RME, the maximum exposure reasonably expected to occur at the site (EPA, 1989a). If the RME concentration is determined to be below the appropriate threshold, then it is likely that all other lesser exposure concentrations at the site will also be below levels of concern. Exposure parameters that will be used to estimate the RME are provided in Table 1 for groundwater exposure pathways and in Tables 2 and 3 for surface water and sediment, respectively.

## 6.1 GROUNDWATER AND SURFACE WATER INGESTION

A receptor can ingest water by drinking it or through using household water for cooking. An estimate of intake from ingesting water is calculated as follows (EPA, 1989a):

$$I_w = \frac{C_w \cdot IR \cdot FI \cdot ED \cdot EF}{BW \cdot AT}$$

where:

| | | |
|---|---|---|
| $I_w$ | = | intake of contaminant from drinking water (mg/kg/day) |
| $C_w$ | = | concentration of contaminant in water (mg/L) |
| IR | = | ingestion rate (L/day) |
| FI | = | fraction ingested from contaminated source (unitless) |
| EF | = | exposure frequency (days/year) |
| ED | = | exposure duration (years) |
| BW | = | body weight (kg) |
| AT | = | averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)] |

## 6.2 DERMAL CONTACT WITH WATER

The estimate of intake of contaminants in water via absorption through the skin is determined using the concentration of a chemical in the water source evaluated. Evaluation of the dermal absorption pathway is performed for residents and construction workers exposed to groundwater and trespassers, recreational users and maintenance workers exposed to surface water using EPA default exposure parameters. The amount of a chemical taken into the body upon exposure via dermal contact is referred to as an absorbed dose. The absorbed dose is calculated using the dermal guidance contained in EPA 1989a, 1991b, and 1992b:

**Table 1**
**Parameters Used to Estimate Potential Exposures For Groundwater Receptors[a,b]**

| Pathway Parameter | Age-adjusted Resident | Child Resident | Construction Worker |
|---|---|---|---|
| ***Ingestion of Groundwater*** | | | |
| IR (L/day) | 1 8[d] | 1 | 0.1[c] |
| FI (unitless) | 1.0 | 1.0 | 1.0 |
| EF (days/year) | 350 | 350 | 250 |
| ED (years) | 30[d] | 6 | 1[c] |
| BW (kg) | 59 | 15 | 70 |
| AT-Noncancer (days) | 10950[e] | 2190[e] | 250[e] |
| AT-Cancer (days) | 25550[f] | 25550[f] | 25550[f] |
| ***Inhalation of Volatiles from Household Uses of Groundwater*** | | | |
| IR ($m^3$/day) | 15 | 10 | 15 |
| EF (days/year) | 350 | 350 | 250 |
| ED (years) | 30[d] | 6 | 1[c] |
| BW (kg) | 59 | 15 | 70 |
| AT-Noncancer (days) | 10950[e] | 2190[e] | 365[e] |
| AT-Cancer (days) | 25550[f] | 25550[f] | 25550[f] |
| ***Dermal Contact with Groundwater*** | | | |
| SA ($cm^2$) | 20090[g] | 5000 | 2200[g] |
| EF (days/year) | 350 | 350 | 250 |
| ED (years) | 30[d] | 6 | 1[c] |
| BW (kg) | 59 | 15 | 70 |
| AT-Noncancer (days) | 10950[e] | 2190[e] | 250[e] |
| AT-Cancer (days) | 25550[f] | 25550[f] | 25550[f] |
| Kp (cm/hour) | Csv[h] | Csv[h] | csv[h] |
| B (unitless) | Csv[h] | Csv[h] | csv[h] |
| ET (hours) | 0.2 | 0 2 | 4[c] |
| t* (hours) | Csv[h] | Csv[h] | Csv[h] |

[a] Parameter values are intended to characterize the RME The age-adjusted resident is used to evaluate carcinogenic groundwater constituents and the child resident is used to evaluate noncarcinogenic groundwater constituents.
[b] Parameter values obtained from EPA (1991), unless otherwise noted.
[c] Best professional judgement.
[d] EPA (1997a and 1999). "Resident" is a time-weighted-average adult and child resident. Exposure parameters for the resident are calculated based on default values for the adult and child.
[e] Calculated as the product of ED (years) x 365 days/year.
[f] Calculated as the product of 70 years (assumed lifetime ) x 365 days/year.
[g] EPA (1997a). Surface area for the resident includes the entire body surface area. Surface area for the construction worker includes hands and feet.
[h] Chemical specific value.

## Table 2
## Parameters Used to Estimate Potential Exposures For Surface Water Receptors[a,b]

| Pathway Parameter | Trespasser | Maintenance Worker | Recreational User |
|---|---|---|---|
| *Incidental Ingestion of Surface Water* | | | |
| Ingestion Rate (L/day) | 0.005[d] | 0.005[d] | 0.005[d] |
| Exposure Frequency (days/year) | 12[d] | 12[d] | 24[d] |
| Exposure Duration (years) | 6[d] | 24[d] | 10[d] |
| Body Weight (kg) | 56 | 70 | 70 |
| Averaging Time-Noncancer (days) | 2,190[e] | 8,760[e] | 3,650[e] |
| Averaging Time-Cancer (days) | 25,550[f] | 25,550[f] | 25,550[f] |
| *Dermal Exposures to Surface Water* | | | |
| Skin Surface Area ($cm^2$) | 980[g] | 1,120[g] | 1,120[g] |
| Exposure Frequency (days/year) | 12[d] | 12[d] | 24[d] |
| Exposure Duration (years) | 6[d] | 24[d] | 10[d] |
| Body Weight (kg) | 56 | 70 | 70 |
| Averaging Time-Noncancer (days) | 2,190[e] | 8,760[e] | 3,650[e] |
| Averaging Time-Cancer (days) | 25,550[f] | 25,550[f] | 25,550[f] |

[a] Parameter values are intended to characterize the RME.
[b] Parameter values obtained from EPA (1991c), unless otherwise noted.
[c] EPA (1989a).
[d] Best professional judgement.
Ingestion rate estimated as 1/10th the volume of incidental ingestion while wading.
Exposure Frequency: Assumes that the recreational user will visit the site 2 days of every month; trespasser will visit once a month; and maintenance worker will work in the water bodies once a month.
Exposure Duration: Assumes that the recreational user will visit the site for 10 years; the trespasser will visit during the 6 years between age 13 and 18; and the maintenance worker will work for a traditional 24 year working age.
[e] Calculated as the product of ED (years) x 365 days/year.
[f] Calculated as the product of 70 years (assumed lifetime) x 365 days/year.
[g] Based on the surface area of adult hands for the maintenance worker and recreational user and teenage hands and feet for the trespasser

**Table 3**
**Parameters Used to Estimate Potential Exposure**
**For Sediment Receptors**

| Pathway Parameter | Trespasser | Maintenance Worker | Recreational User |
|---|---|---|---|
| *Incidental Ingestion of Sediment* | | | |
| Ingestion Rate (mg/day) | 5[a] | 5[a] | 5[a] |
| Fraction Ingested (unitless) | 1[a] | 1[a] | 1[a] |
| Sediment Exposure Frequency (day/yr) | 12[a] | 12[a] | 24[a] |
| Exposure Duration (years) | 6[a] | 24[a] | 10[a] |
| Body Weight (kg) | 56 | 70 | 70 |
| Averaging Time-Noncancer (days) | 2,190[b] | 8,760[b] | 3,650[b] |
| Averaging Time-Cancer (days) | 25,550[c] | 25,550[c] | 25,550[c] |
| *Dermal Exposures to Sediment* | | | |
| Skin Surface Area ($cm^2$) | 980[d] | 1,120[d] | 1,120[d] |
| Skin Adherence Factor ($mg/cm^2$) | 0.3[e] | 0.08[e] | 0 08[e] |
| Absorption Factor (unitless) | Chemical-specific[f] | Chemical-specific[f] | Chemical-specific[f] |
| Exposure Frequency (days/year) | 12[a] | 12[a] | 24[a] |
| Exposure Duration (years) | 6[a] | 24[a] | 10[a] |
| Body Weight (kg) | 56 | 70 | 70[d] |
| Averaging Time-Noncancer (days) | 2,190[b] | 8,760[b] | 3,650[b] |
| Averaging Time-Cancer (days) | 25,550[c] | 25,550[c] | 25,550[c] |

[a] Best professional judgment
Ingestion rate is 1/10[th] of the adult soil ingestion rate.
Fraction Ingested: For RME, it is assumed that 100 percent of the sediment ingested on days that the site is visited.
Exposure Frequency Assumes the recreational user visits the site two days each month, trespasser will visit once a month, and maintenance worker will work in the water body once a month.
Exposure Duration· Assumes the recreational user visits the site for 10 years, trespasser will visit during the 6 years between age 13 and 18; and the maintenance worker will work for a traditional 24 year working age.

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

[c] Calculated as the product of 70 years (assumed lifetime) x 365 days/year

[d] EPA (1997a). Surface area based on adult hand surface area for recreational user and maintenance worker and teenage hand for trespasser.

[e] EPA, 1998b Adherence factor for trespasser based on child default value; value for maintenance worker and recreational user is based on adult default value.

[f] EPA, 1998b

$$I_w = \frac{D_{event} \cdot SA \cdot EF \cdot ED}{BW \cdot AT}$$

where:

| | | |
|---|---|---|
| $I_w$ | = | intake through skin from showering or wading (mg/kg/day) |
| $D_{event}$ | = | absorbed dose per event (mg/cm²-event) |
| SA | = | skin surface area (cm²) |
| EF | = | exposure frequency (days/year) |
| ED | = | exposure duration (years) |
| BW | = | body weight (kg) |
| AT | = | averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)] |

$D_{event}$ can be calculated as:

$$D_{event} = C_v \cdot 2 \cdot K_p \cdot CF\,[(6 \cdot TAO \cdot ET)/\pi]^{+0.5}\ if\ ET < t^*,$$

or

$$D_{event} = C_v \cdot K_p \cdot CF\,[ET + (2 \cdot TAO\,(1 + 3B))]/(1 + B)\ if\ ET > t^*$$

where:

| | | |
|---|---|---|
| $C_w$ | = | concentration of constituent in water (mg/L) |
| $K_p$ | = | permeability constant (cm/hour) |
| TAO | = | lag time (hour) |
| B | = | partitioning coefficient (unitless) |
| ET | = | exposure time (hours) |
| $\pi$ | = | Pi (3.14) |
| $t^*$ | = | time to equilibrium conditions (hours) |
| CF | = | conversion factor (0.001 L/cm³) |

## 6.3 INHALATION OF VOLATILES RELEASED FROM GROUNDWATER

The amount of a chemical taken into the body via exposure to volatilization of chemicals is evaluated using the concentration of a chemical in the water source (EPA, 1991a). Intake from the volatilization of chemicals in household water is calculated using the Andelman model (EPA, 1991a):

$$I_w = \frac{C_w \cdot K \cdot IR_i \cdot EF \cdot ED}{BW \cdot AT}$$

where:

$I_w$ = intake of volatile in water from inhalation (mg/kg/day)
$C_w$ = concentration of contaminant in water (mg/L)
K = volatilization factor (0.5 L/m$^3$)
$IR_i$ = inhalation rate (m$^3$/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

This exposure pathway will only be evaluated for organic chemicals with a Henry's Law constant greater than 1 x $10^{-5}$ and with a molecular weight of 200 g /mole or less (EPA, 1991a).

## 6.4 INCIDENTAL INGESTION OF SEDIMENT

The estimation of intake of contaminants in sediment is determined using the concentration in sediment at the location of interest (EPA, 1989b).

$$I_s = \frac{C_s \cdot IR \cdot CF \cdot FI \cdot EF \cdot ED}{BW \cdot AT}$$

where:

$I_s$ = intake from sediment (mg/kg-day)
$C_s$ = concentration of contaminant in sediment (mg/kg)
IR = ingestion rate (g/day)
CF = conversion factor ($10^{-3}$ kg/g)
FI = fraction ingested from contaminated source (unitless)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

## 6.5 DERMAL CONTACT WITH SEDIMENT

The estimation of intake of organic contaminants in sediment via absorption through the skin is determined using the concentration in sediment at the location evaluated (EPA, 1991b).

$$AB_s = \frac{C_s \cdot CF \cdot SA \cdot AF \cdot ABS \cdot EF \cdot ET \cdot ED}{BW \cdot AT \cdot TC}$$

where:

| | | |
|---|---|---|
| $AB_s$ | = | amount of constituent absorbed during contact with sediment (mg/kg-day) |
| $C_s$ | = | concentration of constituent in sediment (mg/kg) |
| SA | = | skin surface area available for contact ($cm^2$/event) |
| AF | = | skin adherence factor ($mg/cm^2$) |
| ABS | = | absorption factor (unitless) |
| CF | = | conversion factor ($10^{-6}$ kg/mg) |
| EF | = | exposure frequency (events/year) |
| ET | = | event time (hours/day) |
| TC | = | time conversion (24 hours/day) |
| ED | = | exposure duration (years) |
| BW | = | body weight (kg) |
| AT | = | averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)] |

Chemical-specific ABS will be presented upon the selection of COPCs.

*This page was intentionally left blank.*

# 7.0 TOXICITY ASSESSMENT

The toxicity assessment describes appropriate toxicity values that are used to generate estimates of potential health risks associated with chemical exposure. This is accomplished by identifying appropriate sources of toxicity values and reviewing available information to identify the most appropriate values to use in the assessment. In addition, the toxicity assessment provides the basis for developing summaries of the potential toxicity of the COPCs for inclusion in the risk assessment. This is accomplished by reviewing available information on the toxicity of the COPCs and summarizing the factors pertinent to the exposures being assessed.

Toxicity values used in the risk assessment are provided by the EPA (2000). The data used by the EPA to guide the derivation of cancer slope factors (SFs) for carcinogenic effects and reference doses (RfDs) for noncarcinogenic effects may include epidemiological studies, long-term animal bioassays, short-term test, and comparisons of molecular structure. Data from these sources are reviewed to determine whether a chemical is likely to be toxic to humans. Because of the lack of available human studies, however, the majority of toxicity data used to derive SFs and RfDs come from animal studies.

The most appropriate animal model, i.e., the species biologically most similar to the human, is identified in the development of the RfD. In the absence of sufficient data to identify the most appropriate animal model, the most sensitive animal species is chosen. The RfD is generally derived from the most comprehensive toxicology study that characterizes the dose-response relationship for the critical effect of the chemical. Preference is given to studies using the exposure route of concern. In the absence of such data, however, an RfD for one route of exposure may be extrapolated from study data that was generated using a different route of exposure. Uncertainty factors are applied to the highest no observed adverse effect level (NOAEL) to adjust for inter- and intraspecies variation, deficiencies in the toxicological database, and use of short-term rather than long-term animal studies.

SFs are classified in different groups according to the amount of evidence available that points to the chemicals carcinogenicity. Weight-of-evidence Group A (human carcinogen) or Group B (probable human carcinogen) chemicals are generally derived from cancer studies that adequately identify positive results, identify the target organ in the test animal, and characterize the dose-response relationship. SFs for Group C (possible human carcinogen) chemicals are derived when data are sufficient, but are not derived for Group D (not classified) or E (evidence of noncarcinogenicity) chemicals.

The toxicity assessment will include a list of toxicity values for both carcinogenic and noncarcinogenic effects and toxicity profiles that summarize the data used to derive the toxicity values.

*This page was intentionally left blank.*

# 8.0 RISK CHARACTERIZATION

The purpose of the risk characterization step is to integrate the exposure and toxicity assessments to generate quantitative expressions of cancer risk and noncancer hazard. The risk characterization is performed in accordance with EPA risk assessment guidelines (EPA, 1989a). To characterize potential noncarcinogenic effects, comparisons are made between projected intakes of chemicals and toxicity values. To characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure are estimated from projected intakes and chemical-specific dose-response information.

Risk characterization serves as the bridge between risk assessment and risk management and is, therefore, a key step in the ultimate site decision-making process. This step summarizes risk assessment information for the risk manager to consider with other factors important for decision-making such as economics, technical feasibility, and regulatory context. The following sections provide separate discussions for carcinogenic and noncarcinogenic effects because the methodology differs for these two modes of chemical toxicity. In addition to providing methods for calculating risk estimates, this section provides information for the interpretation of results with regard to the uncertainty associated with the estimates (EPA, 1989a).

## 8.1 CARCINOGENIC RISK ESTIMATES

Cancer risk will be compared to a target risk range of $1x10^{-6}$ to $1x10^{-4}$. Total cancer risk from all exposures can be summed:

$$Total\ Cancer\ Risk = \Sigma\ Cancer\ Risk_i$$

where:

Total Cancer Risk = Total lifetime cancer risk from exposures to all chemicals (unitless)

$Cancer\ Risk_i$ = Lifetime cancer risk from exposures to chemical contaminant $i$ ($i$=1...n) (unitless)

Cancer risk from exposures to chemical contaminants can be estimated using the equation:

$$Cancer\ Risk_i = I_i \cdot SF_i$$

where:

$Cancer\ Risk_i$ = lifetime cancer risk (unitless) from chemical contaminant $i$ ($i$=1...n)

$I_i$ = total daily intake of contaminant $i$ ($i$=1...n) from indirect exposures (mg/kg/day)

$SF_i$ = slope factor ($[mg/kg/day]^{-1}$) for chemical contaminant $i$ ($i$=1...n)

## 8.2 NONCANCER HAZARD ESTIMATES

The hazard index (HI) will be used to evaluate noncancer risk for any given target organ. The target HI is 1. The Hazard Quotient (HQ) is used to evaluate noncancer toxicity of individual chemical contaminants. The HQ represents the ratio of the dose received by the exposed individual to the dose that is associated with no adverse effects, i.e. the threshold or RfD. HQs that affect the same target organ (i.e., liver, kidney, etc.) are summed to obtain a HI for an individual target organ. The HI can be estimated using the equation:

$$HI = \Sigma HQ_i$$

where:

| | | |
|---|---|---|
| HI | = | hazard index (unitless) |
| $HQ_i$ | = | hazard quotient for chemical $i$ ($i$=1...n) (unitless) |

The HQ for exposures to chemical contaminants which have noncancer health effects can be estimated using the equation below:

$$HQ_i = \frac{I_i}{RfD_i}$$

where:

| | | |
|---|---|---|
| $HQ_i$ | = | hazard quotient for chemical $i$ ($i$=1...n) (unitless) |
| $I_i$ | = | total daily intake from exposures to chemical contaminant $i$ ($i$=1...n) (mg/kg/day) |
| $RfD_i$ | = | reference dose for chemical $i$ ($i$=1...n) (mg/kg/day) |

## 8.3 DEVELOPMENT OF RISK MAPS

In order to generate risk maps (i.e., risk isopleth maps), it is necessary to calculate an estimate of risk for every location on the site map. For example, if a plume of TCE is found in one area at concentrations that range form $1.6 \times 10^{-3}$ mg/L to $1.6 \times 10^{-1}$ mg/L, a corresponding risk map will describe the TCE as a risk plume ranging in cancer risk from approximately $1 \times 10^{-6}$ to $1 \times 10^{-4}$ for residential receptors. This can be accomplished by calculating a unit risk value (risk per mg/L) for each COPC and multiplying that value by every concentration value at each point in a concentration plume map for the same COPC. These risk estimates will be contoured in the same manner as the concentration contours. A similar procedure will be followed for noncarcinogens using unit HI values.

Contaminant Risk Maps will be created for each of the following risk scenarios:

1) Cancer/Resident
2) Noncancer/Resident
3) Cancer/Construction Worker

4) Noncancer/Construction Worker

In addition to selected COPC-specific risk maps, total risk maps combining cancer risk for all COPCs, and total hazard maps combining noncancer hazard for all noncarcinogenic COPCs will be prepared for each exposure scenario.

## 8.4 UNCERTAINTY ASSESSMENT

Calculated risk estimates are subject to varying degrees of uncertainty from a variety of sources. Areas of uncertainty in a risk assessment can be categorized as: 1) generic or methodological, and 2) site-specific. Methodological uncertainties are those that are inherent to the methods or procedures used for risk assessments, that is, policy decisions made to reflect the EPA's desire to error on the side of conservatism. Site-specific areas of uncertainty are those characteristics of the site or the investigation of the site that could result in over- or underestimates of risk. The assessment of uncertainty will be qualitative. The most significant sources of uncertainty in the risk assessment will be itemized and qualitatively evaluated for their potential to contribute to either the over- or underestimation of risk.

*This page was intentionally left blank.*

# 9.0 ECOLOGICAL RISK ASSESSMENT

A quantitative assessment of potential ecological risks associated with COPCs will be performed as part of risk assessment. A preliminary evaluation of existing data indicate that groundwater is the primary environmental media of concern. However, groundwater is found to intercept surface-water bodies in the study area. Since surface water and sediment are potentially complete exposure pathways for ecological receptors, an ecological risk assessment will be included.

The State of Texas has recently published ecological risk assessment guidance (TNRCC, 2000a). This guidance applies to sites regulated within the TNRCC Remediation Division. Although this site is regulated under CERCLA, and since this guidance mirrors the EPA's Ecological Risk Assessment Guidance for Superfund (EPA, 1997c), the TNRCC guidance will be used as the primary guidance document used in performing this ecological risk assessment.

The TNRCC ecological risk assessment methodology is a tiered approach to assessing ecological risk. Tier 1 is an exclusion criteria checklist. If the site does not meet the exclusion criteria, a Tier 2, screening-level ecological risk assessment, will be conducted. The Tier 2 assessment will include:

1) A comparison of detected constituent concentrations for non-bioaccumulative COPCs to established ecological benchmarks.
2) Identify communities and major feeding guides and their representative species which are supported by habitats at the site.
3) Develop a conceptual model which graphically depicts the movement of COPCs through media to communities and the feeding guides.
4) Discuss COPC fate and transport and toxicological profiles.
5) Prepare a list of input data which includes values from the literature (e.g., exposure factors, intake equations, NOAEL, and lowest observed adverse effect level (LOAEL) values, references) and reasonably conservative exposure assumptions, and then calculate the total exposure to selected ecological receptors from each COPC not eliminated according to item number 1.
6) Utilize an ecological HQ methodology to compare exposures to NOAELs in order to eliminate COPCs that pose no unacceptable risk (i.e., NOAEL HI $\leq$1). If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.
7) Less conservative assumptions for exposure may be applied and the HQs re-calculated. If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.
8) Develop an uncertainty analysis which discusses the major areas of uncertainty associated with the screening level ecological risk assessment. If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.

9) Calculate medium-specific protective concentration levels (PCLs) bounded by NOAELs and LOAELs for those COPCs which are not eliminated as a result of the HQ exercises or the uncertainty analysis.
10) Make recommendations for managing ecological risk at the site based on final PCLs. Recommendations can also be made for proceeding with a Tier 3 evaluation.

## 10.0 REFERENCES

Gilbert, R.O., 1987, Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York, NY.

Kao, J.K., F. K. Patterson, and J. Hall, 1985, Skin Penetration and Metabolism of Topically Applied Chemicals in Six Mammalian Species, Including Man: An *In Vitro* Study with Benzo(a)pyrene and Testosterone. Toxicology and Applied Pharmacology. Vol 81:502-516.

Ryan, E.A., E.T. Hawkins, et al., 1987, Assessing Risk from Dermal Exposure at Hazardous Waste Sites. In: Bennett, G. and J. Bennett, eds. Superfund '87: Proceedings of the Eighth National Conference; November 16-18; Washington, D.C. The Hazardous Materials Control research Institute. pp.166-168.

Skowronski, G.A., R. M. Turkall, and M.S. Abdel-Rahman, 1988, Soil Adsorption Alters Bioavailability of Benzene in Dermallly Exposed Male Rats. American Industrial Hygiene Association Journal. Vol 49(10):506-511.

Texas Natural Resource Conservation Commission (TNRCC), 2000, Ecological Risk Assessment and Development of Ecological Protective Concentration Levels. (Chapter 350 - Texas Risk Reduction Program - §350.77)

U.S. Environmental Protection Agency (EPA), 2000, Region 6 Media-Specific Screening Criteria Tables.

U.S. Environmental Protection Agency (EPA), 1998a, Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments). Solid Waste and Emergency Response, Washington, DC. OSWER 9285.7-01D.

U.S. Environmental Protection Agency (EPA), 1998b, Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment. NCEA-W-0364. External Review Draft.

U.S. Environmental Protection Agency (EPA), 1997a, Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, DC. PB 98-124217.

U.S. Environmental Protection Agency (EPA) 1997c, Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Solid Waste and Emergency Response. EPA 540/R-97/006.

U.S. Environmental Protection Agency (EPA) 1995a, Review of a Methodology for Establishing Risk-Based Soil Remediation Goals for Commercial Areas of the California Gulch Site. Technical Review Workgroup for Lead, October 26, 1995.

U.S. Environmental Protection Agency (EPA), 1995b, Region III Technical Guidance Manual: Assessing Dermal Exposure from Soil. Office of Superfund Programs, Hazardous Waste Management Division. EPA/903/K-95/003.

U.S. Environmental Protection Agency (EPA), 1995c, Supplemental Region VI Risk Assessment Guidance. Dallas, TX.

U.S. Environmental Protection Agency (EPA), 1994a, Uptake/Biokinetic Model, Version 0.99. Office of Health and Environmental Assessment, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA), 1994b, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. Office of Solid Waste and Emergency Response, Washington, DC. (OSWER Directive #9355.4-12) EPA/540/F-94/043.

U.S. Environmental Protection Agency (EPA), 1992a, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance, Office of Solid Waste Management Division, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1992b, Dermal Exposure Assessment: Principles and Applications. Office of Research and Development, Washington, DC. EPA/600/8-91/011B.

U.S. Environmental Protection Agency (EPA), 1992c, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment, Interim Guidance. Office of Emergency and Remedial Response, Washington, DC. August 18.

U.S. Environmental Protection Agency (EPA), 1992d, Supplemental Guidance to RAGS: Calculating the Concentration Term. Office of Emergency and Remedial Response, Washington, DC. Publication #9285.7-081.

U.S. Environmental Protection Agency (EPA), 1991a, Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual, Part B, Development of Risk-Based Preliminary Remediation Goals. Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1991b, Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual, Supplemental Guidance: Dermal Risk Assessment Interim Guidance. Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1991c, Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual, Supplemental Guidance: Standard

Default Exposure Factors. Office of Emergency and Remedial Response, Washington, DC. OSWER Directive 9285.6-03.

U.S. Environmental Protection Agency (EPA), 1990, National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule. 40 CFR Part 300, March 8.

U.S. Environmental Protection Agency (EPA), 1989a, Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual, Part A. Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002.

U.S. Environmental Protection Agency (EPA), 1989b, Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, DC. EPA/600/8-89/043.

# FINAL PAGE

## ADMINISTRATIVE RECORD

FINAL PAGE