FINAL

RCRA FACILITY INVESTIGATION REPORT
WEST BRINE FIELD

ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

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LIST OF PLANS AND ATTACHMENTS

LIST OF ACRONYMS

AA	Atomic Absorption Spectrophotometer
AISL	Part 201 Generic Acute Inhalation Screening Levels
AMSL	Above Mean Sea Level
ANPR	Advance Notice of Proposed Rulemaking
AOC	Area of Concern
ASTM	American Society for Testing and Materials
BGS	Below Ground Surface
CAP	Corrective Action Program
CDDs	Chlorinated Dibenzo-p-Dioxins
CDFS	Chlorinated Dibenzofurans
CFR	Code of Federal Regulations
CLP	U.S. EPA Contract Laboratory Program
COPC	Contaminant of Potential Concern
CRA	Conestoga-Rovers & Associates, Inc.
CRDL	Contract Required Detection Limit
CSF	Cancer Slope Factor
CSO	Combined Sewer Overflow
DCC	Part 201 Generic Industrial Direct Contact Criteria
DEHA	Diethyihydroxylamine
DMP	Data Management Plan
DNAPL	Dense Non-Aqueous Phase Liquid
DOCC	Description of Current Conditions Report
DOT	U.S. Department of the Interior
DOT	U.S. Department of Transportation
EDQL	Ecological Data Quality Level
EHQ	Exposure Route Hazard Quotient
EMSOFT	USEPA Exposure Model for Soil Organic Fate and Transport
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
FESL	Part 201 Generic Flammability and Explosivity Screening Levels
FS	Feasibility Study
GC	Gas Chromatograph
GC /MS	Gas Chromatograph /Mass Spectrometer
GCC	Part 201 Generic Industrial Groundwater Contact Criteria
GCPC	Part 201 Generic Industrial Groundwater Contact Protection Criteria
GPR	Ground Penetrating Radar

LIST OF ACRONYMS (CONT'D)

GSI	Part 201 Groundwater Surface Water Interface Criteria
GVIIC	Part 201 Generic Industrial Groundwater Volatilization to Indoor Air Inhalation Criteria
HASP	Health and Safety Plan
HEAST	Health Effects Summary Tables
HI	Hazard Index
HPLC	High Performance Liquid Chromatography
HQ	Hazard Quotient
HSI	Habitat Suitability Index
HSL	Hazardous Substance List
ICP	Inductively Coupled Plasma Spectrometer
IRIS	U.S. EPA Integrated Risk Information System
IRM	Interim Remedial Measure
LNAPL	Light Non-Aqueous Phase Liquid
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MIRIS	Michigan Resource Information System
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSA	Methane Sulfonic Acid
MSAM	Methane Sulfonamide
MSC	Methane Sulfonyl Chloride
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OMEE	Ontario Ministry of the Environment and Energy
OPP	Organophosphate Pesticide
ORNL	Oak Ridge National Laboratory
OSWER	U.S. EPA Office of Solid Waste and Emergency Response
OVA	Organic Vapor Analyzer
OVM	Organic Vapor Monitor
PAHs	Polyaromatic Hydrocarbons
PAM HEP	Pennsylvania Modified Habitat Evaluation Process
PCBs	Polychlorinated Biphenyls
PCDDs	polychlorinated Dibenzo-p-Dioxins
PCDFs	polychlorinated Dibenzofurans

PID	Photoionization Detector
PRG	USEPA Region IX Preliminary Remediation Goal
PSIC	Part 201 Generic Industrial Particulate Soil Inhalation Criteria
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAP	Remedial Action Plan
RBCs	Risk-Based Calculations
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference
SEMCOG	Southeast Michigan Council of Governments
SI	Site Investigation
SL	Screening level
SOW	Scope of Work
SQL	Sample Quantitation Limit
STL	Severn Trent Laboratories
SVIIC	Part 201 Generic Industrial Soil Volatilization to Indoor Air Inhalation Criteria
SVOCs	Semi-volatile Organic Compounds
SWMU	Solid Waste Management Unit
SWQD	MDEQ Surface Water Quality Division
TAL	Target Analyte List
TCDDs	Tetrachlorinated Dibenzo-p-Dioxins
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TICs	Tentatively Identified Compounds
TWG	Technical Work Group
UCL	Upper Confidence Limit
UGLCCS	Upper Great Lakes Connecting Channels Study
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Services
USGS	U.S. Geological Survey
UTL	Upper Tolerance Limit

LIST OF ACRONYMS (CONT'D)

VOCs	Volatile Organic Compounds
VSI	Visual Site Investigation
VSIC	Part 201 Generic Industrial Ambient Air Infinite Source Volatile Soil Inhalation Criteria
WELUT	Western Land Use Team
Weston	Roy F. Weston, Inc.
Weston EMD	Roy F. Weston Environmental Metrics Division
Weston EMI	Roy F. Weston Environmental Metrics, Inc. laboratory
Weston ETL	Roy F. Weston Environmental Technology Laboratory
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report presents the evaluation of information obtained during the Phase I RFI conducted by Roy F. Weston, Inc. (Weston) and the Phase II RFI conducted by Conestoga-Rovers & Associates (CRA) for the West Brine Field located in Riverview, Michigan (Site).

The Site location is presented on Figure 1.1. The Site layout is presented on Figure 1.2.

The purpose of this RFI Report is to respond to Attachment III, Tasks IV, V and VI, of the final Consent Order (dated September 21, 1989) between the United States Environmental Protection Agency (U.S. EPA) Region 5 and Pennwalt Corporation, subsequently known as Elf Atochem NA, currently known as ATOFINA Chemicals, Inc.'. Tasks V and VI require that the information obtained from Task IV (the Phase I and Phase II RFIs) be presented to the U.S. EPA in a comprehensive document. As agreed to during the September 22, 1998 meeting between the U.S. EPA and ATOFINA Chemicals, Inc., all results from the Phase I and Phase II RFIs are being presented in this RFI Report.

The Consent Order requires ATOFINA Chemicals, Inc. to conduct a RFI to determine whether a release of hazardous wastes or constituents has occurred from regulated units, solid waste management units (SWMUs), or other source areas into soils and, possibly, surface water and/or groundwater; to determine the nature and extent of any releases; and to determine potential risk to human and ecological receptors, if any.

The following sections provide a background to the completion of the Phase I and Phase II REIs.

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[1] On December 31, 1989, Pennwalt Corporation underwent a corporate reorganization. Certain affiliate companies were merged into and with Pennwalt Corporation, which was the surviving corporation. The name of Pennwalt Corporation was changed to Elf Atochem NA. Elf Atochem NA became ATOFINA Chemicals, Inc. on June 19, 2000.

1.1 PROJECT BACKGROUND

Phase I RFI Background

As specified in Attachment III, Task III, of the final Consent Order, the focus of Phase I involved an investigation of the environmental setting (on-Site and regional hydrogeology, soils, and surface water/sediment); a source characterization; and a study to identify potential receptors, if any, at the West Brine Field.

The RFI Phase I activities were performed by Weston in accordance with the *P.11 Work Plan—Phase I* (Weston, revised August 1996) approved by the U.S. EPA in August 1996.
RFI Phase I field activities were conducted from September 1996 through March 1997.

The Draft Phase I RFI Report was submitted to the U.S. EPA in September 1997 in accordance with Tasks V and VT of the final Consent Order. As noted above, as agreed to during the September 22, 1998 meeting between the U.S. EPA and ATOFINA Chemicals, Inc., the Draft Phase I RFI Report was not finalized and, instead, all results from the Phase I and Phase TI RFIs are being presented in this RFI Report.

Phase II RFI Background

As specified in Attachment III, Task III, of the final Consent Order, the focus of the Phase II RFI involved a focussed SWMU/Area characterization based upon the results of the Phase I RFI. Specifically, the characterization primarily focussed on delineating the horizontal and vertical extent of the SWMUs and other potentially impacted areas (herein called "Areas") identified during the Phase I RFI, and obtaining data to supplement that collected during the Phase I RFI. The Phase II RFI also encompassed the preparation of a risk assessment to evaluate potential risks to human and ecological receptors.

The RFI Phase TI activities were performed in accordance with the *P.11 Work Plan-Phase II* (Weston, revised September 1999), as approved by the U.S. EPA in August 1999. RFI Phase IT field activities were conducted from October 1999 to February 2000.

1.1.1 SITE REGULATORY BACKGROUND

Historically, the ATOFINA Chemicals, Inc. Riverview Plant included parcels known as the West Plant, West Brine Field, and East Plant. The address for the Riverview plant is

ATOFINA Chemicals, Inc., Riverview Plant, 17168 West Jefferson Avenue, Riverview, MI 48192.

The following is a list of primary contacts with regard to the West Brine Field RFI:

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1.1.2 SITE DESCRIPTION

The West Brine Field is presently part of the Riverview operating facility and is currently an undeveloped, open/grassed and slightly to highly vegetated, area. The West Brine Field is approximately 92 acres in size and is bounded to the north, west, south, and east by Pennsylvania Avenue, Clark Avenue, Colvin Avenue, and Electric Avenue, respectively. It also includes two smaller parcels south of Colvin Avenue, on either side of McKinley Street. The West Brine Field property is currently surrounded by an approximately 7-foot high fence, and access to the Site is restricted to ATOFINA Chemicals, Inc. authorized personnel only. The location of the West Brine Field is shown on Figure 1.1. Electric Avenue, railroad easements, and the West Plant bound the West Brine Field to the east. To the west and south, residential areas bound the West Brine Field. The northern boundary borders light industrial and residential areas. A general Site layout and the topography of the Site are presented on Figure 1.2. The West Brine Field is located in Riverview, Michigan. The Site is generally flat and is bisected by Huntington Drain, which flows from west to east.

As presented in the following section, the West Brine Field was used primarily in the past for supplying brine solution to the East Plant.

1.1.3 HISTORY OF SITE OPERATIONS

The West Brine Field property consists of a portion of one parcel that Pennwalt acquired from Sharples Chemicals in 1955. There are 12 closed brine wells located on the Site, along with their associated piping and a brine storage tank. In the past, salt brine was pumped (i.e., the solution was mined) from production wells installed in the region's natural salt deposits in the West Brine Field area. The salt brine was used as a raw material to produce hydrogen, chlorine, and caustic for the chlor-caustic process in the former East Plant. These products were purified and packaged for shipment from facilities at the former East Plant. The salt brine production well system consisted of wells spaced over the West Brine Field north of Colvin Avenue, and ancillary piping and equipment for extraction. In addition, a brine holding tank was located in the southern part of the West Brine Field (north of Colvin Avenue) near the pumphouse to support operation of the salt brine production well system. All of the brine wells were abandoned (plugged and cemented) in 1986 after the East Plant was shut down.

Additional production at the West Brine Field consisted of an area in the southern portion of the Site that was used for activities supporting the production of nonic compounds (Process 40). This operation was discontinued in 1962, and the facilities were subsequently dismantled. Other areas of the West Brine Field, including one of the smaller parcels south of Colviri Avenue, were used in the past for disposal of materials from processes conducted at the West Plant. These areas are discussed in more detail in Section 1.1.5 of this Report.

1.1.4 PREVIOUS INVESTIGATIONS AND CORRECTIVE ACTION ACTIVITIES

Previous corrective action at the Site involved SWMU 2. In July 1994, a RCRA Corrective Action, Interim Measures Work Plan (Interim Work Plan) was submitted by Weston on behalf of ATOFINA Chemicals, Inc. for the pre-excavation investigation activities and the removal of drums located at SWMU 2 (Weston, 1994). In July 1994, TJ.S. EPA Region 5 approved the Interim Work Plan of which the pre-excavation activities were performed by Weston from September *13* to 22, 1994. 'During pre-excavation activities, waste characterization sampling of source soils and groundwater showed that the material was characteristically hazardous due to the presence of benzene in soil. No metals issues were identified in the source soils or

groundwater within the SWMU. Removal actions were performed during the period of February to June 1995. All soil samples collected following SWMU 2 remediation were below applicable clean-up levels. The results of the work performed at SWMTJ 2 were presented in two separate documents: RCRA Facility Investigation/Corrective Action Interim Investigation Report for Former Landfill 2 (SWMU 2) (Weston, 1995a); and Interim Remedial Measure Corrective Action Report for Former Landfill 2 (SWMU 2) (Weston, 1995b).

1.1.5 SOURCE AREAS

SWMUs/Areas identified at the West Brine Field, as specified in the West Brine Field scope of work (SOW) listed in Attachment III, Table 2, of the Consent Order, are listed in Table 1.1 of this Report. In addition, Table 1.1 presents information on the activities from which these SWMUs/Areas were associated, and the materials that were contained in those SWMUs/Areas. The existence and contents of these SWMUs/Areas were determined based on a review of Site records, historical maps, historical aerial photographs, employee interviews, and visual inspections as presented in the Description of Current Conditions Report (DOCC) (Weston, 1990). This was the basis for the selection of the SWMUs/Areas to be included in the Consent Order and to be investigated as part of the RFI.

The majority of the scope of the RFI, pursuant to Attachment III, Task III, of the Consent Order, is to provide additional information concerning whether a release of hazardous substances has occurred from a SWMU/Area, and the nature and extent of constituents, if any, pertaining to these SWMUs/Areas.

As shown in Table 1.1, materials within SWMUs 1, 3 and 4 and Area 7 are believed to have been from Process 12 (amylphenol filter cake and drummed still bottoms) and Process 22 (Vultacs - polyamyl phenol disulfides) from the West Plant. As presented in Appendix A (Field Investigation Summaries), each type of waste encountered in SWMUs 1, 3 and 4 and Area 7 was sampled. For the purposes of this document, waste is defined as industrial-related substances encountered in a SWMU/Area and sampled as part of the RFI. Section 4.0 presents results of waste samples collected from each SWMU. No waste samples were collected from SWMU 2 as a removal action was completed there in 1995 (see Section 1.1.4).

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1.2 OVERVIEW AND OBJECTIVES

The overall objective of this RFI Report is to present the results of Phases I and II of the RFI for the West Brine Field, which consisted of an investigation of the Site and regional hydrogeology, soils, groundwater, surface water and sediment; quantification of the extent of groundwater, soil, and SWMU/Area contamination; identification of potential receptors that could be impacted by identified constituents; and development of a human health and ecological risk assessment to evaluate hazards or risks potentially posed to humans or ecological receptors by the residual materials detected at the Site.

The primary objectives of the RFI Phase I, listed according to specific project plans outlined in the RFI Phase I Work Plan, were as follows:

- Environmental Setting Plan—Collect additional information and evaluate Site hydrogeology, geology, and hydrology to supplement and verify information regarding the environmental setting at the West Brine Field. This included an evaluation of Site hydrogeology, soils, surface water, and sediment.

- Potential Receptor Identification Plan—Collect data to describe the human populations and environmental systems that are susceptible to potential exposure from the West Brine Field This included the collection and review of existing data regarding chemical analysis of biological data and observable effects on ecosystems.

- Source Characterization Plan—Collect data to describe and characterize the SWMUs/Areas and the materials they contain. The objectives were to use this information, in conjunction with other information collected during the investigation, to determine if a release had occurred, and to characterize an identified release as to the size, rate, and hazardous constituents involved, if any.

Following the completion of the Phase I RFI, additional data was required to achieve the objective of the Phase I RFI Source Characterization Plan. As such, the Phase II RFI Work Plan was developed and implemented. The primary objective of the RFI Phase II, consistent with the RFI Phase TI Work Plan, was as follows:

- Constituent Characterization and Supplemental Source Characterization Plan—Collect data to define the extent, origin, direction, and rate of movement of constituents. This characterization was conducted with respect to SWMUs or Areas characterized in the Phase I RFI as potentially impacting Site soils and/or groundwater (based on comparison of data to screening levels). Groundwater, soil,

surface impoundments, air, and subsurface gas media were addressed. Additional data was collected to describe and characterize contents of some SWMUs not sufficiently characterized during Phase I. The objectives were to use this information, in conjunction with other information collected during the investigation, to determine whether a release of hazardous substances has occurred from a SWMU/Area, and the nature and extent of constituents at the Site.

Table 1.2 lists the SWMUs/Areas investigated and the specific objectives for each SWMU/Area as part of the RFI. The specific scope of work completed for the Phase I and Phase II investigations is presented in Section 2.

SWMU 2 was investigated previously under an investigative and corrective action program implemented prior to the RFI. During the RPI, depressions were observed west of SWMU 1 adjacent to Colvin Avenue. This Area was sampled as part of this program and is referred to as Area 7 in this report.

The secondary objectives of RFI Phases I and II, listed according to specific project plans presented in the Phase I and Phase II RFI Work Plans, are as follows:

- Project Management Plan—Adhere to the overall technical approach, management plan, and schedule for the RFI Phase II as presented in this section of the Work Plan.

- Data Collection Quality Assurance (QA) Plan—Use specified project methods and procedures to ensure that all information, data, and resulting decisions are technically sound, statistically valid, and properly documented.

- Data Management Plan (DMP)--Use specified project methods to document and track investigation data and results, including the identification and setup of data documentation materials and procedures, project file requirements, and project-related progress-reporting procedures and documents.

- Health and Safety Plan (HASP) —Use specified procedures and protocols that were implemented to ensure the health and safety of all Weston personnel and CRA personnel. subcontractors, and ATOFINA Chemicals, Inc. personnel during RFI field activities.

- Community Relations Plan—Use specified techniques to distribute information to the public regarding investigation activities and results.

1.3 REPORT ORGANIZATION

This RFI Report is comprised of the following sections:

- Section 1.0 - Introduction
- Section 2.0 - Investigation Activities (overview of the investigation activities)
- Section 3.0 - Environmental Setting (discussion of the environmental setting and pathways, including a potential receptor study and evaluation of screening levels)
- Section 4.0 - Results of Investigations (results of the source characterization and delineation for the Phase I and Phase II investigations)
- Section 5.0 - Data Quality (a discussion of data quality issues)
- Section 6.0 - Risk Assessment (human health and ecological risk assessment)
- Section 7.0 - Conclusions/Recommendations (the overall conclusions and recommendations of the RFI)
- Section 8.0 - References (lists references used in conjunction with preparation of this RFI Report)

In addition, the following appendices and attachments are provided with this report (refer to the Table of Contents for what they contain):

- Appendix A —Field Investigative Summaries (includes chain-of-custody forms)
- Appendix B — Piezometer and Monitoring Well Construction Summaries
- Appendix C — Well Development Logs
- Appendix D — Survey Data
- Appendix E — Geophysical Investigation
- Appendix F — Environmental Setting and Potential Receptor Identification Survey

- Appendix C — Screening Levels
- Appendix H — List of Constituents
- Appendix I — Tentatively Identified Compounds (TICs)
- Appendix J — Human Health and Ecological Risk Assessment
- Appendix K Deed Restrictions
- Attachments - Plan 1(Summary of Detected Constituents Exceeding Part 201 Criteria and EPA SLs); Plan 2 (Summary of Detected Constituents Exceeding EDQLs); and Electronic Validated Laboratory Data (on diskette)

2.0 INVESTIGATION ACTIVITIES

This section summarizes the investigative activities that were completed during the Phase I and Phase II RFI.

2.1 PHASE IRFI

The objectives of the RFI Phase I, implemented from September 1996 through January 1997, were as follows:

- Characterize the on-Site hydrogeology, geology, and hydrology at the West Brine Field (environmental setting characterization);

- Characterize the SWMUs and other potential source Areas not previously investigated at the West Brine Field, which includes determining whether a release has occurred from a SWMU/Area, and its vertical and horizontal extent (source characterization); and

- Identify the human population and environmental systems that may be susceptible to potential constituent exposures from the West Brine Field (potential receptor identification).

The environmental setting and potential receptors were evaluated with respect to the entire Site. The locations of the SWMUs or Areas identified for characterization during the Phase I RFI are presented on Figure 2.1. As identified in Section 1.1.5, the existence of these SWMUs/Areas was determined based on a review of historical information, employee interviews, and visual inspections as presented in the Description of Current Conditions Report (Weston, 1990). This was the basis for the selection of the SWMUs/Areas to be included in the Consent Order and to be investigated as part of the RPI.

To accomplish these objectives, the following field investigations were performed at the West Brine Field:

- Geotechnical borings and piezometer installation;
- Monitoring well installation;
- Geophysical surveys;
- Test pit excavations and SWMU/Area contents and perimeter soils sampling;
- Surface-water and sediment sampling;

- Groundwater sampling;
- Water-level monitoring;
- Slug testing; and
- Potential receptor identification survey.

Field investigative activities were performed in accordance with the procedures and specifications outlined in the U.S. EPA-approved RFI Phase I Work Plan. Discussions of the field activities, sampling rationale, and field procedures are provided in Sections 2.0, 3.0, and 4.0 and Appendix A of the Work Plan. In addition, a brief discussion of each field investigative activity is presented in Appendix A of this report.

Table 2.1 summarizes the field activities and laboratory analyses performed as part of the Environmental Setting and Source Characterization Plans at each SWMU/Area. Table 2.2 explains any deviations between the work proposed in the RFI Phase I Work Plan and the scope of work actually performed during the field investigations.

2.2 PHASE II **RFI**

The objectives of the RFI Phase II, implemented from October 1999 through February 2000, were as follows:

- Further characterize the SWM1Js and other potential source Areas to supplement the data obtained during the Phase I RFI to ensure that the nature and extent of the SWMUs/Areas are known; and

- Conduct a risk assessment to determine human health and ecological risk associated with the West Brine Field.

The locations of the SWMUs or Areas identified for supplemental characterization during the Phase II are presented on Figure 2.1.

To accomplish these, the following field investigations were performed at the West Brine Field:

- Test pit excavations and boreholes;
- SWMU/Area materials and perimeter soils sampling;
- Water-level monitoring; and
- Risk Assessment.

Field investigative activities were performed in accordance with the procedures and specifications outlined in the U.S. EPA-approved RFI Phase II Work Plan. Discussions of the field activities, sampling rationale, and field procedures are provided in Sections 2.0, 3.0, and 4.0 and Appendix A of the Work Plan. In addition, a brief discussion of each field investigative activity is presented in Appendix A of this report.

Table *2.3* summarizes the field activities and laboratory analyses performed as part of the Constituent Characterization and Supplemental Source Characterization Plan at each SWMU/Area. Table 2.4 explains any deviations between the work proposed in the RFI Phase II Work Plan and the scope of work actually performed during the field investigations.

3.0 ENVIRONMENTAL SETTING

The environmental setting of the West Brine Field was characterized to evaluate potential constituent migration pathways. A hydrostratigraphic conceptual model was developed from regional information, boring logs, slug test data, and water-level data, and is used in conjunction with the analytical results (Section 4.0) to evaluate the potential constituent migration pathways. The environmental setting and Site conceptual model information have been used to select screening levels (SLs) (not cleanup levels), which have been used to evaluate RFI Phase I and Phase II data.

3.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

The following information is from published literature referenced below. The West Brine Field is located in Wayne County, in the southeastern portion of Michigan. Wayne County is located on the southeastern rim of the Michigan Basin. The tilted rocks of the Michigan Basin control the topography of the bedrock surface. Resistant sandstones underlie areas of high relief, such as the Thumb Uplands that begin in western Wayne County. Less resistant shales, limestones, and dolomites underlie the low-lying Erie-Huron Lowland along the western edge of Lake Erie and the Detroit River. The uplands attain elevations of more than 1,000 feet above mean sea level (feet amsl). The lowlands lie at elevations from 400 to 600 feet amsl. The bedrock strata generally dip west at 50 feet per mile. The gradient of the bedding is 0.0095 (Mozola, 1969).

The bedrock surface was eroded in preglacial and glacial time into a series of northeast-trending valleys that were widened by glacial scour. A veneer of glacial deposits up to 250 feet thick covers the bedrock surface. The glacial deposits are thickest in the bedrock valleys and in glacial end moraines that were deposited by the retreating Erie-Huron Lobe of the continental ice sheet that covered northern North America 22,000 to 12,000 years ago. Large glacial meltwater lakes formed between the retreating Erie-Huron Lobe and the adjacent uplands. Sediment-laden glacial meltwater filled the glacial lakes with thick accumulations of lacustrine clay and silt. Gravelly, clayey, water-laid moraines were locally deposited in the lakes along the glacier margin. Deltas were deposited in the glacial lakes by streams flowing off the uplands. Beaches were deposited along the lake shores (Mozola, 1969).

The ATOFINA Chemicals, Inc. property is situated on a massive, gravelly, sandy, clay water-laid moraine. Discontinuous lenses of ice-contact sand and gravel underlie and occur within the water-laid moraine. The water-laid moraine is overlain by 6 feet to 12

feet of laminated lacustrine clay and river deposits that thicken toward the west. The water-laid moraine and lake clay are overlain by river deposits and anthropogenic fill. These sediments overlie Dundee limestone, which is locally weathered to 12 feet below the overburden-bedrock interface (Mozola, 1969).

In Wayne County, regional groundwater flows east toward the Detroit River and Lake Erie. Groundwater yields are reported to be between 100 and 500 gallons per minute (gpm) and the water is highly mineralized. However, the groundwater in the bedrock is seldom used as a potable or industrial supply of water because of high natural concentrations of hydrogen sulfide gas, sulfur, iron, and other minerals. The overlying glacial-lacustrine sediments in the Riverview, Michigan area are not typically developed as a water supply resource due to their limited water-yielding capacity. Infiltration rates through the natural surface soils in the area of the ATOFINA Chemicals, Inc. facility are reported to be 0.08 to 0.16 feet per day (Twenter et al., 1975).

3.2 SITE-SPECIFIC GEOLOGY

Three stratigraphic units (unconsolidated and consolidated) are evident at the West Brine Field, as indicated by Phase I data. The three stratigraphic units identified are: fill, brown and gray clay, and limestone bedrock. The division is based on the textural and hydrogeological characteristics of the units. In general, the fill is discontinuous and is concentrated primarily within the SWMU/Area boundaries. The brown and gray clays are present throughout the Site and thicken from approximately 52 feet in the east to 65 feet in the west. The depth to the top of the consolidated unit (limestone bedrock) increases toward the west. Table 3.1 presents the depth to the top of each stratigraphic unit at each drilling location. The distribution and thickness of the subsurface units are presented in the geological cross sections identified on Figure 3.1. Cross sections A-A' and B-B' are illustrated on Figures 3.2 and 3.3, respectively. Individual stratigraphic logs for the West Brine Field are presented in Appendix B of this Report.

The three stratigraphic units, in descending order, identified at the West Brine Field are described in the following subsections.

3.2.1 FILL

Fill material was only observed within the boundaries of the former SWMUs/Areas at the West Brine Field. The fill materials generally consist of topsoil and/or gravel

intermixed with manmade fill material (concrete, metal fragments, etc.) ranging in thickness from 0 to 1.5 feet. The contents of the fill materials are described in detail in the Site-specific test pit excavation discussions (Subsections 4.4.2, 4.6.2, 4.7.2 and 4.8.2).

3.2.2 CLAY

The clay underlying the West Brine Field is a tight, compact, sandy, silty clay (brown and gray clay) with a very low permeability. Average grain sizes, as shown in Appendix Fl, Table F.1-1, indicate that the brown and gray clay have roughly equivalent proportions of sand (25%), silt (32%), and clay (43%), with a trace of gravel (3%). The brown clay is the oxidized, weathered zone of the gray clay. The brown clay contains voids from animal burrows, dissication cracks, and freeze-thaw processes. These voids can allow water to move more readily in the brown clay than in the gray clay. Permeability data collected during the Phase I RFI from Shelby tube samples of the brown clay indicate an average intrinsic permeability of 1.3 x 10' darcys at 20°C, which corresponds to an average hydraulic conductivity of 3.5 x 1O feet per day (1.2 x 10^{-v} cm/sec). Permeability data collected from Shelby tube samples of the gray clay indicate an average intrinsic permeability of 1.6 x 10 darcys at ^{200C,} which corresponds to an average hydraulic conductivity of 4.4 x $1ft^{5}$ feet per day (1.5 x 1O cm/sec). For the purposes of this Report, the brown and gray clays are identified as separate zones within the clay stratigraphic unit.

3.2.2.1 BROWN CLAY

The brown clay is found at the surface at the West Brine Field. However, the brown clay underlies the fill, when present, within the SWMU/Area boundaries. The brown clay is orange-brown to grayish brown, locally mottled, and is 11 to 13 feet thick (Table 3.1).

The brown clay is described as a clay loam based on average grain size analyses. The organic content percentage is relatively low (1.4%). The average percent porosity and moisture content are 30.6% and 15.1%, respectively (Appendix F.1, Table F.1-1).

3.2.2.2 GRAY CLAY

The gray clay underlies the brown clay and is grayish brown to gray and approximately *34* to 53 feet thick across the West Brine Field (Table 3.1). The gray clay contains thin, discontinuous lenses of sand and gravel.

The gray clay is described as a clay loam based on average grain size analyses. The organic content percentage is relatively low (1.1%). The average percent porosity and moisture content are 29.7% and 17%, respectively (Appendix Fl, Table F.1-1).

3.2.3 LIMESTONE BEDROCK

The limestone bedrock is overlain by a layer of gravel in some places and has a weathered zone of bedrock approximately 2 to 9 feet thick. The weathered bedrock is porous, weak, and is easily penetrated by split spoons and augers. Historic stratigraphic logs collected during the installation of the brine wells located at the East Plant and West Brine Field identified the underlying limestone as the Dundee Formation. The depth to the limestone surface ranges between 52 and 67.5 feet below ground surface (bgs), based on stratigraphic data collected during the RFI Phase I field investigation.

3.3 SITE-SPECIFIC HYDROGEOLOGY

Based on the physical characteristics and the relative position of the four stratigraphic units, a three-layer hydrogeologic system was identified. The system consists of the following:

- Shallow water-bearing zone—Comprised of the discontinuous fill and the uppermost part of the brown clay. The depth to shallow groundwater ranged across the Site from approximately 1.5 to 18 feet bgs during the Phase I RFI, and from 7.6 to 20.7 feet bgs during the Phase II RFI. The lack of groundwater in the clay unit during the Phase II RFI was also recorded in the borehole logs completed for the Phase II RFI, and the observation that the surface water in Huntington Drain existed as small, discontinuous, non-flowing ponded water. It appeared that a winter with below-average precipitation affected the shallow water-bearing zone to the extent that the groundwater was not continuous across the Site. This is also supported by the fact that the deep confined water-bearing zone piezometric levels decreased by approximately 3 feet (see below).

- Regional aquitard—Comprised of the lower part of the brown clay and gray clay stratigraphic units.

- Deep confined water-bearing zone _ Comprised of the unconsolidated gravel and weathered bedrock, and the limestone bedrock. The depth to the deep water-bearing zone ranged across the Site from approximately 33 to 42 feet bgs during the Phase I RFI, and from 36.2 to 44.7 feet bgs during the Phase II RFI.

Seven groundwater monitoring wells (MW-001 through MW-007, Figure 2.1) were installed throughout the Site and were screened primarily across the brown and gray clays. These wells monitor the groundwater levels in the shallow water-bearing zone. Six piezometers (BP-200, BP-201, BP-203, BP-204, BP-206, and BP-207, Figure 2.1) were installed throughout the Site and were screened across the unconsolidated material and into the limestone bedrock. These piezometers monitor the groundwater levels in the deep confined water-bearing zone.

A description of the hydrostratigraphic framework at the West Brine Field is summarized in the following subsections.

3.3.1 SHALLOW WATER-BEARING ZONE

Groundwater flow directions in the shallow water-bearing zone were determined from the water-level measurements collected quarterly from monitoring wells MW-O01 through MW-007 and the surface-water stream gauges SW/SD-1 through SW/SD-3 along Huntington Drain. Figures 3.4 through 3.7 illustrate the locations of the wells and directions of shallow groundwater flow at the West Brine Field for the January, March, and May 1997 and January 2000 groundwater monitoring rounds, respectively. Shallow groundwater has generally been recorded during the Phase I RFI as flowing from the northern and southern boundaries of the Site inward toward Huntington Drain, where the flows converge and then move easterly toward Monguagon Creek. However, due to the perched water conditions observed during the Phase II RFI, no definite groundwater direction was discernable.

The permeability of the shallow water-bearing zone is generally low, as seen in well development and slug test results. Hydraulic conductivity (K) estimates determined by slug tests performed on wells screened in this unit range between 0.006 and 0.02 feet per day (2.1x1ft^{6} to 7.lxift^{6} cm/s). This range is related to the highly variable sand, silt, and

clay percentages of the clay stratigraphic unit. These hydraulic conductivity values are presented in Appendix F.2, Table F.2-1. Velocities are discussed in Subsection 3.5.1 of this Report.

3.3.2 REGIONAL AQUTTARD

The regional aquitard is comprised of the lower part of the brown clay and gray clay stratigraphic units. The permeabilities of the massive and dense clay unit, which are indicative of the clay's highly variable sand, silt, and clay percentages, vary between location and depth. Permeameter tests performed on representative samples collected using Shelby tubes indicate that the brown and gray clay stratigraphic units have an average vertical hydraulic conductivity of approximately 3.5 x 1O feet per day ($1.2x10^{-7}$ cm/s) and 4.4 x 1O feet per day ($1.5x10^{8}$ cm/s), respectively (Appendix F.1, Table F.1-1).

3.3.3 DEEP CONFINED WATER-BEARING ZONE

The deep confined water-bearing zone is comprised of the unconsolidated gravel and weathered bedrock, and the limestone bedrock. The depth to the deep water-bearing zone ranged across the Site from approximately 33 to 42 feet bgs during the Phase I RFI, and from 36.2 feet to 44.7 feet bgs during the Phase II RH, representing a decrease in piezometric levels of approximately 3 feet. The lower bedrock is under confined pressures, which were reported to be artesian by Mozola (1969). Near the ATOFINA Chemicals, Inc. property, the deep water-bearing zone is not artesian due to the local pumping at the nearby limestone quarry (Figure 1.1). The limestone bedrock comprises a confined water-bearing zone that exhibits both primary and secondary porosity. The upper weathered zone is not competent, and combined with the overlying gravel, forms the most permeable zone of the water-bearing zone. No permeability testing was performed on the bedrock wells located at the West Brine Field. Groundwater flow, as indicated by the quarterly water-level measurements during 1997 and a groundwater level measurement event in 2000, in the deep confined water-bearing zone flows toward the limestone quarry situated approximately 1 mile southwest of the West Brine Field (Figures 3,8 through 3.11).

3.4 BACKGROUND INFORMATION FOR IDENTIFICATION OF POTENTIAL RECEPTORS

To obtain the information necessary to prepare a risk assessment, a Potential Receptor Identification Survey was performed during the Phase I RFI to identify potential human, flora, and fauna receptors of possible constituents that may migrate through land, air, surface-water, and groundwater pathways. The area of analysis included the West Brine Field and the area within a 1-mile radius of the Site (Figure 3.12). This area encompasses sections of the Cities of Riverview, Southgate, Trenton, and Wyandotte, and the Township of Grosse Ile. The scope of this task included obtaining information for the following parameters: demographics; land use and zoning; surface-water and groundwater uses; biological and ecological characteristics; and prevailing wind direction and climatological characteristics. Primary sources of information used in completing this task included information obtained through field reconnaissance; conversations with local, county, regional, and state agencies; and review of documents and mapping resources. The following subsections discuss West Brine Field and vicinity land use, water use, and discharges. Appendix F provides detailed discussions of West Brine Field and vicinity demographics, ecological characteristics, climatology, and wind characteristics.

3.4.1 LAND USE

3.4.1.1 SITE DESCRIPTION

The 92-acre West Brine Field Site is located in Riverview, Wayne County, Michigan (Figure 1.1). The Site is zoned industrial and is presently undeveloped. Regularly mowed areas are found around the perimeter of the Site. The remainder of the Site is composed of a mosaic of field, scrub/shrub, and wooded areas. Huntington Drain divides the Site in half, flowing from west to east.

3.4.1.2 ADJACENT AREA LAND USE

Four streets bound the Site: Pennsylvania Avenue to the north, Electric Avenue to the east, Colvin Avenue to the south, and Clark Avenue to the west. The City of Wyandotte is located adjacent to the northern property edge, along Pennsylvania Avenue. Land use directly adjacent to the Site is variable. To the west, land use is residential, with a small park (Vreeland Park). To the north, from west to east, land use consists of a park (Memorial Park) with ballfields, Lincoln Junior High School, residential areas, and

commercial/light industry. A Detroit Edison substation is located adjacent to the northeastern corner of the Site. A railroad right-of-way (owned and operated by the Detroit & Toledo Shoreline Railroad; New York Central Railroad; Michigan Central Railroad; and the Detroit, Toledo & Ironton Railroad) and the ATOFINA Chemicals, Inc. West Plant are located immediately east of the Site, and to the south is a residential area. A park with ballfields is located adjacent to the southwestern property section.

Figure *3.12* illustrates the various land uses within a 1-mile radius of the Site. Table *3.2* presents the average acreage and percentage of land uses within each of the municipalities. In general, the region within a 1-mile radius of the Site is highly developed. Land use to the north and west of the Site is primarily residential, with parks and schools. Land use in the area of Route 85 (Fort Road) to the west and northwest of the Site is primarily commercial or light industry. Land use east and south of the Site is primarily industrial. East of the Site is the Trenton Channel of the Detroit River and residential areas of the Township of Grosse Ile.

Major landmarks in the area include the Wayne County Wastewater Treatment Plant (WWTP) located northeast of the Site, the ATOFINA Chemicals, Inc. West Plant facility, and Trenton Channel of the Detroit River east of the Site; and residential areas, a high school, McLouth Steel, and a quarry/fly ash landfill operated by Detroit Edison to the south.

Future land uses for the five municipalities are not expected to vary significantly from existing land uses, primarily because of the highly developed nature of the region. Some municipalities in the study area are currently updating zoning and land-use plans for the area. The Southeast Michigan Council of Governments (SEMCOG) has prepared regionwide maps that depict existing (1990) and predicted future land uses for these areas. Information obtained from municipalities and comparison of SEMCOG land-use maps provide the following general observations on future land uses for each municipality:

- Grosse Ile— SEMCOG identifies a trend toward increased development of open space in Grosse Ile for medium-density residential use. Grosse Tie is continuing to purchase land to preserve open spaces as well as for residential development. It is also pursuing the construction of a research and development facility in its Airport District, and is promoting small commercial businesses in its Central District.

- Riverview— SEMCOG identifies little change in existing land use, but most of the remaining open space would be converted to medium-density residential use, with

smaller areas of commercial and industrial development. It anticipates continued development of areas adjacent to Route 85 (Fort Road, located west of the Site) and other main thoroughfares for commercial uses, including the possible purchase and conversion of residential properties for commercial use. Riverview is currently still updating zoning ordinances, but anticipates the use of land primarily for commercial development.

- Southgate—SEMCOG identifies a shift in the use of open space and cultivated land to residential. Southgate is currently allotting equal use of land for residential and commercial development. However, it is also projecting that more land will be available for commercial development in the future.

- Trenton—SEMCOG identifies the future use of existing open space for industrial development. Trenton anticipates a mixture or commercial, residential, and industrial development in vacant land areas. The majority of development will most likely be for commercial purposes, the least amount of land allocation for residential.

- Wyandotte—SEMCOG indicates little change in land use for the City of Wyandotte, which contains limited open space for future development. The City has prepared a *Master Plan for Future Land Use*. Much of this plan focuses on improvements to existing developed lands (with little or no change in land use) to enhance access and appearance, and allow for greater attention to the unique needs of various locations throughout the City. It identifies the use of portions of waterfront properties for residential and commercial land use.

3.4.2 WATER USE AND DISCHARGES

Water use in the area surrounding the West Brine Field consists primarily of surface water intakes and discharges associated with industrial facilities and drinking water. There is little agriculture in the area, and there is little use of groundwater by private, government, or industrial users in the area. Shallow groundwater is prohibited from use in Wayne County.

There is no use of surface water or groundwater at the West Brine Field because the Site is inactive. Huntington Drain, which divides the Site in half, enters at the western property edge and exits at the eastern property boundary. Huntington Drain flows underground from the Site and emerges on the eastern side of the railroad tracks, and

then converges with Monguagon Creek. Monguagon Creek ultimately discharges to the Trenton Channel of the Detroit River (approximately 3/4 mile downstream of the Site).

The Detroit River has been identified as an Area of Concern (AOC) by the International Joint Commission because degraded water quality conditions impair certain beneficial uses as defined by the Great Lakes Water Quality Agreement of 1978 (as amended) (MDNR and 0MB, 1991). A Remedial Action Plan (RAP) has been jointly prepared by the United States (Michigan) and Canada (Ontario) to address water quality concerns in the Detroit River. Two of the impaired uses in the Detroit River identified in the RAP are constituents in sediments and ambient water quality concerns. Constituents of concern for sediments along the Michigan shoreline in the area of the West Plant include metals, polychlorinated biphenyls (PCBs), and oil and grease. Ambient water constituents include mercury, PCBs, and some metals. Existing potential sources of these constituents include combined sewer overflows (CSOs), industrial and municipal discharges, and non-point sources such as stormwater runoff from urban and industrial areas (MDEQ and OMEE, 1996). PCBs, mercury, and oil and grease have not been identified as constituents of concern at the West Brine Field.

3.4.2.1 GROUNDWATER

There is little use of groundwater by private, government, or industrial users in the area. Shallow groundwater in Wayne County is prohibited for any use. However, discharge of groundwater (which may contain constituents) into surface waters is a concern for the region (UGLCCS, 1988). Discharges to and use of surface water is described in the following section.

3.4.2.2 SURFACE WATER

The only surface water on the West Brine Field is Huntington Drain, which ultimately discharges into the Trenton Channel of the Detroit River. There are no uses of or discharges (surface) to Huntington Drain by the West Brine Field because the Site is inactive. Although surface water within the Huntington Drain has been found to have low to intermittent flow during normal weather conditions, the potential impact of a 100-year flood event on constituent transport is provided in Section 3.5.1.

Of the five municipalities associated with the study area, only the City of Wyandotte operates an independent drinking water facility. The Wyandotte Drinking Water

Department obtains its raw water from the Detroit River. The department supplies a residential base of approximately 3OOOO persons (Wyandotte Municipal Service, 1993). The intake structure for the Wyandotte drinking water plant is located offshore in the Detroit River, upstream of the West Brine Field and beyond the 1-mile radius Site study area. Grosse Tie, Riverview, Southgate, and Trenton receive their drinking water from the City of Detroit (Detroit Water Board, 1993). No private sources of water were identified as a drinking water source within the study area; this includes both private groundwater wells and surface water bodies.

Industrial uses of Detroit River surface waters include, among others, the Wyandotte power plant in the City of Wyandotte, the Monsanto facility in Trenton (Trenton Water Department, 1993), and the ATOFINA Chemicals, Inc. West Plant.

The following is a list of the companies and municipalities discharging to the area of the Trenton Channel, thought to be in the study area, as provided by the MDEQ Surface Water Quality Division (list dated December 16, 1996) and as listed in the Detroit River Remedial Action Plan (MDNR and OME, 1991, MDEQ and OMEE, 1996) and based on ATOFINA Chemicals, Inc. knowledge of the area:

- BASF—Wyandotte.
- Michigan Foundation Company (Trenton).
- ATOFINA Chemicals, Inc.
- McLough Steel Corp. (Trenton).
- Wayne County Wastewater Treatment Plant.
- Wyandotte Water Filtration Plant.
- Bridgestone Firestone landfill (Riverview).
- Wyandotte Electric Plant.
- Federal Marine Terminal, Inc. (Riverview).
- PVS Chemicals, Inc.

3.4.3 ECOLOGICAL CHARACTERISTICS

The approximately 92-acre Site is presently undeveloped. Regularly mowed areas are found around the perimeter of the Site. The remainder of the Site is composed of a mosaic of field, scrub/shrub, and wooded areas. Huntington Drain traverses the center of the Site, flowing from west to east. The Site and the surrounding vicinity are located within the St. Clair-Detroit River Basin. A number of different vegetation communities and other habitat types were identified at the Site, as follows:

- Maintained lawn—The perimeter of the Site is maintained as lawn. Scattered shrubs and trees can be found in this area. Dominant vegetation consists of grasses that could not be identified due to regular mowing. Yarrow *(Achillea millefolium)* and dandelion *(Taraxacum officinale)* also were identified in mowed areas.

- Early successional field—Areas dominated by herbaceous species and not mowed are most common in the southern half of the Site. Common species include common *reed (Phragmites australis),* goldenrods *(Solidago spp.),* New England aster *(Aster novae-angliae),* white asters *(Aster spp.),* and Queen Anne's lace *(Daucus carotci).* Portions of the Site contain dense areas of common reed. Common shrub and sapling species included box elder *(Acer negundo),* quaking aspen *(PopuLus trerniloides),* hawthorne *(Crataegus spp.),* and red-panicle dogwood *(Cornus racernosa).*

- Scrub/shrub—This vegetation community was common throughout the Site, except for the edges where regular mowing occurred. Common shrub and sapling species included box elder, hawthorne, and red-panicle dogwood. Common herbaceous species were those identified in the aforementioned early successional field community.

- Wooded—The northwestern portion of the Site contains a wooded area with the largest trees and a sparse understory. The dominant tree species was box elder. Other species included slippery elm *(Ulmus rubra)* and quaking aspen. The understory includes hawthorne, box elder, and red-panicle dogwood. Herbaceous species include goldenrods and catnip.

- Huntington Drain/riparian—The portion of Huntington Drain traversing the Site consists of steep banks with little or no vegetation. Areas directly adjacent to the stream are vegetated with tree, sapling, and shrub species similar to those identified in the aforementioned scrub/shrub and wooded communities.

- Aquatic habitats— The only aquatic habitat on the Site is Huntington Drain. No fish were observed within the stream during the Phase I RFI field reconnaissance. During the Phase II RFI, Huntington Drain was reduced to sections of non-flowing pond water. As such, the stream provides only marginally suitable habitat for fish and other aquatic organisms.

Wildlife observed during on-Site investigations on October 15, 1996 are listed in Table *3.3.* Juncos, sparrows, and rabbits were commonly observed throughout the Site. No reptiles or amphibians were found during the Site investigations.

Information regarding threatened and endangered plant and animal species and ecologically sensitive habitats was obtained through the Michigan Natural Features Inventory. This information is presented in Table 3.4. None of the listed ecologically sensitive communities were identified at the West Brine Field.

3.5 CONSTITUENT TRANSPORT, PATHWAY ANALYSIS AND IDENTIFICATION OF POTENTIAL RECEPTORS

The information presented in Section 3.4 was used to develop a discussion of constituent transport and pathways analysis for the West Brine Field, and to identify potential receptors. This information was then used to support selection of the SLs (refer to Section 3.6) used to evaluate the analytical data and determine whether further action was needed, and to support the Site-specific human and ecological risk assessment. A summary of constituent transport and exposure pathways is depicted in Figure 3.13 and a pictorial version of the Site conceptual model is provided in Figure 3.14.

3.5.1 CONSTITUENT TRANSPORT

Based on the available information collected during the RFI, groundwater flow, if any, at the Site is primarily horizontal toward Huntington Drain, although during the Phase II RFI, groundwater flow was limited (see Section 3.3.1). Limited recharge enters the aquifer due to the outcropping of clay. Groundwater velocities in the shallow hydrogeological zone measured during the Phase I RFI average approximately 9 x 1O-feet/day (horizontal) and 9 x $1ft^5$ feet/day (vertical). These values result in a water particle moving, on average, 0.3 feet/year horizontally and 0.03 feet/year vertically. These velocities indicate very limited groundwater flow occurs at the West Brine Field. This was especially evident during the Phase II during which surface water was not flowing in Huntington Drain. Horizontal and vertical flow velocities calculated from water-level data and slug testing data from the Phase I are presented on Appendix F.2, Tables F.2.2 and F.2.3.

The primary constituent migration pathway for dissolved-phase constituents is horizontally through the sandy fill and weathered zones within the brown clay. Groundwater is more likely to migrate from the suspected source Areas through the more permeable zones of fill and clay and ultimately discharge to Huntington Drain. The underlying clay unit is massive (60 feet thick) and forms the base of the shallow

water-bearing zone. The low permeability of the clay indicates that downward migration of constituents to the deep confined water-bearing zone is unlikely. However, potential transport of constituents from SWMUs/Areas to Huntington Drain due to the limited groundwater flow and low conductivity of the clay is minimal.

Transport of constituents through the air is unlikely because most of the Site is covered by topsoil and vegetation. The majority of constituents detected within the SWMUs investigated at the West Brine Field exist below the surface, and currently the Site is not active (no human receptors). Although there are residential neighborhoods adjacent to the West Brine Field, access to the Site is restricted by a fenced boundary. There is the possibility of trespassers at the Site. Subsurface groundwater migrates away from the residential neighborhoods and discharges to a surface water body (Huntington Drain) that lies within the fenced boundary. On occasion, Site personnel may need to disturb the fill/soil, and in such limited case, air transport may be a concern. However, this is not anticipated to be an issue when dust control measures are implemented in the event of future soil disturbance.

Transport of constituents via surface water is unlikely during normal weather conditions due to the low to intermittent flow of the Huntington Drain (i.e., during normal flow conditions, the sediment remains undisturbed). To examine the potential effects of a 100-year flood event, the City of Riverview Flood Insurance Rate Map (FIRM), dated September 16, 1981 was reviewed. The limits of the study provided by the National Flood Insurance Program ended at the eastern boundary of the West Brine Field. However, conservatively extending the flood zone to the western end of the Site, shows that flooding may occur over an area approximately 600 feet in width (300 feet north of the drain and 300 feet south of the drain) across the Site. This area would cover SW'IIJs 3 and 4 located north and south of the drain, respectively. With this large of an area affected during a 100-year flood event, flows may transport sediments downstream and may also transport impacted surface material from SWMUs 3 and 4 (although this would likely be minimal due to mature vegetation covering SWMUs 3 and 4). Due to the potential for downstream impact during a 100-year flood event, corrective measures will be evaluated for the Huntington Drain and SWMUs 3 and 4 (SWMUs/Areas to be carried into the corrective measures phase are summarized in Section 7.0).

3.5.2 SITE CONCEPTUAL MODEL AND PATHWAYS ANALYSIS

A Site conceptual model showing a pathways analysis for the West Brine Field is shown in Figures 3.13 and 3.14. The Human Health Site Conceptual Model and the Ecological

Site Conceptual Model were formulated based on several unique features associated with the Riverview properties that serve to mitigate or otherwise limit potential releases and/or exposures. These Site-specific factors were considered within the context of a matrix of the potential sources of constituent release, the environmental media that may serve as sources of exposure, the receptors potentially exposed to those media, and the routes by which receptors intake constituents . The matrix was used to identify the potentially complete exposure pathways. This information has been obtained through an analysis of Site history, Site geography and geology, and the populations of potential receptors.

The Wayne County Department of Public Health ordinances prohibit the installation of any well shallower than 25 feet and a deed restriction is in-place for the Site prohibiting use of groundwater (Appendix K); therefore, the shallow water-bearing zone cannot be used for any purpose. The intermediate aquitard does not yield water at a sufficient rate to be classified as an aquifer or to be used as a drinking water source. Additionally, the deep water-bearing zone is not a suitable drinking water source because it yields groundwater of highly variable quality, typically containing naturally high concentrations of calcium, bicarbonate, sulfate, sodium, chloride, iron, and/or hydrogen sulfide gas (Wiser et al., 1951).

As stated previously, a deed restriction is in-place for the Site, prohibiting the use of groundwater. Additionally, groundwater within a 1-mile radius of the Site is not used as a source of drinking water. Municipal water systems, which draw water from the Detroit River beyond Site influence, serve the surrounding communities. Accordingly, application of drinking water criteria to this aquifer is inappropriate. In accordance with the National Contingency Plan (NCP) and as specified in U.S. EPA's *Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals,* 1991):

> "Ground water that is not an actual or potential source of drinking water may not require remediation to a $1ft^4$ to 1O level (except when necessary to address environmental concerns or allow for other beneficial uses...)"

Instead, environmental considerations, such as potential impacts on surface waters generally determine cleanup standards. A dense clay layer underlies the shallow aquifer and functions as an aquitard to preclude migration of chemical constituents from the upper parts of the clay toward the underlying bedrock aquifer. Vertical groundwater velocities average approximately 9 x 1O feet/day (3.4×10^{-8} cm/s).

Surface water transecting this parcel, however, may intercept shallow groundwater flows. Huntington Drain, which has low to intermittent flow, could be potentially impacted by shallow groundwater movement; however, the hydraulic gradient is low and hydraulic conductivity estimates are approximately 0.3 feet/year. Thus, it is likely that the transfer of constituents from groundwater to surface water in Huntington Drain(is negligible.

3.5.2.1 IDENTIFICATION OF POTENTIAL HUMAN HEALTH RECEPTORS

Land use is an important consideration for ascertaining potential receptors under current and future-use conditions. At present, the Site is fenced and the area is maintained by occasional selective mowing.

Under current use conditions at the Site, two receptors related to human health were considered for potential exposure to Site-related constituents. Currently, the perimeter of this parcel is mowed regularly, and thus, grounds maintenance personnel are potentially exposed to constituents through inhalation of airborne surface soil particles and VOC vapors, incidental ingestion of soil particles, and dermal contact with surface soils. Although the parcel is fenced, a trespasser may potentially gain access to the Site from a number of areas. Consequently, in the event that trespassers do gain access to the Site, they potentially may be exposed to constituents via dermal contact with surface soils, incidental ingestion of surface soils, and inhalation of airborne particulates and VOC vapors.

In addition to the current use conditions, the following pathways, receptors, and routes of exposure were conservatively considered to be a comprehensive assessment of potential risks under future Site-use conditions:

- Hypothetical future construction worker dermal exposure to soils, incidental ingestion of soils, inhalation of fugitive dusts and VOC vapors from soils and dermal exposure to groundwater;

- Hypothetical future office worker inhalation of VOC vapors emanating from soil and groundwater;

- Hypothetical future utility trench worker dermal exposure to groundwater and inhalation of VOC vapors emanating from groundwater.

3.5.2.2 IDENTIFICATION OF POTENTIAL ECOLOGICAL RECEPTORS

The 92-acre West Brine Field is the most ecologically complex and diverse section of the facility. The property is enclosed with a chain-link barbed wire fence that precludes unconstrained movement of many animals to and from the Site. The perimeter of the property consists of grassy areas that are mowed on a regular basis. The remaining portions of this parcel consist of a mosaic of unmowed early successional fields, scrub/shrub communities, elm/aspen- dominated wooded areas, and aquatic and riparian habitat (Huntington Drain).

A quantitative field assessment of the suitability of the habitat types for use by a number of ecological receptors was made using U.S. EPA-approved Habitat Suitability Index (HSI) models (see Table 3.5). The HSI protocols were developed originally for the Western Land Use Team (WELUT) and the Pennsylvania Modified Habitat Evaluation Process (PAM HEP) habitat assessment models. The models used in this study were based on models from WELUT, PAM HEP, and other published sources. Each model assigns a numerical rating between 0 and 1 for the condition of various factors that are important in a species' life history. The species-specific models produce suitability indices for several life requisites such as breeding, food, cover, or water by combining these factor ratings. The total HSI score is, generally, the lowest of the life requisite suitability index of the model. The rationale for this determination is that any single life requisite can limit or exclude a species from utilizing the habitat. It should be noted, however, that a favorable HSI does not guarantee that a species will occupy the habitat, nor does a low HSI preclude a species from being found in the habitat.

The selection of potential ecological receptors was made based on their ecological relevance to the Site and the availability of published HSI models. The potential ecological receptors chosen for this evaluation and their ecological relevance are listed below:

Potential eceptor	*Ecological Relevance*
White-tailed deer	Terrestrial herbivore
Raccoon	Terrestrial omnivore
Muskrat	Semi-aquatic herbivore
Meadow vole	Burrowing terrestrial omnivore
Field sparrow	Avian omnivore

The West Brine Field area scored the highest for habitat quality for the white-tailed deer as shown in Table 3.5; however, the surrounding fence limits free access to the Site, so it is unlikely that the area sustains a permanent population of deer. Rather, it is more likely that the West Brine Field provides food and cover for transient individuals. HSI scores for the meadow vole and field sparrow were moderately high, indicating that the habitat is relatively suitable for these species. Because of a lack of breeding sites, the West Brine Field is unsuitable for supporting a population of raccoons. Likewise, because Huntington Drain does not support adequate aquatic vegetation, the HSI score for the muskrat was determined to be 0.0, indicating unsuitable habitat for this species.

Terrestrial Receptors

Based on the outcome of the HSI modeling, the potential ecological receptors include the white-tailed deer, the meadow vole, and the American Robin. Note that the American Robin was selected in place of the field sparrow following further evaluation. The use of the American Robin as an assessment endpoint receptor is a more conservative approach to assessing risks to avian receptors in that the diet of the American Robin consists of not only fruits, seeds, and grasses (same as the omnivorous field sparrow), but also soil-dwelling invertebrates *(e.g.*, earthworms). Potential routes of exposure for these terrestrial receptors to Site-related constituents include direct exposure via ingestion of surface water, incidental ingestion of surface soil and sediment, and indirect exposure via trophic transfer. Bioconcentration, bioaccumulation, and biomagnification (resulting from trophic transfer) were considered in calculating wildlife exposure rates. Refer to the Risk assessment (Appendix J) for detailed discussions regarding these phenomena.

Aquatic Receptors

Because the flow of surface water in Huntington Drain is low, and possibly intermittent during some portions of the year, it is unlikely that aquatic receptors would reside in this portion of Huntington Drain for any significant period of time. Consequently, aquatic receptor exposure is considered either incomplete or insignificant.

Plant Receptors

Terrestrial plants potentially may be exposed to Site-related constituents through direct contact with either sediment or soil. This exposure may result from root uptake of constituents.

3.6 SELECTION OF RISK-BASED SCREENING LEVELS

A review and evaluation was conducted of currently available regulatory and guidance levels which would be applicable to the West Brine Field. Applicability of specific screening levels was based on the Site conceptual model and pathways analysis. Lists of the SLs are provided in Appendix C and discussed in the following sections.

3.6.1 HUMAN HEALTH SCREENING CRITERIA

The MDEQ has been delegated authority by Region 5 of the U.S. EPA to implement the Corrective Action Program (CAP) under RCRA. A Memorandum of Understanding (MOU) between the U.S. EPA and the MDEQ establishing Region 5's recognition of Michigan's CAP was executed on November 3, 2000. The MOU identifies Michigan Act 451, Part 201 criteria as the U.S. EPA-approved guidance levels for RCRA corrective actions.

Consequently, based on the current property zoning, the Part 201 Generic Industrial Criteria were used as the SLs to compare against data obtained from the Phase I and Phase II RFIs. MDEQ Generic Industrial Criteria include criteria for soil/waste including: direct contact, infinite source volatile soil inhalation, particulate soil inhalation criteria, soil volatilization to indoor air (future use), and soil to groundwater contact protection criteria. These also include criteria for groundwater: groundwater/surface-water interface criteria, groundwater volatilization to indoor air/inhalation (future use), groundwater contact criteria, flammability/explosivity screening, and groundwater acute inhalation screening levels. Part 201 Generic Industrial Criteria are discussed in more detail in Subsection 3.6.1.1.

Additionally, in accordance with U.S. EPA Region 5 policy[1] EPA Region 5 SLs from Appendix D of the Region 5 Model QAPP, (EPA, 1998) were used for screening soil and groundwater concentrations. The U.S. EPA Region 5 values consist of a combination of pathway-specific soil screening levels (SSLs), U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) and U.S. EPA maximum contaminant levels (MCLs). U.S. EPA Region 5 SLs are discussed in detail in Subsection 3.6.1.2.

3.6.1.1 PART 201 GENERIC INDUSTRIAL CLEANUP CRITERIA

The Part 201 Generic Industrial Criteria (revised June 7, 2000) were used as risk-based SLs for surface soils, subsurface soils, [S1AMU] contents to determine if the SWMUs/Areas had been adequately delineated. The values for the industrial category use were used because the future use of the West Brine Field will be restricted to industrial (the Site is currently zoned industrial). As presented in Appendix K, a deed restriction is in-place for the Site, restricting the Site to industrial uses. The relevant and applicable Part 201 Generic Industrial Criteria for the Site are as follows:

- Soils:
  - Part 201 Generic Industrial Ambient Air Infinite Source Volatile Soil Inhalation Criteria (VSIC)
  - Part 201 Generic Industrial Direct Contact Criteria (DCC)
  - Part 201 Generic Industrial Groundwater Contact Protection Criteria (GCPC)
  - Part 201 Generic Industrial Particulate Soil Inhalation Criteria (PSIC)
  - Part 201 Generic Industrial Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC)

- Groundwater
  - Part 201 Groundwater Surface Water Interface (GSI) Criteria
  - Part 201 Generic Industrial Groundwater Contact Criteria (GCC)
  - Part 201 Generic Industrial Groundwater Volatilization to Indoor Air Inhalation Criteria (GVIIC)
  - Part 201 Generic Flammability and Explosivity Screening Levels
  - Part 201 Generic Acute Inhalation Screening Levels

The Part 201 generic drinking water criteria that are based on human health risks due to the consumption of drinking water or the soil pathway to groundwater/drinking water were not considered applicable to the West Brine Field since a deed restriction has been placed on the property prohibiting the use of groundwater (Appendix K), groundwater in Wayne County is unusable as a potable water supply, and the hydraulic conductivities of the shallow water-bearing zone are very low such that a sustainable water supply is not possible. GSI protection criteria for soils were not used since monitoring wells have been installed at the Site to measure the actual quality of the groundwater , and similarly surface water samples were collected to determine the actual surface water quality.

Generic assumptions (an acceptable risk for carcinogens of 10 and a hazard quotient [HQ] less than or equal to 1 for noncarcinogens) and risk-based calculations (RBCs) were used to determine the Part 201 generic criteria protective of human health at an *industrial site*. *U.S. EPA Risk Assessment Guidance for Superfund* (U.S. EPA/540/1-89/002, December 1989) was used to guide the MDEQ calculation procedure.

For soils, the VSIC and PSIC were calculated to be protective of exposure from inhalation of airborne soil constituents (volatiles and particulates) in ambient air. The DCC values were calculated to be protective of humans against long-term, systematic health effects from ingestion of and dermal contact with contaminated soil. The GCPC are soil values to protect migration to groundwater where there is a groundwater contact pathway of concern. The SVIIC were developed to be protective of constituents volatilizing and entering indoor buildings when the foundation is in contact with soil contaminated with volatile constituents.

For groundwater, the GSI criteria define the maximum allowable hazardous substance concentration in the GSI or at the edge of the mixing zone. CCC and acute inhalation SLs were developed to be protective of Site workers/personnel who would be in contact with groundwater (when excavating) from exposure to dermal contact with and inhalation of volatile constituents from groundwater. GVIIC are to be protective of exposure to constituents volatilizing and entering indoor buildings when the foundation is within 10 feet of groundwater containing volatile constituents. The flammability/explosivity screening is a default value to ensure that any of the risk-calculated values are not greater than a value that would cause an explosion or combustion threat.

3.6.1.2 U.S. EPA REGION 5 RISK-BASED SCREENING LEVELS

U.S. EPA Region 5 SLs were used for screening soil and groundwater. For soils, the U.S. EPA Region 5 values consist of a combination of pathway-specific SSLs and U.S. EPA Region 9 Soil PRGs. The U.S. EPA Region 9 Soil PRGs are separated into residential and industrial land uses. For the purposes of this evaluation and consistent with the Site's industrial zoning, U.S. EPA Region 9 Industrial Soil PRGs were used for comparisons to Site soil data. The Industrial Soil PRGs were established by the U.S. EPA based on exposure to a combination of soil ingestion, inhalation of volatiles or fugitive dust, and dermal exposure.

For risk-based screening of constituents in groundwater, the US. EPA requires that SLs account for potential residential use. Therefore, in accordance with Appendix D of the Region 5 Model QAPP, U.S. EPA MCLs were used. However, MCLs exist for less than 100 constituents . Therefore, in accordance with Appendix D of the Region 5 Model QAPP, for constituents that did not have a MCL, the U.S. EPA Region 9 Groundwater PRG value was used.

For the human health and ecological risk assessment (Appendix J, summarized in Section 6.0), U.S. EPA Region 9 PRGs were used for screening soil and groundwater and where Region 9 PRGs were not available, MDEQ Part 201 criteria were used. Refer to Section 6 and Appendix J for details regarding screening levels used for the human health and ecological risk assessment.

3.6.2 ECOLOGICAL SCREENING CRITERIA

In accordance with U.S. EPA Region 5 policy, soil, sediment, and surface-water levels of Site-related constituents were screened against the U.S. EPA Region 5 Ecological Data Quality Levels (EDQLs) in order to facilitate the ecological risk screening process. The EDQLs are obtained from the U.S. EPA Region 5 Model QAPP, Appendix C, April 1998 (U.S. EPA, 1998). By screening media-specific constituent concentrations against these criteria, those constituents that represent a possible threat to the environment can be identified and evaluated further.

3.6.3 SOIL AND GROUNDWATER: BACKGROUND

Results from analyses of background samples were used to evaluate concentrations of metals detected in other areas of the Site. Metals concentrations can vary greatly because of differences in background conditions from region-to-region and site-to-site. Concentrations of metals in background soil and groundwater were compared to background data prior to comparing the samples to the agency SLs. As such, metals presented on Plans 1 and 2 are greater than both the screening levels identified in this section and background.

Section 4.0 presents results of field investigations and provides a comparison of detected constituents to screening levels identified in this section.

4.0 RESULTS OF INVESTIGATIONS

4.1 INTRODUCTION

This section presents the results of the field investigation and the geotechnical and chemical testing of samples collected from the Site during the Phase I and II RFIs. The results indicate that the SWMUs/Areas have been adequately delineated and that no further investigations are required to collect information to support a risk assessment.

Discussions of the results for each SWMU/Area are presented in individual subsections, and reference summary data tables and plans. The field activities summarized in these subsections are further detailed in Appendix A. The data tables present validated analytical results only for those constituents that were detected in samples collected at the Site. A complete list of the analytical parameters is provided in Appendix H. A discussion of the data validation is provided in Section 5.0.

Full analytical laboratory reports are not contained in this report; however, validated databases are provided to U.S. EPA on a diskette included in this report. The databases are in ASCII flat files of fixed width columns. A file exists for 1) surface/groundwater samples, and 2) soil/sediment samples. The databases can be opened with most spreadsheet or database programs. As stated in the RFI Phase I Work Plan, 10% of the full Contract Laboratory Program (CLP) data packages will be made available to U.S. EPA following a written request to ATOFINA Chemicals, Inc.

The results for the polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs) are shown in the tables as equivalent concentrations of the 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (TCDD) isomer. The toxicity equivalent concentrations for PCDDs/PCDFs were calculated using the methodology presented in *the U.S. EPA document: Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and -Dibenzofurans (CDDs and CDFs) and 1989 Update (U.S.* EPA/625/3-89/016, March 1989). The PCDD/PCDF "raw" data (i.e., the data points that have not been converted to equivalent 2,3,7,8-TCDD concentrations) are provided in the electronic database. Refer to Section 6.0 for further discussion regarding. PCDDs/PCDFs.

As discussed below, tentatively identified compounds (TICs) are reported for volatile organic compounds (VOCs) and semi-VOCs (SVOCs) for most samples. TICs are organic compounds that were detected in samples but that are not on the standard analyte lists (e.g., Appendix IX or TCL). There are no analytical standards for the TICs;

therefore, the concentrations are reported as estimated values. Further discussion of TICs is presented in Section 6.0. A summary of detected TICs are presented in Appendix I.

4.2 DATA ADEQUACY

The adequacy of the data collected form the Phase I and Phase II RFIs was evaluated to determine if further investigations were warranted. The evaluation process was based on that used during the preparation of the Phase II Work Plan and included the consideration of principles included in Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities (Advance Notice of Proposed Rulemaking [ANPR], 61 *Federal Register* 19432) including: (1) corrective action decisions should be based on risk, and (2) characterization of constituents can be delineated to risk-based concentration levels (screening levels) so long as the sample results are sufficient to support cleanup decisions. Also, as addressed in the ATOFINA Chemicals, Inc. Consent Order, such screening levels were used to assist in determining whether the constituents found at the Site warranted further study.

The selection of screening levels for the evaluation of RFI data was based on the applicable Part 201 generic criteria, U.S. EPA Region 5 Risk-Based SLs, and EDQLs (see Section 3.6). These criteria were compared to concentrations of the constituents detected from sampling and analyses conducted for the RFI. Applicability was based on the Site conceptual model (e.g., type of media and hydrogeological conditions at the Site).

The characterization of SWMUs/Areas was also designed to collect and analyze samples of materials that were most representative of the source areas (highest concentrations). This was accomplished through a historical review of Site records, maps, and aerial photographs; employee interviews; and biased field investigative techniques. The biased field investigation consisted of procedures to find the most representative materials, which include geophysical studies, test pits, and field-screening techniques.

As demonstrated in the following sections, the data collected is sufficient to proceed with a thorough data evaluation and completion of a risk assessment. The following sections provide discussions of the data, and a summary of the Site risk assessment is provided in Section 6.0.

4.3 BACKGROUND SAMPLING

Background sampling for soils and groundwater was performed during the Phase I RFI. The following sections discuss the results and establish background concentrations to which the concentrations of constituents detected in the soil and groundwater samples collected from the specific SWMUs/Areas were compared.

4.3.1 ACTIVITY AND SAMPLING EFFORT

Table 2.1 provides a summary of the field activities conducted and sample analyses performed for background soil and groundwater characterization. To establish background concentrations, three soil borings were advanced and sampled, and three shallow groundwater monitoring wells were installed and sampled in areas believed to be unaffected by previous operations: the locations of the background soil borings and monitoring wells are shown on maps 1 and 2.

Overall, the results of the background sampling were typical of an industrial area. Three soil samples (O6SBO1 through 06SB03) and three groundwater samples (MW-O01, MW-005 and MW-007) were collected from native material and were considered to be representative of background conditions. The analytical results for these samples are discussed in the following paragraphs and are provided in Tables 4.1 to 4.4.

4.3.2 SUMMARY OF BACKGROUND SOIL SAMPLE RESULTS

In the background soil samples, the following constituents were detected:

- 2 VOCs,
- 2 SVOCs,
- 1 pesticide,
- 13 metals,
- sulfide, and
- various semi-volatile TICs (0.15 mg/kg to 1.1 mg/kg).

Of the detected constituents, only sulfide was detected above applicable screening levels. Sulfide was encountered in SB-1 at 10-12 feet bgs above EDQLs only. A summary of the risk assessment performed to evaluate potential ecological risks associated with exceedances of EDQLs is provided in Section 6.0.

Note that metals concentrations in background soil (Table 4.3) were not compared to criteria as they are considered background. In order to establish the validity of using the Site-specific background soil sample metals concentrations as background levels, a comparison was made with literature metals concentration ranges for eastern Michigan and eastern United States soils (Table 4.1). Generally, the Site-specific background metals concentrations were within the range of literature metals concentrations.

A statistical analysis was performed for the background soil metals concentrations for comparison with metals concentrations in samples collected at other areas of the Site. A 95% upper tolerance limit (UTL) was calculated for each metal concentration. This means that it can be said with a confidence of 95% that this upper limit will cover at least 95% of the population of concentrations of metals in the background samples. The 95% UTLs for metals in soils are provided in Table 41. Metals concentrations at each area of the Site were compared to the 95% UTL derived from the background soil samples. Since background metals concentrations calculated from samples analyzed during the Phase I RFI were not available for aluminum, calcium, iron, magnesium, manganese, potassium, and sodium which were analyzed during the Phase II RFI, background samples from the ATOFINA Chemicals, Inc. East Plant clay unit were used. This clay unit is the same clay unit as those samples collected for background at the West Brine Field. The seven constituents were not included in the Phase I RFI since the parameter list used was the Appendix IX; the TAL metals list was used for the Phase II RFI.

4.3.3 SUMMARY OF BACKGROUND GROUNDWATER SAMPLE RESULTS

In one or more of the background groundwater samples, the following constituents were detected:

- 1 VOC (acetone),
- 1 SVOC (bis(2-ethylhexyl)phthalate),
- 6 soluble metals,
- 13 total metals, and
- 1 semi-volatile TIC (0.004 mg/L).

Of the detected constituents, only bis(2-ethylhexyl)phthalate (a common field/laboratory artifact) was detected above U.S. EPA MCLs. No Part 201 Industrial Criteria were exceeded. Note that the background groundwater samples were not compared to GSI criteria, as monitoring wells MW-002, MW-003 and MW-004 have been

installed at the Site to measure the actual quality of groundwater, and similarly, surface water samples were collected to determine the actual surface water quality. Additionally, note that metals concentrations were not compared to criteria as they are considered background. Discussions regarding the validity of using MW-O01, MW-005 and MW-007 as background monitoring wells are provided below.

Background monitoring well MW-O01 was installed in the northern portion of the WBF. This area is upgradient of the Huntington Drain, in an area believed to be unaffected by previous operations and downgradient of only residential properties. As such, it is believed that the concentrations found in MWOO1 represent Site-specific background in groundwater north of the Huntington Drain.

Background monitoring wells MW-005 and MW-007 are located near the southern property boundary, in an area believed to be unaffected by previous operations and downgradient of the former SWMU 2 and residential properties. As described in Section 1.1.4, drum/soil removal actions were performed at SWMU 2 from February to June 1995. Waste characterization sampling of source soils and groundwater, prior to remediation in 1995, showed that the material was characteristically hazardous due to the presence of benzene in soil (metals were not a concern). Metals detected in the soil leachate were similar to soluble metals results (and lower than total metals results) in groundwater samples collected from MW-005 and MW-007. Additionally, one groundwater sample collected from within a source area test pit showed total metals in source groundwater generally below total metals encountered in MW-005 and MW-007. Based on these results, along with the fact that no soil samples collected following SWMU 2 remediation exceeded applicable criteria, it is apparent that the former presence of SWMU 2 is not likely to increase constituent concentrations in downgradient groundwater. Furthermore, as shown on Table 4.2, metals encountered in all background wells (MW-001, MW-005 and MW-007) are very similar. This is important as the background wells are located greater than 1,400 feet apart and separated by the Huntington Drain.

Based on the background well locations (near property boundaries, in areas believed to be unaffected by previous Site uses), the fact that upgradient properties/areas are not likely to adversely influence groundwater in background wells, and similarities of metals concentrations across the Site, it is believed that the highest concentrations found in background wells MW-005 and MW007 are representative of values that can be considered background in the area south of the Huntington Drain.

Background groundwater metals concentrations north of the Huntington Drain (MW-OO1) and south of the Huntington Drain (MW-005 and MW-007) are presented on Table 4.2. Groundwater metals concentrations from each monitoring well located north of the Huntington Drain were compared to the concentrations detected in MW-0O1. Groundwater metals concentrations from each monitoring well located south of the Huntington Drain were compared to the highest concentration detected in MW-005 and MW-007.

4.4 FORMER LANDFILL 1 (SWMU 1)

4.4.1 ACTIVITY AND SAMPLING EFFORT

Table 2.1 and 2.3 provide a summary of the field activities conducted and sampling analyses performed for source and groundwater characterization at SWMU 1. The field activities are further described in Appendix A which includes the test pit and borehole logs. In order to characterize SWMU 1, a geophysical survey was initially conducted followed by the excavation of 10 test pits and installation of 13 soil borings. One sample of SWMU materials was collected. To assess the potential migration of compounds identified in the SWMT.J, ten soil samples were collected from beneath and beside the SWMU, and one shallow groundwater monitoring well was installed downgradient of SWMU 1 and sampled. SWMU 1 sample locations are illustrated on Plans 1 and 2.

4.4.2 GEOPHYSICAL INVESTIGATION, TEST PIT EXCAVATION, AND SOIL BORING INSTALLATION

Based on the results of the geophysical investigation, test pit excavation, and soil boring installation activities, the physical characteristics of SWMU 1 and its lateral and vertical boundaries were adequately delineated. The area in the vicinity of SWMU 1 is generally covered by 6 to 12 inches of topsoil, under which lies a brown silty clay that becomes mottled with gray silty clay at approximately 7 to 9 feet bgs. This mottled clay extends to the bottom of the deepest test pit (17 feet bgs). The moisture of the soil during the Phase I and Phase II RFI ranged from dry to moist with increasing depth. Although the water level observed during the Phase I RFI in nearby monitoring well MW-006 of 2 feet bgs on January 8, 1997 does not support this observation, the water level of 20.5 feet bgs on January 4, 2000 during the Phase II RFI appears to indicate that the dry to moist condition of the soil is a result of seasonal discontinuous perched water (see Appendix A for water levels).

As defined by unimpacted brown silty clay identified in borings O1SBO5, O1SBO7, O1SB14, and O1SBO3 (for depth) and the west half of BTP1-8, SWMU 1 boundaries encompass an area of approximately 160 feet (north-south) by 85 feet (east-west) by 14.5 feet deep. Within this area, the geophysical surveys identified an anomaly indicative of buried ferrous material. Subsequent test pit excavation and soil boring activities visually confirmed the lateral extent of the fill material and confirmed the presence of randomly dispersed drums. Solids encountered at SWMU 1 included wood, brick, fabric, heavily stained soils, and metal drums containing a dark brown, translucent, oily liquid and a denser, white, opaque, highly viscous fluid. The condition of the drums ranged from poor to partially disintegrated. The drums are concentrated in the center of the SWMU area (between the geophysical grid coordinates 75N and 120N, and between 105E and 120E). The depths of the drums ranged from 2.5 feet bgs in BTP1-4 to 10 feet bgs in BTP1-9. Liquids from these drums were observed in the form of oily seams to a maximum depth of 14 feet bgs in BTP1-7. Strong odors were emitted from the drum liquids, stained soils, and adjacent unstained soils. These areas also exhibited elevated levels of organic vapor content ranging from 15 to 1,250 parts per million (ppm) above background levels. A sample of material (01WM01), representative of drum contents, was collected from 2.5 to 3 feet bgs in BTP1-4 (refer to test pit logs in Appendix A). Results of the waste sampling are shown on Tables 4.5 and 4.6 and summarized in Section 4.4.3, below. Extent of waste material is described in Sections 4.4.4 through 4.4.6.

At the north end of SWMU 1 between borings O1SBO8 and O1SB12, a white ash-like material and staining/odors were detected at approximately 2 to 4 feet bgs. This impacted soil was not detected in borings O1SB15 to the northeast and O1SB14 to the north. The white ash like material with staining/odors was sampled in O1SB16 at 3 feet bgs. Results of the sampling are shown on Table 4.7 and summarized in Section 4.44, below.

The drum contents (O1WMO1), soil directly beneath the SWMU material, soil around the perimeter and beneath the SWMU, and downgradient groundwater were subsequently collected and sampled.

4.4.3 SWMU **1 WASTE SAMPLING**

Analytical results for SWMU 1 waste are presented in Tables 4.5 and 4.6. The following compounds were detected in SWMU 1 waste:

2 SVOCs,

- 13 metals,
- sulfide,
- various volatile TICs (74 J mg/kg to 3,200 J mg/kg), and
- various semi-volatile TICs (52 J mg/kg to 12,000 J mg/kg).

The following organic compounds were detected over applicable Part 201. U.S. EPA SSL, and/or EDQL screening levels:

Parameters	*Units*	*Max Conc.*	*Part201*	*SSL*	*EDQL*
Semi-Volatile Organics					
Naphthalene	mg/kg	140			x
Phenol	mg/kg	1200			x

The following inorganic compounds were detected over applicable Part 201, U.S. EPA SSL, EDQL and/or background screening levels:

Parameters	*Units*	*Max Conc.*	*Part 201*	*SSL*	*EDQL*	*Background*
Meta is						
Mercury, Total	mg/kg	0.14			x	x
General Chemistry						
Sulfide, Total	mg/kg	154			x	

As shown above, exceedances are limited to background and EDQLs. A summary of the risk assessment performed to evaluate potential ecological risks associated with SWMU 1 is provided in Section 6.0.

As identified in Table 4.6, SWMU 1 contents are not RCRA characteristically hazardous.

4.4.4 SWMU 1 **SOIL SAMPLING**

Analytical results for SWMU 1 soil are presented in Table 4.7. The following compounds were detected in SWMU 1 soil:

- 2VOCs,
- 4 SVOCs,
- 19 metals,
- sulfide,

- various volatile TICs (0.006 J mg/kg to 1,100 NJ mg/kg), and
- various semi-volatile TICs (0.076 J mg/kg to 2,100 J mg/kg).

The following organic compounds were detected over applicable Part 201, U.S. EPA SSL, and/or EDQL screening levels:

Parameters	*Units*	*Max Conc.*	*Part201 SSL*	*EDQL*
Semi-Volatile Organics				
Phenol	mg/kg	640		x

The following inorganic compounds were detected over applicable Part 201, U.S. EPA SSL, EDQL and/or background screening levels:

Parameters	*Units*	*Max Conc,*	*Part201*	*SSL*	*EDQL*	*Background*
Metals						
Aluminum, Total	mg/kg	19900				x
Arsenic, Total	mg/kg	11.0		x	x	x
Cobalt, Total	mg/kg	15.7			x	x
Magnesium, Total	mg/kg	18100				x
Nickel, Total	mg/kg	47.4			x	x
Thallium, Total	mg/kg	1.7			x	x
Zinc, Total	mg/kg	84.2			x	x

As shown above, exceedances were limited to U.S. EPA SSLs (arsenic only), EDQLs and background. As shown on Plan 1, arsenic was encountered throughout the Site (including in areas thought to be unaffected by historical Site operations) at similar concentrations. These similarities, combined with the lack of arsenic in waste materials, indicates that the levels of arsenic identified on Site, are likely to be background. All compounds were detected below applicable Part 201 Industrial Criteria. A summary of the risk assessment performed to evaluate potential human health and ecological risks associated with SWMU 1 is provided in Section 6.0.

4.4.5 SWMU **1 GROUNDWATER SAMPLING**

Analytical results for SWMU 1 groundwater are presented in Table 4.8. The following compounds were detected in SWMU 1 groundwater:

- 1 SVOC,
- 5 soluble metals,
- 13 total metals, and
- various semi-volatile TICs (0.005 $_J$ mg/kg to 0.027 $_J$ mg/kg).

The following organic compounds were detected over applicable Part 201 and/or U.S. EPA MCL screening levels:

Parameters	*Units*	*Max Conc. Part 201 MCL*	
Semi-Volatile Organics			
Bis(2-Ethylhexyl)Phthalate	mg/L	0.01	x

The following inorganic compounds were detected over applicable Part 201, U.S. EPA MCL, and/or background screening levels:

Parameters	*Units*	*Max Conc. Part 201 MCL Background*		
Meta is				
Lead, Soluble	mg/L	0.0075	x	x
Tin, Total	mg/L	0.014		x

As shown above, only soluble lead, total tin and bis(2-ethylhexyl)phthalate were detected above background and/or U.S. EPA MCLs.. No Part 201 Industrial Criteria were exceeded. Note that SWMU 1 groundwater samples (MW-006) were not compared to GSI criteria, as monitoring wells MW-002, MW-003 and MW-004 have been installed at the Site to measure the actual quality of groundwater, and similarly, surface water samples were collected to determine the actual surface water quality. Additionally, it is important to note that bis(2-ethylhexyl)phthalate is a commonTTld7laboratory contaminant and may be an artifact of field and/or laboratory procedures.

A summary of the risk assessment performed to evaluate potential human health risks associated with SWMU 1 is provided in Section 6.0.

4.4.6 SUMMARY OF SAMPLING RESULTS

In summary, the results of the sampling activities indicate that naphthelene, phenol, bis(2-ethylhexyl)phthalate (a common laboratory artifact) and various metals are present

in the soil and/or groundwater at concentrations exceeding background, EDQLs and/or U.S. EPA SLs at SWMU 1.

Although soil and groundwater exceedances exist, the vertical migration of constituents is limited by the very low permeability of the silty clay layer. The likelihood of impacting downgradient receptors is low due to the very slow horizontal groundwater migration velocities and dilution potential between SWMU 1 and Huntington Drain, and the fact that the groundwater is not used as a source of drinking water at the Site or at downgradient locations. In addition, access to SWMU 1 is restricted by the Site's fenced boundary. Therefore, the potential for human contact other than for industrial uses is also unlikely.

With the physical and chemical information presented above, SWMU 1 has been adequately delineated. Further evaluation of SWMU 1 has been addressed in the human health and ecological risk assessment presented in Section 6.0. Based on the human health and ecological risk assessment, the contaminant concentrations do not pose human health risks, however, ecological risks are possible due to the presence of phenol in waste and soil samples. As a result of these exceedances, and also due to the existence of buried drums, corrective measures will be evaluated for SWMU 1 (SWMUs/Areas to be carried into the corrective measures phase are summarized in Section 7.0).

4.5 FORMER LANDFILL 2 (SWMU 2)

4.5.1 PREVIOUS REMEDIAL ACTIVITIES

Tn September 1994, an investigation of the buried drums identified for removal as part of the Interim Work Plan (Weston, 1994) was completed, and the removal actions subsequently were performed from February 1995 to June 1995. The scope of work included surface soil sampling, the excavation and disposal of drums and associated soils, confirmatory soil sampling from the bottom of the excavation, and installation of three piezometers to monitor water levels downgradient of the former landfill. The results are presented in two reports, the Investigation Report and the Corrective Action Report (Weston, 1995a, 1995b).

4.6 FORMER LANDFILL 3 (SWMU *3)*

4.6.1 ACTIVITY AND SAMPLING EFFORT

Table 2.1 and 2.3 provide a summary of the field activities conducted and sampling analyses performed for source and groundwater characterization at SWMIJ 3. The field activities are further described in Appendix A which includes the test pit and borehole logs. In order to delineate and characterize SWMU 3, a geophysical survey was conducted followed by the excavation of 52 test pits. Three samples were collected from the SWMU contents. Twenty-nine soil samples were collected from beneath and beside the SWMU to assess the potential migration of compounds. In addition, two shallow groundwater monitoring wells were installed downgradient of the SWMU and sampled. Sample locations are illustrated on Plans 1 and 2.

4.6.2 GEOPHYSICAL INVESTIGATION AND TEST PIT EXCAVATION

Based on the results of the geophysical investigation and the test pit excavation activities, the lateral and vertical boundaries of the former landfill were delineated. North of the geophysical coordinate 50N grid line, the SWMU 3 area is generally covered by 6 inches of topsoil, under which lies 1.5 to 3.5 feet of brown silty clay. Beneath this layer there is a firm gray silty clay, occasionally mottled or streaked with brown silty clay. The area south of the geophysical coordinate 50N grid line is mostly disturbed and filled with dark sandy silt and miscellaneous solids. Undisturbed soil beneath the fill consists mainly of brown/gray mottled silty, clay. The moisture of the soil during the Phase I and Phase I RFIs ranged from very dry to moist with increasing depth. This was generally supported by the water level observed in nearby monitor well MW-002 (approximately 8 feet bgs on January 7, 1997 and 9 feet on January 4, 2000) (see Appendix A for water levels).

As defined by visually unimpacted brown/gray silty clay identified in test pits BTP3-17, -18, -21,- 26, -39,- 40, -42, -46,- 49, -50, -51, and -52, SWMU 3 boundaries encompass an area of approximately 170 feet (north-south) by 1,250 feet (east-west) by 10 feet deep. Within this area, the geophysical surveys identified three primary anomalies, excluding the buried utility line (anomaly 2), indicative of fill material. These anomaly locations are illustrated on Plans 1 and 2. Subsequent test pit excavation activities visually confirmed the lateral extent of the fill material and confirmed the presence of construction rubble (BTP3-5 through BTP3-7 [anomaly 1.] and the east half of SWMU 3), miscellaneous debris (BTP3-8 and BTP3-9 [anomaly 3], BTP3-13 through BTP3-15

[surface debris I and the east half of SWMU 3), and a material thought by facility personnel possibly to be Vultacs (test pit locations 10 and 11 [anomaly 4]). Vultacs were used in the manufacturing of rubber. In general, miscellaneous debris is located south of the geophysical coordinate SON grid line. The miscellaneous debris consisted of large quantities of broken and unbroken glass, plastic, fabric, tires, and other items. The depth of miscellaneous debris was greatest near Huntington Drain (10 feet bgs in BTP3-15). Mixed with the miscellaneous debris was construction debris, such as wood, bricks, concrete, and metal. An isolated area of construction debris was also located in the vicinity of BTP3-5, BTP3-6, and BTP3-7. This area is visible on the surface as a pit approximately 4 feet deep and 20 feet in diameter. Construction debris, such as asphalt, terra cotta pipe, building stone, concrete, metal culvert, and chain-link fence, was located from 0 to 4 feet bgs in and around the pit. The third type of solids encountered, a black, tarry material (Vultacs), was observed in BTP3-10 and BTP3-11. This solid is present as a horizontal layer ranging from 0.5 to 1 foot thick and from 1.5 to 4 feet bgs. As shown on Table A-3 in Appendix A.1, samples of this material were collected from BTP3-10.

A mothball-like odor was emitted from BTP3-10, and a gasoline-like odor was emitted from BTP3-11. The odors appeared to originate from stained soil found beneath the solids because elevated levels (5 to 8 ppm) of organic vapors were measured only in these strata. An odor was also observed in BTP3-13. This odor was similar to the odors observed in West Plant monitor wells MW-006 and MW-007. Organic vapor measurements up to 28 ppm above background were recorded from stained soils in BTP3-13. No odors or stains were detected west of the geophysical grid, indicating that no hazardous wastes were associated with the construction and miscellaneous debris identified in this area. As shown on Table A-3 in Appendix Al, samples of the material emitting odors were collected from BTP3-10 and BTP3-13. BTP3-11 was not sampled due to the close proximity and similar soil type identified in BTP3-10.

In general, SWMU 3 surficial debris was observed laterally to the embankments of Huntington Drain and vertically to depths of up to 10 feet bgs. Test pits BTP3-26, BTP3-50, and BTP3-51, completed between SWMU 3 and Huntington Drain, indicate that there is a strip of tan/brown/gray silty clay which exists south of SWMU 3, although some debris was visible during the Huntington Drain reconnaissance (see Section 4.9.1). In addition to those listed previously, test pit locations BTP3-1 through 4, and BTP3-12 appeared to be unaffected by Site activities. The miscellaneous debris, Vultacs, soil beneath and around the SWMU, and downgradient groundwater were subsequently sampled.

4.6.3 SWMU 3 WASTE SAMPLING

Analytical results for SWMU 3 waste are presented in Tables 4.9 and 4.10. The following compounds were detected in SWMU 3:

- 3VOCs,
- 16 SVOCs,
- 15 metals[1]
- 3 PCDFs,
- various volatile TICs (0.049 J mg/kg to 0.66 J mg/kg), and
- various semi-volatile TICs (0.34 J mg/kg to 9,200 J mg/kg).

The following organic compounds were detected over applicable Part 201, U.S. EPA SSL, and/or EDQL screening levels:

Parameters	*Units*	*Max Conc.*	*Part201*	*SSL*	*EDQL*
Semi-Volatile Organics					
Benzo(a)Pyrene	mg/kg	0.67		x	
Bis(2-Ethylhexyl)Phthalate	mg/kg	3.4			x
Dioxins/Furans (TEQ)					
2,3,7,8-TCDD (TEQ Value)	jig/kg	0.01685			x

The following inorganic compounds were detected over applicable Part 201, U.S. EPA SSL, EDQL and/or background screening levels:

Parameters	*Units*	*Max Conc.*	*Part 201*	*SSL*	*EDQL*	*Background*
Metals						
Lead, Total	mg/kg	21.6			x	x
Mercury, Total	mg/kg	0.36			x	x
Tin, Total	mg/kg	1.5				x
Zinc, Total	mg/kg	90.8			x	x

As shown above, exceedances were limited to U.S. EPA SSLs (benzo(a)pyrene only), EDQLs and background. All compounds were detected below applicable Part 201 Industrial Screening levels. A summary of the risk assessment performed to evaluate potential human health and ecological risks associated with SWMU 3 is provided in Section 6.0.

As identified in Table 4.10, SWMU 3 contents are not RCRA characteristically hazardous.

4.6.4 SWMU 3 SOIL SAMPLING

Analytical results for SWMU 3 soil are presented in Table 4.11. The following compounds were detected in SWMU 3 soil:

- 2 VOCs,
- 17SVOCs,
- 22 metals,
- 4 PCDFs,
- various volatile TICs (0.72 J mg/kg to 4.0 J mg/kg), and
- various semi-volatile TICs (0.075 NJ mg/kg to 310 J mg/kg).

The following organic compounds were detected over applicable Part 201, U.S. EPA SSL, and/or EDQL screening levels:

Parameters	*Limits*	*Max Conc.*	*Part201*	*SSL*	*EDQL*
Semi-Volatile Organics					
Benzo(a)Pyrene	mg/kg	0.84	x		
Naphthalene	mg/kg	37			x
N-Nitrosodiphenylamine	mg/kg	1.2			x
Dioxins/Furans (TEQ)					
2,3,7,8-TCDD (TEQ Value)	kg/kg	0.03468		x	x

The following inorganic compounds were detected over applicable Part 201, U.S. EPA SSL, EDQL and/or background screening levels:

Parameters	*Units*	*Max Conc.*	*Part 201*	*SSL*	*EDQL*	*Background*
Metals						
Aluminum, Total	mg/kg	17800				x
Arsenic, Total	mg/kg	21.7		x	x	x
Cobalt, Total	mg/kg	22.1			x	x

Parameters	Un2ts	Units Conc.	Part 201	SSL	EDQL	Background
Metals Cont'd						
Copper, Total	mg/kg	147			x	x
Iron, Total	mg/kg	63200				x
Lead, Total	mg/kg	218			x	x
Magnesium, Total	mg/kg	16600				x
Manganese, Total	mg/kg	2930	x			x
Mercury, Total	mg/kg	1.6			x	x
Nickel, Total	mg/kg	42.1			x	x
Tin, Total	mg/kg	8.3			x	x
Zinc, Total	mg/kg	315			x	x

As shown above, each applicable criterion was exceeded. A summary of the risk assessment performed to evaluate potential human health and ecological risks associated with SWMU 3 is provided in Section 6.0.

As illustrated in Plan 1, manganese was detected in test pits 23, 25, and 39 at concentrations which exceed Part 201 generic PSIC (inhalation of soil particles) at the depth interval of 5 to 7 feet bgs. However, manganese concentrations detected in tests 26 (near 23), 39, and 51 (near 25) (and at the upper interval in all other soil samples in SWMU 3) were below the Part 201 generic PSIC criteria. This indicates that, with the current inactive status of the Site, the elevated manganese concentrations at the lower 5-7-foot intervals do not pose a threat to human health.

4.6.5 SWMU 3 **GROUNDWATER SAMPLING**

Analytical results for SWMU 3 groundwater are presented in Table 4.12. The following compounds were detected in SWMU 3 groundwater:

- 2 VOCs,
- 1SVOC,
- 11 soluble metals,
- 14 total metals, and
- various semi-volatile TICs (0.004 J mg/L to 0.018 J mg/L).

The following organic compounds were detected over applicable Part 201 and/or U.S. EPA MCL screening levels:

Parameters	Units	Max Conc.	Part 201	MCL	Background
Semi-Volatile Organics					
Bis(2-Ethylhexyl)Phthalate	mg/L	0.01		x	
Volatile Organics					
Chloroform	mg/L	0.005		x	

The following inorganic compounds were detected over applicable Part 201, U.S. EPA MCL, and/or background screening levels:

Parameters	Units	Max Conc.	Part 201	MCL	Background
Metals					
Antimony, Total	mg/L	0.189		x	x
Arsenic, Soluble	mg/L	0.007		x	x
Arsenic, Total	mg/L	0.0405		x	x
Barium, Total	mg/L	0.706			x
Beryllium, Total	mg/L	0.0048		x	x
Cadmium, Soluble	mg/L	0.0033	x		x
Chromium, Soluble	mg/L	0.0026			x
Chromium, Total	mg/L	0.143	x		x
Cobalt, Total	mg/L	0.156	x		x
Copper, Soluble	mg/L	0.0028			x
Copper, Total	mg/L	0.16	x		x
Lead, Total	mg/L	0.106	x	x	x
Mercury, Total	mg/L	0.00027	x		x
Nickel, Soluble	mg/L	0.009			x
Nickel, Total	mg/L	0.208	x		x
Thallium, Total	mg/L	0.0022		x	x
Vanadium, Soluble	mg/L	0.0034			x
Vanadium, Total	mg/L	0.157	x		x
Zinc, Soluble	mg/L	0.0329			x
Zinc, Total	mg/L	0.446	x		x

As shown above, background, U.S. EPA MCLs and Part 201 Industrial criteria were exceeded. Part 201 criteria exceedances are limited to the following compounds that were detected above Part 201 GSI:

- soluble cadmium,
- total chromium,
- total cobalt,
- total copper,
- total lead,
- total mercury,
- total nickel,
- total vanadium, and
- total zinc.

It should be noted, however, that the parameters which are above the Part 201 GSI criteria are primarily total metals (the exception is soluble cadmium which was detected at 0.0033 mg/L, just above the GSI criteria of 0.0025 mg/L). This is because the groundwater samples were collected using a bailer and were highly turbid (see Appendix C) which increased the total metals concentrations. ATOFINA Chemicals Inc. understands that analyses for inorganic compounds being evaluated relative to the GSI pathway should be on unfiltered samples (using low-flow sampling techniques). However, using a bailer and providing filtered (0.45 micron filter) groundwater samples for metals analysis was the approved method at the time groundwater samples were collected from SWMU 3. Groundwater sampling techniques are summarized in Appendix A.

Taking into account the highly turbid samples, actual metals concentrations which would flow to Huntington Drain via groundwater transport, are likely better represented by the soluble concentrations which are very near or below GSI criteria. Regardless of whether or not soluble results are more applicable for evaluating constituents at the GSI, total results have been used for the determination of human health and ecological risks. Refer to Section 6.0 for a summary of the risk assessment performed to evaluate potential human health risks associated with SWMU 3.

4.6.6 SUMMARY OF SAMPLING RESULTS

In summary, the results of the sampling activities indicate that n-nitrosodiphenylamine naphthalene, bis(2-ethylhexyl)phthalate (a common laboratory artifact), 2,3,7,8-TCDD (TEQ value), benzo(a)pyrene, chloroform (a common laboratory artifact) and various metals are present in the soil and/or groundwater at concentrations exceeding background, EDQLs and/or U.S. EPA SLs at SWMU 3. Part 201 exceedances in SWMTJ 3 were limited various metals exceeding GSI criteria and manganese in soil exceeding

PSIC criteria. As previously stated, the FSIC exceedance was at a depth interval of 5 to 7 feet bgs where particulate soil inhalation exposures are unlikely. Additionally, the GSI exceedances were from total metals concentrations (with the exception of soluble cadmium) of highly turbid groundwater samples.

Although soil and groundwater exceedances exist, the vertical migration of constituents is limited by the very low permeability of the silty clay layer. The likelihood of impacting downgradient receptors is low due to the very slow horizontal groundwater migration velocities and dilution potential between SW'1U 3 and Huntington Drain, and the fact that the groundwater is not used as a source of drinking water at the Site or at downgradient locations. In addition, access to SWMU 3 is restricted by the Site's fenced boundary. Therefore, the potential for human contact other than for industrial uses is also unlikely.

With the physical and chemical information presented above, SWMU 3 has been adequately delineated. Further evaluation of SWMU 3 has been addressed in the human health and ecological risk assessment presented in Section 6.0. Although constituents were detected above applicable screening levels in SWMU 3, based on the human health risk assessment, the concentrations identified do not pose unacceptable human health risks. A single detection of thallium in SWMU 3 surface soils above EDQLs resulted in unacceptable ecological risk posed to the avian receptor selected for evaluation even though this detection of thallium was at a level below background concentrations. Because of the potential for adverse ecological effects from exposure to thallium, and the presence of waste (construction debris and potential drummed still bottoms), SWMU 3 warrants potential corrective measures. SWMUs/Areas to be carried into the corrective measures phase are summarized in Section 7.0.

4.7 FORMER LANDFILL 4 (SWMU 4)

4.7.1 ACTIVITY AND SAMPLING EFFORT

Tables 2.1 and 2.3 provide a summary of the field activities conducted and sampling analyses performed for source and groundwater characterization at SWMU 4. The field activities are further described in Appendix A which includes the test pit and borehole logs. In order to delineate and characterize SWMU 4 constituents and adjacent soils, a geophysical survey was conducted followed by the excavation of 14 test pits and installation of 2 soil borings. In accordance with the approved Work Plan, three samples were collected from SWMU 4 contents and eight soil samples were collected from

beneath and beside SWMU 4 to assess the potential migration of compounds. In addition, one shallow groundwater monitoring well was installed downgradient of SWMU 4 and sampled. Sample locations are illustrated on Plans 1 and 2.

4.7.2 GEOPHYSICAL INVESTIGATION, TEST PIT EXCAVATION, AND SOIL BORING INSTALLATION

Based on the results of the geophysical investigation, test pit excavation, and soil boring installation activities, the physical characteristics of SWMU 4 and its lateral and vertical boundaries were delineated. The area in the vicinity of SWMU 4 is generally covered by 6 to 12 in. of topsoil, under which lies brown silty clay that becomes mottled with gray silty clay at approximately 6 to 8 feet bgs. This gray clay extended to the bottom of the deepest test boring (17 feet bgs). The moisture of the soil during the Phase I and Phase II RFI ranged from very dry to saturated. This is generally supported by the water level in nearby monitor well MW-004 which was approximately 7.5 feet bgs on January 7, 1997 and 10 feet bgs on January 4, 2000 (see Appendix A).

As defined by unimpacted silty clay identified in borings 2 and *3* (for depth) and test pits BTP4-11, BTP4-12, and BTP4-13, SWMU 4 boundaries encompass an area of approximately 135 feet (north-south) by 45 feet (east-west) by 15 feet deep (maximum depth). Within this area, the geophysical surveys identified three primary anomalies indicative of buried fill material beneath the surficial tar-like material. Subsequent test pit excavations identified solid materials consisting mainly of a purple-brown clayey fill material. Mixed with the solids were isolated pieces of fabric and small pockets of black, tarry material to depths of up to 7.5 feet; green, clayey material; and reddish-purple liquid. Strong amyl phenol odors were emitted from the solids, which also exhibited elevated levels of organic vapor content (up to 60 ppm above background). In accordance with the approved Work Plan, a sample of this material was collected from BTP4-14 from 4 to 5 feet bgs.

Undisturbed native soil was observed at test pit locations BTP4-2, -7, -10, -11, -12, and - 14, at monitoring well location MW-004, and boring 04SB02. In accordance with the approved Work Plan, SWMU contents, soil beneath and beside the SWMU, and downgradient groundwater were subsequently sampled. The locations of samples collected were consistent with those specified in the approved Work Plan. In general, samples collected during the Phase I RFI were collected from SWMU contents. Phase II activities concentrated on preferential collection of samples from areas and depths where field screening and visual observations indicated that the boundaries of the

SWMU had been reached. This methodology was specifically stated in the approved Work Plan.

4.7.3 SWMU 4 WASTE SAMPLING

Analytical results for SWMU 4 contents are presented in Tables 4.13 and 4.14. The following compounds were detected in SWMU 4:

- 6VOCs,
- 3 SVOCs,
- 14 metals,
- 2 PCDFs,
- sulfide,
- various volatile TICs (4.1 J mg/kg to 360 NJ mg/kg), and
- various semi-volatile TICs (0.023 NJ mg/kg to 120,000 J mg/kg).

The following organic compounds were detected over applicable Part 201, U.S. EPA SSL, and/or EDQL screening levels:

Parameters	*Units*	*Max Conc.*	*Part 201*	*SSL*	*EDQL*
Volatile Organics					
Benzene	mg/kg	0.46			x
Carbon Disulfide	mg/kg	34		x	x
Methylene Chloride	mg/kg	6.0			x
Semi-Volatile Organics					
N-Nitrosodiphenylamine	mg/kg	2000	x	x	x
Naphthalene	mg/kg	730	x	x	x
Phenol	mg/kg	17000	x		**x**
Dioxins/Furans (TEQ)					
2,3,7,8-TCDD (TEQ Value)	mg/kg	0.00525			x

The following inorganic compounds were detected over applicable Part 201, U.S. EPA SSL, EDQL and/or background screening levels:

Parameters	*Units*	*Max Conc.*	*Part201*	*SSL*	*EDOL*	*BKGRD*
Metals						
Arsenic, Total	mg/kg	11.8		x	x	x
Cobalt, Total	mg/kg	15.5			x	x
Copper, Total	mg/kg	184			x	x
Lead, Total	mg/kg	199			x	x
Mercury, Total	mg/kg	1.1			x	x
Nickel, Total	mg/kg	393			x	x
Tin, Total	mg/kg	2.1				x
Zinc, Total	mg/kg	156			x	x
General Chemistry						
Sulfide, Total	mg/kg	135			x	

As shown above, the following compounds were detected above the Part 201 criteria identified in parentheses at a sample depth of 2.5 to 3 feet bgs:

- n-nitrosodiphenylamine (GCPC)
- naphthalene (SVIIC, VSIC), and
- phenol (DCC, GCPC).

A summary of the risk assessment performed to evaluate potential human health and ecological risks associated with SWMU 4 is provided in Section 6.0.

As identified in Table 4.14, SWMU 4 contents are not RCRA characteristically hazardous.

4.7.4 SWMU 4 SOIL SAMPLING

Analytical results for SWMU 4 soil are presented in Table 4.15. The following compounds were detected in SWMU 4 soil:

- 1VOC,
- 3 SVOCs,
- 19 metals,
- sulfide,
- various volatile TICs (0.006 J mg/kg to 0.11 J mg/kg), and

various semi-volatile TICs (0.077 NJ mg/kg to 250 NJ mg/kg).

The following organic compounds were detected over applicable Part 201, U.S. EPA SSL, and/or EDQL screening levels:

Parameters	*Units*	*Max Conc.*	*Part 201*	*SSL*	*EDQL*
Semi-Volatile Organics					
Naphthalene	mg/kg	0.16			x
Phenol	mg/kg	3900			x

The following inorganic compounds were detected over applicable Part 201, U.S. EPA SSL, EDQL and/or background screening levels:

Parameters	*Units*	*Max Conc.*	*Part201*	*SSL*	*EDQL*	*Background*
Metals						
Aluminum, Total	mg/kg	15200				x
Arsenic, Total	mg/kg	13.3		x	x	x
Cobalt, Total	mg/kg	16.3			x	x
Copper, Total	mg/kg	72.5			x	x
Lead, Total	mg/kg	95.5			x	x
Magnesium, Total	mg/kg	24200				x
Mercury, Total	mg/kg	0.69			x	x
Nickel, Total	mg/kg	93.5			x	x
Sodium, Total	mg/kg	2450				x
Thallium, Total	mg/kg	1.5			x	x
Zinc, Total	mg/kg	108			x	x

As shown above, exceedances were limited to U.S. EPA SSLs (arsenic only), EDQLs and background. It is important to note that metals detected in SWMU 4 soil samples far exceeded the number of metals detected in SWMU 4 waste samples (see Section 4.7.3). This suggests that metals in SWMU 4 soil are not likely SWMU-related (i.e. not likely related to the material disposed in the SWMU) and are instead reflective of background conditions. All compounds were detected below applicable Part 201 Industrial Criteria. A summary of the risk assessment performed to evaluate potential human health and ecological risks associated with SWMU 4 is provided in Section 6.0.

4.7.5 SWMU 4 GROUNDWATER SAMPLING

Analytical results for SWMU 4 groundwater are presented in Table 4.16. The following compounds were detected in SWMU 4 groundwater:

- 1 SVOC,
- 6 soluble metals,
- 12 total metals, and
- various semi-volatile TICs (0.004 $_J$ mg/L to 0.007 $_J$ mg/L).

The following organic compounds were detected over applicable Part 201 and/or U.S. EPA MCL screening levels:

Parameters	*Units*	*Max Conc. Part 201 MCL*	
Semi-Volatile Organics			
Bis(2-Ethylhexyl)Phthalate	mg/L	0.01	x

The following inorganic compounds were detected over applicable Part 201, U.S. EPA MCL, and/or background screening levels:

Parameters	*Units*	*Max Conc. Part 201 MCL Background*	
Metals			
Tin, Total	mg/L	0.0108	x
Vanadium, Soluble	mg/L	0.0025	x

As shown above, only total tin and soluble vanadium were detected above background and bis(2-ethylhexyl)phthalate was detected above U.S. EPA MCLs. No Part 201 Industrial Criteria were exceeded. It is important to note that bis(2-ethylhexyl)phthalate is a common field/laboratory contaminant and may be an artifact of field and/or laboratory procedures.

A summary of the risk assessment performed to evaluate potential human health risks associated with SWMU 4 is provided in Section 6.0.

4.7.6 SUMMARY OF SAMPLING RESULTS

In summary, the results of the sampling activities indicate that benzene, carbon disulfide, methylene chloride (a common laboratory artifact), n-nitrosodiphenylamine, naphthalene, phenol, bis(2-ethylhexyl)phthalate (a common laboratory artifact), 2,3,7,8-TCDD (TEQ value), sulfide, and various metals are present in the soil and/or groundwater at concentrations exceeding applicable screening levels.

Although soil and groundwater exceedances exist, the vertical migration of constituents is limited by the very low permeability of the silty clay layer. The likelihood of impacting downgradient receptors is low due to the very slow horizontal groundwater migration velocities and dilution potential between SWMU 4 and Huntington Drain, and the fact that the groundwater is not used as a source of drinking water at the Site or at downgradient locations. In addition, access to SWMU 4 is restricted by the Site's fenced boundary. Therefore, the potential for human contact other than for industrial uses is also unlikely.

With the physical and chemical information presented above, SWMU 4 has been adequately delineated. Further evaluation of SWMU 4 has been addressed in the human health and ecological risk assessment presented in Section 6.0. As described in the risk assessment, the contaminant concentrations identified in SWMU 4 do not pose unacceptable human health risks, however, ecological risks are possible due to the presence of phenol in soil samples. As a result of the potential ecological risks, corrective measures will be evaluated for SWMU 4 (SWMUs/Areas to be carried into the corrective measures phase are summarized in Section 7.0).

4.8 AREA 7

4.8.1 ACTIVITY AND SAMPLING EFFORT

Tables 2.1 and 2.3 provide a summary of the field activities conducted and sampling analyses performed for source characterization at Area 7. The field activities are further described in Appendix A which includes the test pit and borehole logs. Area 7, located west of SWMLJ 1 and north of Colvin Avenue, was added to the RFI program during the Phase I RFI based on field observations of a depressed surface. In order to identify and characterize the soil present at Area 7, the excavation of 5 test pits and the installation of 1 soil boring were conducted. Four soil samples were collected. The sample locations are illustrated on Plans 1 and 2.

4.8.2 TEST PIT EXCAVATION AND SOIL BORING INSTALLATION

Based on the results of test pit excavation and soil boring installation activities, the physical characteristics of Area 7 and its lateral and vertical boundaries were delineated. Laterally, the extent of the fill was observed in the areas outlined on Plans 1 and 2. The area in the vicinity of Area 7 is generally covered by 12 inches of topsoil, under which lies a brown/gray silty clay. Within boring 3, the brown clay becomes mottled with gray silty clay at approximately 7 to 9 feet bgs. The contents of the material observed in Area 7 test pits consisted primarily of disturbed and stained gravelly brown silt and silty clay that becomes mottled with gray silty clay at approximately 5.5 feet bgs. A very strong odor and staining were detected in the clay to depths of up to 12.5 feet. The stained clay exhibited elevated levels of organic vapor content ranging up to 585 parts per million (ppm) above background levels. No impacted soils were identified in test pits 4 and 5.

The impacted soils in Area 7 and the soil directly beneath were subsequently collected and sampled. As Area 7 wasn't identified until Phase I RFI activities had already begun, the existing Work Plan did not provide for sampling locations in Area 7. Therefore, locations of samples collected during the Phase I investigation were based on visual observations and PID readings. The Phase II sample locations were based on the Phase II Work Plan.

4.8.3 AREA 7 SOIL SAMPLING

Analytical results for Area 7 soil are presented in Table 4.17. The following compounds were detected in Area 7 soil:

- 9VOCs,
- *3* SVOCs,
- 16 metals,
- various volatile TICs (0.007J mg/kg to 1.1 $_{j}$ mg/kg), and
- various semi-volatile TICs (0.12 NJ mg/kg to 75 NJ mg/kg).

No metals were detected above background screening levels in Area 7 soil. The following organic compounds were detected over applicable Part 201, U.S. EPA SSL, and/or EDQL screening levels:

Parameters	Units	Max Conc. Part 201	SSL	EDQL
Semi-Volatile Organics				
N-Nitrosodiethylamine	mg/kg	O.78J	x	x

As shown above[1] only n-nitrosodiethylamine was detected above U.S. EPA SSLs and EDQLs. All compounds were detected below applicable Part 201 Industrial Criteria. A summary of the risk assessment performed to evaluate potential human health and ecological risks associated with Area 7 is provided in Section 6.0.

4.8.4 SUMMARY OF SAMPLING RESULTS

In summary, the results of the sampling activities indicate that n-nitrosodiethylamine is present in the soil at concentrations exceeding U.S. EPA SSLs and EDQLs.

Although exceedances exist, the vertical migration of constituents is limited by the very low permeability of the silty clay layer. The likelihood of impacting downgradient receptors is low due to the very slow horizontal groundwater migration velocities and dilution potential between Area 7 and Huntington Drain, and the fact that the groundwater is not used as a source of drinking water at the Site or at downgradient locations. In addition, access to Area 7 is restricted by the Site's fenced boundary. Therefore, the potential for human contact other than for industrial uses is also unlikely.

With the information presented above and that obtained from test pitting, Area 7 has been adequately delineated. Further evaluation of Area 7 has been addressed in the human health and ecological risk assessment presented in Section 6.0. As described in the risk assessment, potential human health risks exist in Area 7 due to the presence of n-nitrosodiethylamine m soil Ecological risk drivers (thallium and phenol) identified in the risk assessment were not detected in Area 7 soil. As a result of the potential human health risks associated with n-nitrosodiethylamine, corrective measures will be evaluated for Area 7 (SWMUs/Areas to be carried into the corrective measures phase are summarized in Section 7.0).

4.9 HUNTINGTON DRAIN (AREA 5)

4.9.1 ACTIVITY AND SAMPLING EFFORT

Table 2.1 provides a summary of the field activities conducted and sampling analyses performed for surface-water and sediment characterization at Huntington Drain. In order to characterize surface water and sediment, surface-water and sediment samples were collected from upgradient, midgradient, and downgradient locations along the length of the drain. The sampling locations are illustrated on Plans 1 and 2. Specific sampling data recorded during surface water and sediment sampling are presented in Appendix A.1, Attachment 2.

A field reconnaissance of Huntington Drain during the sampling activities found visibly disturbed soil (mounds) along the northern embankment of the drain with isolated pockets of miscellaneous surficial debris and a surficial black tar-like material (see SWMU 3 — Section 4.6.2). This material was also found in Huntington Drain sediments at locations SW/SD-02 and SW/SD-03. In addition, isolated pockets of disturbed soil (mounds) also were observed along the southern embankment of Huntington Drain.

4.9.2 SURFACE-WATER SAMPLING

Analytical results for Huntington Drain surface water are presented in Table 4.18. The following compounds were detected in Huntington Drain surface water:

- 1SvOC,
- 5 soluble metals,
- 3 total metals, and
- 1 semi-volatile TIC (0.004 J mg/L).

Surface water results were compared to EDQLs only. Of the detected constituents, only cadmium and bis(2-ethylhexyl)phthalate were detected above surface water EDQLs. Bis(2-ethylhexyl)phthalate is a common field/laboratory contaminant and may be an artifact of field and/or laboratory procedures. In general, the surface water quality of the downstream sample was similar to that of the upstream sample.

A summary of the risk assessment performed to evaluate potential ecological risks is provided in Section 6.0.

4.9.3 **SEDIMENT SAMPLING**

Analytical results for Huntington Drain sediment are presented in Table 4.19. The following compounds were detected in Huntington Drain sediment:

- 1 VOC,
- 21 SVOCs,
- 17 metals,
- 8 pesticides,
- 4 PCDFs,
- cyanide,
- sulfide,
- various volatile TICs (0.01 $_J$ mg/kg to 0.089 $_J$ mg/kg). and
- various semi-volatile TICs (0.15 $_J$ mg/kg to 4.8 $_J$ mg/kg).

Guidance values for sediments consist solely of EDQLs. Detected constituents (organic and inorganic) exceeding EDQLs are listed below.

Parameters	*Units*	*Max Conc.*
Semi- Volatile Organics		
2-Methylnaphthalene	mg/kg	0.25
Acenaphthene	mg/kg	0.24
Acenaphthylene	mg/kg	0.065
Anthracene	mg/kg	0.78
Benzo(a)Anthracene	mg/kg	1.9
Benzo(a)Pyrene	mg/kg	2.1
Benzo(g,h,i)Perylene	mg/kg	1.6
Benzo(k)Fluoranthene	mg/kg	1.2
Bis(2-Ethylhexyl)Phthalate	mg/kg	2.9
Chrysene	mg/kg	2.7
Dibenzo(a,h)Anthracene	mg / kg	0.38
Di-n-Butylphthalate	mg/kg	0.13
Fluoranthene	mg/kg	3.6
Fluorene	mg/kg	0.23
Indeno(1,2,3-cd)Pyrene	mg/kg	1.9
Naphthalene	mg/kg	0.097
Phenanthrene	mg/kg	2.0
Pyrene	mg/kg	5.1
Dioxins/Furans (TEQ)		
2,3,7,8-TCDD (TEQ Value)	ug/kg	0.01937

not screened?

Parameters	*Limits*	*Max Canc.*
Pesticides		
4,4'-DDD	mg/kg	0.25
4,4-DDE	mg/kg	0.012
4,4'-DDT	mg/kg	0.043
Aldrin	mg/kg	0.038
Kepone	mg/kg	0.72
Metals		
Arsenic, Total	mg/kg	13.2
Cadmium, Total	mg/kg	1.8
Chromium, Total	mg/kg	*37.6*
Copper. Total	mg/kg	93.7
Lead, Total	mg/kg	219
Nickel, Total	mg/kg	40.7
Silver, Total	mg/kg	1.4
Zinc, Total	mg/kg	325
General Chemistry		
Cyanide, Total	mg/kg	6.6

A summary of the risk assessment performed to evaluate potential ecological risks is provided in Section 6.0. In general, the concentrations increased between the upgradient and midgradient samples, but decreased between the midgradient and downstream samples, indicating that any impacted sediment remains within close proximity to SWMU 3 and the Site.

4.9.4 SUMMARY OF SAMPLING RESULTS

In summary, results of surface water and sediment sampling along Huntington Drain indicate that several organic and inorganic constituents were detected above EDQLs. Although sampling results indicate that there are Site-related impacts to the sediment, the constituent concentrations decrease at the downstream location. Additionally, as described in the risk assessment summarized in Section 6.0, the ecological risk drivers, thallium and phenol, do not exist in the sediment or surface water above EDQLs.

5.0 DATA QUALITY

5.1 INTRODUCTION

Quality assurance/quality control (QA/QC) procedures were incorporated into the RFI program for the West Brine Field to ensure the collection of quality data for each area investigated, and to facilitate meeting the objectives of the RFI, as outlined in Section 1 of this Report. Additionally, such QA/QC procedures were employed to ensure that all information, data, and resulting decisions of the RFI are technically sound, statistically valid (accurate and precise), and properly documented, and to ensure the completeness of the data. The mechanism for employing the project QA/QC procedures was the Quality Assurance Project Plan (QAPP). The procedures in the QAPP facilitated identifying and monitoring the proper sample collection, handling, and laboratory protocols to be used during the RFI. The original QAPP, prepared for Phase I of the RFI, was prepared by Weston and is contained in Appendix B of the approved RFI Phase I Work Plan. A QAPP Addendum was prepared by CRA for the Phase II RFI and was submitted to the U.S. EPA on October 6, 1999.

This section of the RFI Report presents an overview of the project QA program and discusses the resulting quality of data, primarily analytical data, obtained during the RFI and presented in Sections 3 and 4 of this report.

Chemical analyses and geotechnical tests were conducted to determine the types and concentrations of constituents present in the various media at the Site and to provide environmental data (such as soil characteristics), as discussed in Section 2 of this report. Overall, analyses or tests were chosen based on the compounds produced or used within the specific SWMU/Area or the environmental data needed.

Soil, SWMTJ contents, and sediment samples were analyzed for the entire analyte list given in 40 Code of Federal Regulations (CFR) Part 264, Appendix IX (Appendix IX); Resource Conservation and Recovery Act (RCRA) characteristics (i.e., toxicity, ignitability, corrosivity, and reactivity); the Target Compound List (TCL) volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs); and/or the Target Analyte List (TAL) inorganics. The list of constituents is provided in Appendix H.

Water samples collected at the West Brine Field were analyzed for Appendix IX constituents.

All analytical work completed for the Phase I RFI was performed or administered by Weston's Environmental Metrics Division (EMD) (formerly the Analytics Division). Work was performed in the Weston Environmental Metrics, Inc. (Weston EMI) laboratory, located in University Park, IL, and in the Weston Lionville, PA laboratory. The University Park laboratory performed all analytical analyses, with the exception of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzo-p-furans (PCDFs), for all media. These latter constituents were analyzed by the Lionville facility.

The Phase II RFI analyses were completed in the Quanterra, Inc. North Canton, Ohio laboratory (now Severn Trent Laboratories, Inc., or STL).

Geotechnical analyses for the RFI (during the Phase I) were performed by the Weston Environmental Technology Laboratory (ETL) located in Lionville, PA. Geotechnical analyses used American Society for Testing and Materials (ASTM) methods as discussed in Section 3 of the QAPP.

5.1.1 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) OBJECTIVES

The specific QA/QC objectives for the West Brine Field RFI project are summarized in Table 3-1 of the QAPP. The objectives are divided into the following groups:

- Precision—The degree of agreement between the numerical values of a set of duplicate samples performed in an identical fashion constitutes the precision of the measurement. Precision is reported as relative percent difference (RPD) as expressed by the following formula:

$$RPD = \frac{(C - C_2)}{(C, + C_2)/2} \times 100\%$$

Where: C_1 = Value of original sample.
c_2 = Value of duplicate sample.

- Accuracy—Accuracy is the measure of a result to the accepted (or true) value. Accuracy is assessed by means of reference samples and percent recoveries. Errors may arise from personal, instrumental, or methods factors. Analytical accuracy is expressed as the percent recovery of an analyte that has been added to the sample (or standard matrix, i.e., blank) at a known concentration before analysis, and is expressed by the following formula:

$$\text{Accuracy} = \%\ \text{Recovery} = \frac{A_T - A_o}{A'} \times 100\%$$

Where: A_T = Total amount found in fortified sample.
A_o = Amount found in unfortified sample.
A' = Amount added to sample.

The fortified concentration may be specified by contract (U.S. EPA Contract Laboratory Program [CLP]) or laboratory QC requirements, or may be determined relative to background concentrations observed in the unfortified sample. In the latter case, the fortified concentration should be different enough (two to five times higher) from the background concentration to permit a reliable recovery calculation.

- Completeness—Completeness is a measure of the degree to which the amount of sample data collected meets the project scope and a measure of the relative number of analytical data points that meet all the acceptance criteria for accuracy, precision, and other criteria required by the specific method factors. Completeness is defined by the following two equations:

$$\frac{\text{Number of data analyzed}}{\text{Number of data collected}} \times 100\%$$

$$\frac{\text{Number of data validated}}{\text{Number of data analyzed}} \cdot 100\%$$

The overall QA objective for completeness for the project was to have 95% of the data analyzed and 95% of the data usable without qualification. The ability to meet or exceed this completeness objective was dependent on the nature of samples submitted for analysis. If data could not be reported without qualifications, project completion goals would still be met if the qualified data, i.e., data of known quality even if not perfect, were suitable for specified project goals.

- Representativeness—Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. The representativeness criterion is best satisfied by ensuring that sampling locations are properly selected and a sufficient number of samples are collected. Representativeness is addressed by describing sampling techniques and the rationale used to select sampling locations.

- Comparability—Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable with other measurement data for similar samples and sample conditions. This goal is achieved by using standard techniques to collect and analyze representative samples and by reporting analytical results in appropriate units.

5.2 QUALITY CONTROL PROCEDURES

To meet the QA/QC objectives of the project, the field work and laboratory analyses followed the standardized methods or procedures that were described in Appendices A and B of the approved RFI Phase I Work Plan and are summarized in the following subsections.

5.2.1 FIELD AND LABORATORY QC SAMPLES

Standard analytical QC checks instituted by field and laboratory personnel included, but were not limited to, the following:

- Field/rinsate blanks—Samples prepared using analyte-free (high performance liquid chromatography [HPLCII) water supplied by the laboratory or purchased from commercial sources that certify the quality of the water. Field/rinsate blanks were routed through sampling equipment following sample collection and decontamination. Preservatives or additives were added as required, and the blank sample was then sealed. The field/rinsate blank was shipped with routine samples collected for the same parameter group.

- Trip blanks—Volatile organic sample containers prepared in the laboratory using analyte-free water. The trip blanks accompanied the aqueous field samples during transport to the Site; during collection, packaging, and transport to the laboratory; and during analysis; and were contained in the same type of sample container as those used in the specific sampling effort. One trip blank sample was included with each shipment of aqueous samples designated for volatile organic compound (VOC) analysis.

- Duplicate samples—Samples collected from the same sampling location at the same time. Soil duplicates were homogenized (with the exception of VOC samples). At least one duplicate sample was analyzed from each group of samples of a similar matrix type for every 10 samples collected.

- Matrix spike/matrix spike duplicate (MS/MSD)—Samples in which compounds are added before extraction and analyses. The recoveries for spiked compounds can be used to assess how well the method used for analysis recovers target compounds (i.e., a measure of matrix interference in the sample). When reviewed in conjunction with other QC data, MS/MSDs may indicate reanalysis using a more appropriate method; At least one spiked sample analysis was performed on each group of samples of a similar matrix type and concentration for each batch of samples or for every 20 samples collected, whichever was more frequent.

- Surrogate spiking—Samples in which surrogate compounds are added before sample preparation for organics analysis. The review for spiked surrogate compounds can be used to assess method accuracy for each sample matrix.

5.2.2 FIELD ACTIVITIES

The accuracy of field measurements obtained from the organic vapor monitor (OVM), photoionization analyzer, organic vapor analyzer (OVA), specific conductance meter/temperature probe, pH meter, and turbidimeter was maintained on-Site by appropriate calibration procedures, as described in more detail in Section 8 of the QAPP.

The field investigation procedures used to perform the RFI Phase I and Phase II were presented in Appendix A of the Phase I and Phase II RFI Work Plans, respectively. The field procedures included the following:

- Surface and subsurface soil sampling.

- Surface-water and sediment sampling.

- Installation of monitoring wells in the shallow water-bearing zone.

- Groundwater sampling.

- Monitoring well casing and stream gauge surveying.

- Groundwater and surface-water-level monitoring.
- Slug testing.
- Installation of geotechnical borings/piezometers to the bedrock/overburden interface.
- Geophysical surveying.
- Test pitting and SWMU/Area materials sampling.
- Site reconnaissance and information gathering for potential receptor survey.
- Ancillary field activities, such as decontamination, field measurements, and fluids management.

Sample identification and documentation procedures were followed in the field as specified in Section 4 of the QAPF, including the following:

- Sample containers were labeled with the appropriate information.
- Samples were entered into the chain-of-custody record.
- A unique sample code was assigned to each sample collected.
- Signed custody seals were applied on opposite sides of the container lid.
- Samples were shipped to the analytical laboratory(s) in accordance with all U.S. Department of Transportation (DOT) requirements.

A bound field notebook was maintained by the on-Site technician at the Site to record daily activities, including sample collection and tracking information. Quantitative field data, such as water-level measurements and slug test data, were recorded in bound field notebooks on standardized forms. Qualitative or descriptive field data (such as soil textures) obtained from soil borings and monitoring wells were recorded in the field on standardized forms in field notebooks.

5.2.2.1 FIELD DATA REDUCTION AND VALIDATION

After checking the data in the field notes and forms, the data was reduced to tabular form, wherever necessary. After data reduction into tables or arrays, data sets were reviewed for anomalous values. Any inconsistencies or anomalies discovered were resolved immediately, if possible, by seeking clarification from the field personnel responsible for collecting the data.

5.2.3 LABORATORY ACTIVITIES

5.2.3.1 LABORATORY EQUIPMENT QUALITY CONTROL

The reliability and credibility of laboratory analytical instruments and QA of analytical results were ensured by documented calibration procedures and QC samples (such as method blanks and method spikes). A review of the calibration procedures and the calibration frequencies and QC samples is provided in Section 6 of the QAPP. The following instruments were used to analyze environmental samples:

- Gas chromatograph (GC).
- Gas chromatograph/ mass spectrometer (GC /MS).
- Atomic absorption spectrophotometer (AA).
- Inductively coupled plasma spectrometer (ICP).

Certain TCL VOCs, such as methylene chloride, acetone, 2-butanone, and toluene, are commonly detected as laboratory contaminants. In order to ensure that the data reported are not biased by potential laboratory contamination, certain QA procedures, including reagent blank analyses, were implemented. Assessment of the reagent blanks is discussed in Subsection 5.3.2.

5.2.3.2 LABORATORY DATA

In addition to the data collected in the field and recorded on the chain-of-custody forms, data describing the processing of samples were accumulated in the laboratory and recorded in laboratory notebooks.

Data reduction was performed by the individual analysts and consisted of calculating concentrations in samples from the raw data obtained from the measuring instruments.

The complexity of the data reduction was dependent on the specific analytical method and the number of discrete operations (e.g., extractions, dilutions, and concentrations) involved in obtaining a sample that could be measured.

System reviews were performed at all levels. The individual analyst constantly reviewed the quality of data through calibration checks, QC sample results, and performance evaluation samples. The Section Manager and/or the Analytical Project Manager reviewed the data for consistency and reasonableness with other generated data, and to determine if program requirements had been satisfied. Selected hard copy output of data (e.g., chromatograms, spectra, etc.) was reviewed to ensure that results were interpreted correctly. The Quality Assurance Officer independently conducted a review of selected projects to determine if laboratory and client QA/QC requirements had been met. The final routine review was performed by the Laboratory/Project Manager prior to reporting the results to the client.

5.3 DATA QUALITY

5.3.1 DATA REPORTING

Laboratory reports contain final results, methods of analysis, levels of detection, surrogate recovery data, and method blank data. In addition, special analytical problems and/or any modifications of referenced methods were noted. The raw database is included in this RFI Report on a diskette. As stated in the RFI Work Plan, a hard copy of 10% of the full CLP data packages and data validation reports will be made available to U.S. EPA upon written request to ATOFINA Chemicals, Inc.

The database is in ASCII flat files of fixed width columns. One file exists for each of the surface/groundwater samples and soil/waste/sediment samples. The database can be opened with most spreadsheet or database programs.

5.3,2 DATA VALIDATION/USABILITY REVIEW

Separate from the laboratory's internal data review/data validation, a review of the final analytical data packages was performed to validate results and to determine usability. Criteria to assess usability were taken from the most current version of U.S. EPA's functional guidelines on data validation. Guideline criteria were applied to available documentation. Blank data, surrogate and MS/MSD recovery, and sample

chromatograms were reviewed in light of the guidelines. This validation was performed by project personnel experienced in laboratory procedures and validation procedures, and did not include those persons directly involved with the analysis.

Assessment of the reagent blanks followed the procedures specified in the current *version of* U.S. EPA's *CLP National Functional Guidelines for Organic Data Review* (U.S. EPA, 1994a). The results of the blanks themselves must contain less than five times the U.S. EPA CRDL of methylene chloride, acetone, 2-butanone, toluene, and common phthalate esters, and less than the CRDL of other TCL compounds for the reported blank data to be considered valid. The analytical data for the Site samples were then evaluated using the blank data by the following process and general criteria:

- If a compound is found in a blank but not found in the Site sample, no action is taken.

- Results of common laboratory contaminants, methylene chloride, acetone, toluene, 2-butanone, and common phthalate esters (i.e., di-n-butyl-phthalate) detected in the Site sample at individual concentrations less than 10 times the respective concentration in the blank are qualified as non-detects.

- For other TCL compounds, results of compounds detected in the Site sample at individual concentrations less than five times the respective concentration in the blank are qualified as non-detects.

5.3.3 RESULTS OF DATA VALIDATION/USABILITY REVIEW

The data validation, as discussed previously, was performed using criteria established in *federal guidelines contained in National Functional Guidelines for Organic Data Review* (U.S. EPA, 1994a) and *National Functional Guidelines for Inorganic Data Review (U.S.* EPA, 1994b), as well as good professional judgment. The data validation procedures did not apply to results from geotechnical analyses since these analyses were for physical, not chemical, properties. The data quality was evaluated based on the following parameters:

- Data completeness.
- Holding times.
- Laboratory equipment calibrations.
- GC/MS instrument performance check (organic only).

- CRDLs (inorganic only).
- ICP interference check sample results (inorganic only).
- Blanks.
- Surrogate recoveries (organic only).
- Field/laboratory duplicate precision.
- Internal standard performance (organic only).
- Compound identification/quantitations.
- MS/MSD analyses.
- Detection limit results (inorganic only).
- Laboratory control sample (inorganic only).
- ICP serial dilution analysis (inorganic only).
- Furnace AA results (inorganic only).
- Pesticide instrument performance (pesticides only).

In general, the results of the Phase I and Phase II RFI data validations indicated that the data are usable for evaluating the conditions at the West Brine Field. The goal of completeness for the project is for 95% of the data to be analyzed, and 95% of the data to be usable without qualification. For the Phase I RFI, $^{100\%}$ of the data collected were analyzed and 98.3% of the data analyzed were validated as usable (unusable data were data that were rejected by the validators). For the Phase II RFI, 100% of the data were collected and 100% were usable. These percentages exceed the project completeness goals.

As stated in the Phase I RFI Work Plan, Phase I data validation reports will be made available to U.S. EPA upon written request to ATOFINA Chemicals, Inc. A data validation summary for the Phase I RFI is included as Appendix A.1, Attachment 1. Phase II RFI data validation memoranda are included in Appendix A.2, Attachment 1.

6.0 RISK ASSESSMENT

6.1 INTRODUCTION

This section presents a summary of the human, health and ecological risk assessments conducted for the West Brine Field property. The purpose of the risk assessments was to determine if residual constituents pose unacceptable hazards or risks to potential human or ecological receptors at the Site. The risk assessments are presented in Appendix J.

Based on the conceptual Site models developed during previous phases of the Site assessment process, appropriate and realistic human and ecological exposure scenarios were developed. Human receptors included hypothetical future maintenance workers, office workers, construction workers, utility trench workers, and trespassers. Ecological receptors included the white-tailed deer, the meadow vole, and the American robin.

Data from the Site were tabulated into a database and analyzed for descriptive statistics such as minimum, mean, and maximum concentrations, 95% upper confidence limit of the mean (95% UCL), and distribution type (e.g., normal, lognormal, etc.), among others. Surface soil data were considered to be at a depth of one to three feet, based on the available sample collection intervals. Subsurface data were considered from one to fourteen feet bgs. For both the human health and ecological risk assessments, if a constituent was not detected in a given medium (e.g., surface soil), that constituent was eliminated from further analysis. Appendix $_J$ presents additional detail on these analyses and evaluations.

6.2 HUMAN HEALTH RISK ASSESSMENT

For the human health risk assessment, Site data were screened against applicable Region 9 Preliminary Remediation Goals (PRGs). Criteria were selected for screening based on the chosen receptors and their respective potential exposures to residual constituents at the Site. Maximum concentrations of constituents in surface soils were screened against industrial soil PRGs to account for hypothetical maintenance worker and trespasser exposures. Maximum concentrations of constituents in surface and subsurface soils were compared to the same criteria as surface soils to account for the hypothetical construction worker and hypothetical future office worker exposures. Also for the hypothetical office worker and utility trench worker scenarios, maximum concentrations of constituents in groundwater were compared to tap water PRGs. In all cases, where

U.S. EPA Region 9 PRGs were not available, Michigan Part 201 Screening Criteria were used. If a constituent's maximum concentration exceeded the aforementioned screening criterion (or a screening criterion was not available), it was retained for further quantitative evaluation in the risk assessment. If a constituent's maximum concentration was less than a screening criteria, that constituent was dropped from the quantitative analyses associated with the potential exposures represented by the screening criterion. Constituents without PRGs or Part 201 screening criteria were also retained for quantitative analysis.

Some organic compounds detected in soils at the West Brine Field were not conclusively identified by the analytical laboratory and were therefore reported as Tentatively Identified Compounds (TICs). According to regulatory guidance, a qualitative analysis of TICs at the West Brine Field is appropriate and underway. This assessment, to be presented in the forthcoming Corrective Measures Study (CMS), will include the examination of a number of factors including: detection frequency; spatial distribution; concentration levels; toxicology; and additional traditional risk assessment techniques.

Sometimes a sample may be reported as nondetect for a specific constituent but the detection limit for that constituent is unusually elevated. Elevated detection limits can result from laboratory practices *(e.g.,* dilutions) undertaken to address chemical or sample interference during analysis. In some cases, these detection limits may be elevated to the point where they exceed screening criteria but the sample is still reported as nondetect and treated thusly during the risk assessment process. Actual concentrations of constituents in these samples may be less than typical detection limits, thus, treating them as nondetect in a risk assessment may be appropriate. Conversely, constituents in these samples may be present at concentrations near the elevated detection limit (exceeding screening criteria) and so treating them as nondetect may underestimate associated risks and the potential for adverse health affects. For this latter reason, constituents that were reported as nondetect in 100% of the samples in a given medium at the West Brine Field Site were addressed qualitatively in the risk assessment. The potential for underestimating risks and the overall uncertainty in the quantitative estimations is not likely to be substantial as a result of the possible presence of constituents reported as 100% nondetect.

A thorough review of the West Brine Field dioxin and furan sample analysis data revealed that samples were analyzed only for 2,3,7,8-TCDD and total homologue groups *(e.g.,* Total TCDDs, Total PeCDDs, Total HxCDFs, Total TCDFs, Total PeCDFs, and Total HxCDFs). The reported data do not differentiate between 2,3,7,8-substituted and non-2,3,7,8-substituted CDD/CDF congeners, therefore the true contribution of the

2,3,7,8-substituted congeners (the relatively more toxic group of CDDs/CDFs) is unknown. In an effort to quantify potential risks associated with exposures to dioxin/furan compounds given the lack of congener-specific data from the West Brine Field, TEF calculations were performed using total homologue group results based on the best available technique presented in Part I of the 1989 U.S. EPA interim guidance *document: Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and -Dibenzofurans (CDDs and CDFs) and 1989 Update (U.S.* EPA/625/3-89/016, March 1989).

Potential exposures to construction workers, maintenance workers, office workers, utility trench workers, and trespassers were estimated based on paradigms from widely accepted U.S. EPA guidance documents. Exposure parameters were extracted from U.S. EPA or MDEQ guidance or were developed for Site-specific scenarios where published values were not available or realistic. Subchronic exposures were considered to be less than seven years whereas chronic exposures were considered to be greater than seven years, in accordance with U.S. EPA risk assessment guidance.

Toxicity indices, reference doses (RfDs) and cancer slope factors (CSFs), were retrieved from a hierarchy of sources including U.S. EPA's Integrated Risk Information System (IRIS), Health Effects Summary Tables (HEAST), and National Center for Environmental Assessment (NCEA). If published toxicity values did not exist for a given constituent, provisional values were developed using published toxicity data (such as No Observed Adverse Effect Levels) and U.S. EPA-accepted methodology for the derivation of toxicity benchmarks.

The results of the exposure assessment and toxicity characterization were combined to estimate hazard indices and cancer risk levels for the receptors hypothetically accessing the Site in the future. Hazard and risk calculations were summed for each exposure route and then summed again for each exposure pathway by receptor.

The risk characterization revealed no estimated cancer risk levels exceeding the lx 10 benchmark with the exception of the maintenance worker scenario. Potential risk to the maintenance worker ($3x1ft^5$) was solely attributable to the presence of a single detection of n-nitrosodiethylamine in Area 7. No total hazard indices exceeded the 1.0 *de minimis* benchmark.

6.3 ECOLOGICAL RISK ASSESSMENT

For the ecological risk assessment (ERA), surface soil, sediment, and surface water analytical data were used as the basis for statistical and ecological exposure analysis and were screened against appropriate U.S. EPA Region 5 Ecological Data Quality Levels (EDQLs). Soil EDQLs were used for comparison with shallow-depth soil concentrations, however these benchmarks were not available for all COPCs. In the absence of soil EDQLs, values developed by Oak Ridge National Laboratory (ORNL) were used for comparative purposes. If the maximum concentration of a constituent was greater than the applicable benchmark, or if a screening criterion was not available, the constituent was retained for quantitative exposure assessment.

Exposure routes for the white-tailed deer included ingestion of surface water and vegetation, as well as incidental ingestion of soil and sediment. Exposure routes for the meadow vole included incidental soil and sediment ingestion, surface water ingestion, and ingestion of plants. Exposure routes for the American robin included incidental ingestion of soil and sediment, ingestion of surface water, ingestion of terrestrial invertebrates, and ingestion of vegetation. The use of conservative exposure assumptions for each of these receptors resulted in estimated exposures representative and sufficiently protective of other species comprising their respective trophic guilds.

Characteristics of terrestrial ecological receptors such as habitat needs, food preference, reproductive cycles, seasonal activities such as migration, and selective use of resources influenced constituent exposure. These factors were utilized in the formulation of an exposure assessment equation that estimated a mass-specific, time-weighted average intake for each medium or food source.

No unacceptable risk was predicted to individual white-tailed deer from residual constituent levels in West Brine Field sediment or surface water. Similarly, no unacceptable risk to individuals was predicted from incidental soil ingestion. Potential risk to individual deer is indicated from ingesting upland vegetation. This potential risk is attributable to phenol in surface soil. No unacceptable risks were estimated for the deer population as a whole.

Hazard indices (HIs) developed for the soil ingestion exposure pathway suggested a potential risk to individual meadow voles. Potential population-level effects to meadow voles may be incurred resulting from ingestion of soil-dwelling vegetation. Potential risk from this pathway stems primarily from the presence of phenol.

For individual American robins, HIs exceeded unity for the soil, soil invertebrate, and vegetation ingestion pathways. Potential vegetation ingestion risk to robin populations is attributable primarily to phenol in surface soils. Thallium and phenol contribute to the majority of the potential risk to robin populations from the soil invertebrate ingestion pathway, however detectable levels of thallium in SWMU 3 surface soils were below background concentrations for this element.

Hazards from aluminum in soils to ecological receptors were considered negligible based on the low bioavailability of this metal as well as the comparability of West Brine Field concentrations to typical concentrations from undisturbed soils across the United States. Likewise, risks associated with zinc and chromium are also considered to be negligible, given that elemental concentrations at the West Brine Field Site are at levels near or below typical concentrations found across the United States.

7.0 CONCLUSIONS/RECOMMENDATIONS

As stated in Section 1.0, the Consent Order required ATOFINA Chemicals, INC. to conduct a RFI to determine whether a release of hazardous wastes or constituents has occurred from the SWMUs/Areas into soils and, possibly, sediment, surface water and/or groundwater; to determine the nature and extent of any releases; and to determine potential risk to human and ecological receptors, if any.

The results presented in this RFI Report have demonstrated that all three RFI objectives have been met through the completion of the Phase I and Phase II RFIs. First, constituents were detected in five SWMUs/Areas investigated above detection limits or background, indicating that a release of constituents has occurred. Secondly, the test pits and boreholes have determined that the boundaries of each SWMU/Area have been delineated. Finally, based on applicable potential exposure pathways, the human and ecological risk assessments have determined that potential human health risks are limited to the presence of n-nitrosodiethylamine in Area 7 soil and ecological risk drivers are limited to thallium and phenol in WBF surface soil.

The following subsections summarize the results of the RFI and elaborate on these conclusions presented above.

7.1 ENVIRONMENTAL SETTING AND PATHWAYS

7.1.1 GEOLOGY

The West Brine Field stratigraphy consists primarily of a tight compact silty clay (brown and gray) with varying degrees of permeability. The silty clay consists of two visibly distinct groups (brown and gray clay) with similar textures and compositions. The brown clay is a slightly more permeable subunit ($1ft^{7}$ cm/s) than the gray clay (10 cm/s).

7.1.2 HYDROGEOLOGY

Three hydrogeologic zones were identified during the investigation activities, which are comprised of a shallow water-bearing zone, intermediate aquitard, and deep confined water-bearing zone. Shallow groundwater generally flows very slowly (due to low permeabilities) from the northern and southern boundaries of the Site inward toward

Huntington Drain, where the flows converge and then move easterly toward Monguagon Creek. However, during parts of the year, this groundwater is discontinuous. The impermeable intermediate aquitard prevents vertical migration.

Groundwater in the deep water-bearing zone is not used as a source of drinking water due to the high concentrations of naturally occurring chlorides, hydrogen sulfides, and methane in the limestone bedrock. Groundwater in the shallow water-bearing zone is not used due to a deed restriction, and the relatively low yielding capacity of the clay.

7.1.3 POTENTIAL RECEPTOR IDENTIFICATION SURVEY

The following conclusions can be drawn from the Potential Receptor Identification Survey conducted for the West Brine Field:

- Land in the vicinity of the West Brine Field is used for industrial, residential, commercial, and recreational purposes. Human receptors other than occasional Site workers and trespassers do not have direct access to the Site.

- Groundwater within a 1-mile radius of the Site is not a source of drinking water and groundwater in the shallow water-bearing zone less than 25 feet bgs is restricted by Wayne County from use. Area drinking water is obtained from the Detroit River upstream of the West Brine Field. Groundwater at the Site is restricted from use due to deed restrictions.

- The habitat at the Site and around the Site is typical habitat that has been physically disturbed by humans (e.g., filling activities, clearing of vegetation, mowed lawns, etc.). Based on conditions at the time of the Site inspection, there was no observed evidence of stressed vegetation, stressed terrestrial populations, or other indicators that there have been adverse effects to the flora or fauna. The habitat in Huntington Drain would support fish, although none were observed during the Site reconnaissance. The Detroit River in the vicinity of the West Brine Field is used for recreational fishing; various fish and waterfowl species are found in the Detroit River ecosystem.

- Based on the Site reconnaissance, there were no observable effects on the ecosystem as a result of Site history or current conditions.

7.1.4 PATHWAYS AND SCREENING LEVELS

Based on the information obtained from the Site environmental setting and the Potential Receptor Identification Survey, the following applicable screening levels were identified for the West Brine Field and were used for comparison to detected constituents:

- Soils:
  - — Part 201 Generic Industrial Ambient Air Infinite Source Volatile Soil Inhalation Criteria (VSIC)
  - — Part 201 Generic Industrial Direct Contact Criteria (DCC)
  - — Part 201 Generic Industrial Groundwater Contact Protection Criteria (GCPC)
  - — Part 201 Generic Industrial Particulate Soil Inhalation Criteria (PSIC)
  - — Part 201 Generic Industrial Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC)
  - — EPA Region 9 Industrial Soil Preliminary Remediation Goals (PRGs)
  - — U.S. EPA Region 5 Ecological Data Quality Levels (EDQLs)

- Groundwater
  - — Part 201 Groundwater Surface Water Interface (GSI) Criteria
  - — Part 201 Generic Industrial Groundwater Contact Criteria (GCC)
  - — Part 201 Generic Industrial Groundwater Volatilization to Indoor Air Inhalation Criteria (GVIIC)
  - — Part 201 Generic Flammability and Explosivity Screening Levels
  - — Part 201 Generic Acute Inhalation Screening Levels
  - — U.S. EPA Maximum Contaminant Levels (MCLs)
  - — U.S. EPA Region 9 Groundwater PRGs

- Sediment
  - — U.S. EPA Region 5 Ecological Data Quality Levels (EDQLs)

- Surface Water
  - — U.S. EPA Region 5 Ecological Data Quality Levels (EDQLs)

Additional screening criteria used include comparison to RCR.A characteristics to determine if SWMU contents/soil tested were RCRA characteristic hazardous wastes. Background metal concentrations were used to screen results prior to comparing them to the previously listed guidance levels.

7.2 SOURCE CHARACTERIZATION AND GROUNDWATER QUALITY

The results of the data evaluation presented in Section 4.0 show that, although SWMUs are present at the Site, and constituents related to the SWMUs and Site activities were detected in soil, groundwater, surface water, and sediment to some extent, any impact to these media is relatively small.

The lateral and vertical boundaries of fill materials observed at SWMUs 1, 3, and 4 were delineated using test pits and soil borings. SWMU 1 contents, including drums and filter cake, were found in an area approximately 160 feet long by 85 feet wide and 14.5 feet deep. SWMU 3 contents, including miscellaneous debris, construction rubble, and Vultacs, were found in an area approximately 170 feet long by 1,250 feet wide and 10 feet deep. SWMU 4 contents, including purple-brown clayey fill, were found in an area approximately 135 feet long by 45 feet wide and up to 15 feet deep. In Area 7, stained/odorous soils were identified in an area of approximately 80 feet by 100 feet by 12.5 deep. All SWMU contents were sampled for comparison to SLs.

The results of the SWMU characterizations are summarized below:

1. SWMU 1 - The results of the sampling activities indicate that naphthelene, phenol, bis(2-ethylhexyl)phthalate and various metals are present in the soil and/or groundwater at concentrations exceeding background, EDQLs and/or U.S. EPA SLs. SWMU 1 was adequately delineated.

2. SWMU 3 - The results of the sampling activities indicate that n-nitrosodiphenylamine, naphthalene, bis(2-ethylhexyl)phthalate, 2,3,7,8-TCDD (TEQ value), benzo(a)pyrene, chloroform and various metals are present in the soil and/or groundwater at concentrations exceeding background, Part 201, EDQLs and/or U.S. EPA SLs. Part 201 exceedances in SWMU 3 were limited various metals exceeding GSI criteria and manganese in soil exceeding PSIC criteria. The PSIC exceedance was at a depth interval of 5 to 7 feet bgs where particulate soil inhalation exposures are unlikely. Additionally, the GSI exceedances were from total metals concentrations (with the exception of soluble cadmium) of highly turbid groundwater samples. SWMU 3 was adequately delineated.

3. SWMU 4 - The results of the sampling activities indicate that benzene, carbon disulfide, methylene chloride, n-nitrosodiphenylamine, naphthalene, phenol, bis(2-ethylhexyl)phthalate, 2,3,7,8-TCDD (TEQ value), sulfide, and various metals are

present in the soil and/or groundwater at concentrations exceeding background, Part 201, EDQLs and/or U.S. EPA SLs. SWMU 4 was adequately delineated.

4. Area 7 - The results of the sampling activities indicate that n-nitrosodiethylarnine, is present in the soil at concentrations exceeding U.S. EPA SSLs and EDQLs. Area 7 was adequately delineated.

0. 5) — The results of surface water and sediment sampling Huntington Drain indicate that several organic and inorganic constituents were detected above EDQLs. However, the ecological risk drivers, thallium and phenol, do not exist in the sediment or surface water above EDQLs. The concentrations decrease towards the downstream sampling location. Area 5 was adequately characterized.

As discussed in Section 4.0, various metals were detected above background concentrations; however, since 1) metals were detected below applicable Part 201 industrial criteria at the SWMU's/Area's boundaries and 2) the test pits and soil borings physically identified the extent of the SWMU/Area contents, the horizontal and vertical limits of each SWv1U/Area have been defined. Furthermore, the presence of multiple inorganic constituents in soils at concentrations exceeding calculated background levels, as well as the absence of these inorganics in the waste materials and in historic manufacturing process at the source facilities (East Plant and West Plant), indicate that the background concentrations for inorganics my have been underestimated by the background sampling and subsequent upper confidence limit calculations.

No SWMU/Area contents at the West Brine Field were determined to be RCRA characteristic hazardous wastes.

7.3 RISK ASSESSMENT

The human health and ecological risk assessments were conducted to determine if residual constituents pose unacceptable hazards or risks to potential human or ecological receptors at the Site. Based on the conceptual Site models developed during previous phases of the Site assessment process, appropriate and realistic human and ecological exposure scenarios were developed. Data from the Site were tabulated into a database and analyzed for descriptive statistics.

The risk characterization revealed no estimated cancer risk levels exceeding the $lxl0^{-5}$ benchmark with the exception of the maintenance worker scenario. Potential risk to the maintenance worker ($3x10^{5}$) was solely attributable to the presence of a single detection of n-nitrosodiethylamine in Area 7. No total hazard indices exceeded the 1.0 *de minimus* benchmark.

The ecological risk assessment identified potential risk to individual deer from ingesting upland vegetation attributable to phenol in surface soil. No unacceptable risks were estimated for the deer population as a whole. Hazard indices (HIs) developed for the soil ingestion exposure pathway suggested a potential risk to individual meadow voles. Potential risk from this pathway stems primarily from the presence of phenol. For individual American robins, HIs exceeded unity for the soil, soil invertebrate, and vegetation ingestion pathways. Potential vegetation ingestion risk to robin populations is attributable primarily to phenol in surface soils. Thallium and phenol contribute to the majority of the potential risk to robin populations from the soil invertebrate ingestion pathway, however detectable levels of thallium in SWMU 3 surface soils were below background concentrations for this element.

7.4 SUMMARY

In summary, based on the information obtained during the RFI and potential risks identified in the human and ecological risk assessments, the following SWMUs/Areas will be included in a Corrective Measures Study (CMS):

1. SWMTY 1 - Based on the human health risk assessment, the constituent concentrations do not pose human health risks. However, ecological risks are possible due to the presence of phenol in waste and soil samples. As a result of these exceedances, and also due to the existence of buried drums, SWMU 1 will be included in a CMS.

2. SWMU 3 - Although constituents were detected above applicable criteria in SWMU 3, based on the human health risk assessment, the concentrations identified do not pose unacceptable human health risks. A single detection of thallium in SWMTJ 3 surface soils resulted in unacceptable potential ecological risk posed to the avian receptor selected for evaluation (albeit the concentration was below Site-specific background levels). Because of the potential for adverse ecological effects from exposure to thallium, the presence of waste (construction debris and potential

drummed still bottoms), and the potential for effects on SVVMU 3 during a 100-year flood event, SWMTJ *3* will be included in a CMS.

3. SWMU 4 - Based on the human health risk assessment, the concentrations identified do not pose unacceptable human health risks. However, ecological risks are possible due to the presence of phenol in soil samples. As a result of potential ecological risks and the potential effects on SWMU 4 during a 100-year flood event, SWMU 4 will be included in a CMS.

t

0. rea7 - Based on the human health risk assessment, potential human health risks exist in Area 7 due to the presence of n-nitrosodiethylamine in soil. Ecological risk drivers (thallium and phenol) identified in the ecological risk assessment were not detected in Area 7 soil. As a result of the potential human health risks associated with n-nitrosodiethylamine, Area 7 will be included in a CMS.

4. Huntington Drain (Area 5) — Although no unacceptable ecological risks are attributed to the surface water or sediments in the Huntington Drain, potential does exist for sediment transport downstream during a 100-year flood event. Therefore, Area 5 will be included in the CMS.

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TABLE 1.1

SUMMARY OF BACKGROUND INFORMATION FOR SWMUS/AREAS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

SWMU/Area	*Identification*	*Description/Contents*[1]
SWMU 1	Former Landfill 1	Believed to have been a former disposal area for filter cake from Process 12[2] at the West Plant; possibly Vultacs (polyamyl phenol disulfides - West Plant Process 22[3]). Dates and means of disposal are not known.
SWMU 2	Former Landfill 2	Interim Remedial Measure (IRM) completed in 1994/1995.
SWMU 3	Former Landfill 3	Believed to have been a former disposal area for filter cake and drummed still bottoms from Process 12 at the West Plant; possibly Vultacs (West Plant Process 22). Dates and means of disposal are not known.
SWMU 4	Former Landfill 4	Believed to have been a former disposal area for filter cake from Process 12 at the West Plant; possibly Vultacs (West Plant Process 22). Records indicate that disposal may have taken place in 1968. Means of disposal are not known
SWMU 7	Area identified during RFI Phase I activities.	Believed to have been a former disposal area. Dates and means of disposal are not known.

Notes:

(1) Description/Contents are based on the Description of Current Conditions Report (Weston, 1990), historical records and knowledge of ATOFINA Chemicals, Inc. personnel.

(2) Process 12 consisted of three separate batch operations (reaction, distillation and product flaking) that produced ortho, para, and di-tertiaryamylphenol (this process ceased in 1990 – Process 12 currently produces methane sulfonamide). The chemical reaction in the process included the reaction of isoamylene with phenol in the presence of phosphoric acid and a silica-alumina clay catalyst. Caustic was used to neutralize the catalyst. Solid wastes consisted of a clay catalyst filter cake that is a 50/50 mixture of clay catalyst and crude product. Hazardous constituents in the amylphenol filter cake consisted of: phenol; 2,4-dimethylphenol; 2,4,6-trichlorophenol; p-chloro-m-cresol; and pentachlorophenol.

(3) Process 22 currently operates and runs on a batch basis producing polyamyl phenol disulfides (Vultacs). Sulfer mono chloride, paratertiary amyl phenol, stearic acid, industrial white oil and napthol are used as raw materials. Hydrogen chloride is generated during the reaction as a byproduct. The alkylamine product is solidified on a moving belt filter then drummed or flaked.

(4) The lateral and vertical boundaries of fill materials observed at SWMUs 1, 3, and 4 were delineated using test pits and soil borings. SWMU 1 contents, including drums and filter cake, were found in an area approximately 160 feet long by 85 feet wide and 14.5 feet deep. SWMU 3 contents, including miscellaneous debris, construction rubble, and Vultacs, were found in an area approximately 170 feet long by 1,250 feet wide and 10 feet deep. SWMU 4 contents, including purple-brown clayey fill, were found in an area approximately 135 feet long by 45 feet wide and up to 15 feet deep. In Area 7, stained/odorous soils were identified in an area of approximately 80 feet by 100 feet by 12.5 deep.

TABLE 1.2

SUMMARY OF DATA NEEDS, QUALITY OBJECTIVES, AND DATA USES
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Unit/Area	RFI Objectives	Data Needed	Proposed Data Collection and Evaluation Activities	Analytical* Level
Brine field area/Huntington Drain	Supplement and verify the existing environmental setting information at the site and evaluate the site.	Field measurement, geotechnical analyses. Chemical analysis of surface water and sediments.	Well installation, piezometer installation, subsurface lithologic logging, geotechnical analyses (physical properties and permeability), slug testing, and water elevation measurements. Analyze surface-water and sediment samples from Huntington Drain for Appendix IX constituents.	I
Landfill 1—SWMU 1	Determine if a release has occurred.	Chemical analysis of groundwater and soils.	Analyze groundwater and grab soil samples for Appendix IX and TCL/TAL constituents.	III
			Analyze grab soil samples for semivolatiles.	III
	Determine the dimensions of the unit.	Geophysics, borings, test pit information.	Perform ground-penetrating radar (GPR) survey, borings, and test pitting.	I
	Characterize the properties of solid materials, if any.	RCRA characterization and chemical analysis of solid materials.	Analyze solid materials for Target Compound List (TCL) semivolatiles and Appendix IX constituents.	III
Landfill 2—SWMU 2	Investigate quality of groundwater.	Chemical analysis of groundwater.	Analyze groundwater for Appendix IX constituents.	III
	Investigate quality of surface water.	Chemical analysis of surface soils.	Analyze surface soils for TCL semivolatiles and Appendix IX constituents. (Completed prior to RFI Phase I .)	III
	Determine the dimensions of the unit.	Geophysics information.	Perform GPR and magnetometer surveys. (Completed prior to RFI Phase I.)	I
Landfill 3 — SWMU 3	Determine if a release has occurred.	Chemical analysis of groundwater and soils.	Analyze groundwater and soil samples for Appendix IX and TCL/TAL constituents.	III
	Determine the dimensions of the unit.	Geophysics and test pit information.	Perform GPR and magnetometer surveys and test pitting.	I

TABLE 1.2

SUMMARY OF DATA NEEDS, QUALITY OBJECTIVES, AND DATA USES
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Unit/Area	RFI Objectives	Data Needed	Proposed Data Collection and Evaluation Activities	Analytical* Level
Landfill 3 — SWMU 3 (continued)	Characterize the properties of solid materials, if any.	RCRA characterization and chemical analysis of solid materials.	Analyze solid materials for TCL semivolatiles, Appendix IX constituents, and RCRA characteristics.	III
Landfill 4— SWMU 4	Determine if a release has occurred.	Chemical analysis of groundwater and soils.	Analyze groundwater and soil samples for Appendix IX and TCL/TAL constituents.	III
	Determine the dimensions of the unit.	Geophysics, borings, test pit information.	Perform GPR survey, borings, and test pitting.	I
	Characterize the properties of solid materials, if any.	RCRA characterization and chemical analysis of solid materials.	Analyze solid materials for TCL semivolatiles, Appendix IX constituents, and RCRA characteristics.	III
SWMU 7	Determine if a release has occurred.	Chemical analysis of soils.	Analyze soil samples for TCL semivilatiles, TAL metals, and sulfide..	III
	Determine the dimensions of the unit.	Borehole and test pit information.	Perform borings and test pitting.	I
	Characterize the properties of solid materials, if any.	Chemical analysis of solid materials.	Analyze solid materials for Appendix IX volatiles and semivolatiles..	III
Plant area	Determine background concentrations.	Chemical analyses of groundwater and soils from historically undisturbed areas.	Analyze groundwater and soil samples for Appendix IX constituents.	III

*Analytical levels as defined by EPA/840/G-87/1003.

Level I: Field screening or analysis for total organic/inorganic vapor detection or other parameters using portable instruments and/or field test kits. Results are often not compound-specific and not quantitative, but results are available in real time.

- Limitations: Instruments respond to naturally occurring compounds.
- Data quality: If instruments are calibrated and data are interpreted correctly, an indication of contamination can be provided.

Level III: Analyses are performed at a fixed-base analytical laboratory. Data uses include risk assessment, site characterization, and evaluation of alternatives. Analysis is for organics and inorganics, and it may be analyte-specific. Analysis uses EPA procedures (can be other than Contract Laboratory Program [CLP] procedures), and RCRA characteristic tests.

- Limitations: Tentative identification in some cases, yet data quality of CLP may be provided.
- Data quality: Similar procedures and detection limits to CLP; CLP level of quality assurance/quality control (QA/QC) (validation, documentation) not required.

TABLE 2.1

SAMPLING AND ANALYTICAL ACTIVITIES SUMMARY – PHASE I RFI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Unit/Area	Field Activity	Number of Samples	Laboratory Analyses[a]
Landfill 1 (SWMU 1)	Conduct geophysical survey (GPR, EM, MAG).	NA	NA
	Excavate test pits (10).	NA	NA
	Sample solids from test pits.	2	TCL SVOCs Appendix IX
	Sample solids representing drum contents.	1	TCL SVOCs Appendix IX RCRA characteristics
	Sample soil from beneath solids in test pits.	2 1	TCL SVOCs Appendix IX
	Install, sample, and slug test monitor well MW-006.	1	Appendix IX
Landfill 2 (SWMU 2)[b]			
Landfill 3 (SWMU 3)	Conduct geophysical survey (GPR, EM, MAG).	NA	NA
	Excavate test pits (15).	NA	NA
	Sample solids from test pits.	3 1	TCL SVOCs Appendix IX RCRA characteristics
	Sample soil from beneath solids in test pits.	6 1	TCL SVOCs Appendix IX
	Install, sample, and slug test monitor wells MW-002 and MW-003.	2	Appendix IX
Landfill 4 (SWMU 4)	Conduct geophysical survey (GPR, EM, MAG).	NA	NA
	Excavate test pits (10).	NA	NA
	Sample solids from test pits.	2 1	TCL SVOCs Appendix IX, RCRA characteristics
	Sample soil from beneath solids in test pits.	2 1	TCL SVOCs Appendix IX
	Install, sample, and slug test monitor well MW-004.	1	Appendix IX
Surface depressions[c] (SWMU 7)	Excavate test pits (3).	NA	NA
	Sample soil from test pits.	2	Appendix IX VOCs and SVOCs

TABLE 2.1

SAMPLING AND ANALYTICAL ACTIVITIES SUMMARY – PHASE I RFI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Unit/Area	Field Activity	Number of Samples	Laboratory Analyses[a]
Huntington Drain	Sample surface water.	3	Appendix IX
	Sample sediment.	3	Appendix IX
	Install stream gauges (3).	NA	NA
Background	Sample subsurface soil	3	Appendix IX
	Install, sample, and slug test two monitor wells, MW-001, MW-005 and MW-007.	3	Appendix IX
	Advance six geotechnical borings (BP-200, BP-201, BP-203, BP-204, BP-206, and BP-207) and install piezometers in the boreholes.	26	Geotechnical analyses

[a]The acronyms for the various analyses are defined as follows:
TAL = Target Analyte List.
TCL = Target Compound List.
RCRA characteristics = Toxicity Characteristic Leaching Procedure (TCLP), corrosivity, reactivity, and ignitability.
SVOCs = Sem-volatile organic compounds.
VOCs = Volatile organic compounds.
Appendix IX = 40 CFR 264, Appendix IX Groundwater Monitoring List.
Geotechnical analyses = Gradation, plasticity, specific gravity, natural moisture content, organic content, density, porosity, and permeability.
NA = Not applicable.
GPR = Ground penetrating radar.
EM = Electromagnetic terrain conductivity.
MAG = Magnetometry.

[b] This SWMU remediated in 1995. The scope of work included surface soil sampling, the excavation and disposal of drums and associated soils, confirmatory soil sampling from the bottom of the excavation, and installation of three piezometers to monitor water levels downgradient of the former landfill. The results are presented in two reports, the Investigation Report and the Corrective Action Report (Weston, 1995a, 1995b).

[c]Area identified during site reconnaissance but not listed in RFI Phase I Work Plan or Consent Order.

TABLE 2.2

DEVIATIONS BETWEEN THE PROPOSED WORK AND THE WORK ACTUALLY PERFORMED
PHASE I RFI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Site	Deviations
West Brine Field	One year of quarterly 48-hour continuous groundwater level monitoring was not performed. Results of previous groundwater monitoring tests at the East Plant provided sufficient data to amend the monitoring frequency to quarterly water-level measurements. This was discussed in a letter from Mr. Lawrence Bove (Weston) to Mr. Michael Valentino (U.S. EPA) dated 28 January 1997.
Landfills 1, 3, and 4	EM survey was not proposed in the RFI Phase I Work Plan, but was performed in conjunction with the GPR and MAG surveys to further delineate the former landfill boundaries. A description and methodology of the EM survey is provided in Appendix A of this report.
Surface depressions (SWMU 7)	Test pit excavation and surface soil sampling was performed, but was not proposed in the RFI Phase I Work Plan.

TABLE 2.3

SAMPLING AND ANALYTICAL ACTIVITIES SUMMARY – PHASE II RFI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Unit/Area	Field Activity	Number of Samples	Laboratory Analyses[a]
Landfill 1 (SWMU 1)	Install boreholes around boundary (12) and beneath solids (1).	NA	NA
	Sample soils from boreholes.	5	TCL SVOCs TAL metals, sulfide
		2	TCL VOCs, TCL SVOCs, TAL metals, sulfide
	Sample soil from beneath solids in borehole.	1	TCL SVOCs TAL metals, sulfide
Landfill 3 (SWMU 3)	Install test pits around boundary (36).	NA	NA
	Sample soils from test pits.	22	TCL SVOCs, TAL metals
Landfill 4 (SWMU 4)	Install test pits (3) and boreholes (1) around boundary and boreholes (1) beneath solids.	NA	NA
	Sample soils from test pits and boreholes.	8	TCL VOCs and SVOCs, TAL metals, sulfide
	Install test pit (1) in SWMU and sample solids	1	TCL VOCs and SVOCs, TAL metals, sulfide
Surface depressions (SWMU 7)	Install test pits around boundary (2).	NA	NA
	Install borehole beneath solids (1) and sample soils.	1	TCL SVOCs, TAL metals, sulfide

[a]The acronyms for the various analyses are defined as follows:
TAL = Target Analyte List.
TCL = Target Compound List.
SVOCs = Sem-volatile organic compounds.
VOCs = Volatile organic compounds.
NA = Not applicable.

TABLE 2.4

DEVIATIONS BETWEEN THE PROPOSED WORK AND THE WORK ACTUALLY PERFORMED
PHASE II RFI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Site	Deviations
West Brine Field	A groundwater elevation measurement event was conducted at the West Brine Field, but was not proposed in the Work Plan.

TABLE 3.1

STRATIGRAPHY THICKNESS OF UNCONSOLIDATED SEDIMENTS AND DEPTH TO BEDROCK
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Location ID	Depth to Top of Unit (ft bgs)					
	Fill and Topsoil	Brown Clay	Gray Clay	Gravel	Limestone Bedrock	TD
Piezometers—Deep						
BP-200	0-0.65	0.65	11.1	64.4	67.5	72.5
BP-201	0-0.9	2	10	59	61	67
BP-203	0-2	2	18	52	61.3	68
BP-204	0-2	2	10	NE	56	61.5
BP-206	0-0.8	0.8	12	NE	52	55
BP-207	0-2	2	13.1	61.8	65	69
Monitor Wells—Shallow						
MW-001	0-0.9	0.9	10	NE	NE	27
WM-001A	0-0.9	0.9	10	NE	NE	17
MW-002	0-6	6	15.1	NE	NE	22
MW-003	0-2	2	18	NE	NE	24
MW-004A	0-6	6	12	NE	NE	19
WM-004	0-2	2	10	NE	NE	27
MW-005	0-0.7	0.7	13.2	NE	NE	15
MW-006	0-0.8	0.8	12	NE	NE	29
WM-006A	0-0.8	0.8	12	NE	NE	15
MW-007	0-5	5.0	NE	NE	NE	15

Key
NE = Not encountered.
TD = Total depth.

TABLE 3.2

MUNICIPALITY LAND USES
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Land-Use Category	Municipality*									
	Grosse Ile		Riverview		Southgate		Trenton		Wyandotte	
	Acres	% Cover	Acres	% Cover	Acres	% Cover	Acres	% Cover	Acres	% Cover
Single family residential	2,294	40.6	82.5	29.3	1,965	44.8	1,526	33.2	1,877	55.8
Multiple family residential	78	1.4	90	3.2	212	4.8	123	2.7	16	0.5
Commercial and office	50	0.9	122	4.3	629	14.3	190	4.1	415	12.3
Institutional	137	2.4	231	8.2	263	6.0	202	4.4	133	3.9
Industrial	18	0.3	353	12.5	114	2.6	644	14.0	476	14.1
Transportation, communications, utilities	440	7.8	243	8.6	91	2.1	430	9.4	177	5.3
Cultivated land	54	1.0	65	2.3	362	8.2	0	0	0	0
Woodlands, shrubs, grassland, wetlands	2,517	44.5	886	31.4	752	17.1	1,201	26.1	272	8.1
Water	24	0.4	4	0.2	0	0	11	0.2	0	0
Barren, extractive	40	0.7	0	0	0	0	275	6.0	0	0
Total area (acres)	5,652	100.0	2,076.5	100.0	4,388	100.0	4,602	100.0	3,366	100.0

Source: SEMCOG (Southeast Michigan Council of Governments) Community Profiles, 1996.

*Indicates that municipalities are only partially with the study area. Acreage and % cover statistics encompass that total area for each municipality.

TABLE 3.3

FAUNA AND FLORA IDENTIFIED ON OCTOBER 15, 1996
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Scientific Name	Common Name
Birds	
Ardea herodius	Great blue heron
Buteo lagopus	Rough-legged hawk
Cardinalis cardinalis	Northern cardinal
Junco hyemalis	Slate-colored junco
Passer domesticus	House sparrow
Turdus migratorius	American robin
Mammals	
Marmota monax	Woodchuck
Odocoileus virginianus	White-tailed deer
Sylvilagus floridanus	Eastern cottontail
Vegetation	
Acer negundo	Box elder
Acer saccharinum	Silver maple
Acer sp.	Maple
Achillea millefolium	Common yarrow
Agropyron repens	Quack grass
Aster novae-angeliae	New England aster
Aster spp.	White aster
Betula populifolia	Grey birch
Bromus spp.	Bromegrass
Cornus racemosa	Red-panicle dogwood
Crataegus spp.	Hawthorn
Dactylus glomerata	Orchard grass
Daucus carota	Queen Anne's lace
Elaeagnus spp.	Silverberry
Erigeron canadensis	Horseweed

TABLE 3.3

FAUNA AND FLORA IDENTIFIED ON OCTOBER 15, 1996
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Scientific Name	Common Name
Euthamia graminifolia	Linear-leaved goldenrod
Fragaria spp.	Strawberry
Fraxinus sp.	Ash
Ligustrum vulgare	Common privet
Lonicera tatarica	Tartarian honeysuckle
Nepeta cataria	Catnip
Phragmites australis	Common reed
Plantago major	Common plantain
Poa spp.	Bluegrass
Populus tremuloides	Quaking aspen
Polygonum cuspidatum	Japanese knotweed
Rhus typhina	Staghorn sumac
Rosa multiflora	Multiflora rose
Rubus spp.	Raspberry
Rumex crispus	Curled dock
Salix spp.	Willow
Solidago spp.	Goldenrods
Solidago altissima	Tall goldenrod
Ulmus rubra	Slippery elm
Vitis spp.	Grape
Xanthium chinense	Common cocklebur

TABLE 3.4

CURRENT LIST OF RECEPTORS DESIGNATED AS SPECIAL STATUS FOR WAYNE COUNTY, MI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Common Name	Scientific Name	Type	Federal Status	State Status
Lake sturgeon	*Acipenser fulvescens*	A	C2	T
Climbing fumitory	*Adlumia fungosa*	P		SC
Smallmouth salamander	*Ambystoma texanum*	A		E
Lead plant	*Amorpha canescens*	P		SC
Hairy angelica	*Angelica venenosa*	P		SC
Missouri rock cress	*Arabis missouriensis var deamii*	P	C2	SC
Three-awned grass	*Aristida longespica*	P		T
Virginia snakeroot	*Aristolochia serpentaria*	P		T
Tall green milkweed	*Asclepias hirtella*	P		T
White or prairie false indigo	*Baptisia lactea*	P		T
Autumnal water starwort	*Callitriche hermaphroditica*	P		SC
Wild hyacinth	*Camassia scilloides*	P		T
Frank's sedge	*Carex frankii*	P		SC
Sedge	*Carex hyalinolepis*	P		SC
Eastern few-fruited sedge	*Carex oligocarpa*	P		SC
Sedge	*Carex squarrosa*	P		SC
Cattail sedge	*Carex typhina*	P		T
Shellbark or kingnut hickory	*Carya laciniosa*	P		SC
American chestnut	*Castanea dentata*			E
Downy hawthorn (champion tree)	*Crataegus mollis*	O		
Least shrew	*Cryptotis parva*	A		T
Purple wartyback	*Cyclonaias tuberculata*	I		SC
Yellow nut grass	*Cyperus flavescens*	P		SC
White lady slipper	*Cypripedium candidum*	P	3C	T
Beak grass	*Diarrhena americana*	P		T
Catspaw	*Dysnomia sulcata delicata*	I	LE	E
Northern riffleshell	*Dysnomia torulosa rangiana*	I	LE	E

TABLE 3.4

CURRENT LIST OF RECEPTORS DESIGNATED AS SPECIAL STATUS FOR WAYNE COUNTY, MI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Common Name	Scientific Name	Type	Federal Status	State Status
Snuffbox	*Dysnomia triquetra*	I	C2	E
Yerba-De-Tajo	*Eclipta prostrata*	P		SC
Eastern fox snake	*Elaphe vulpina gloydi*	A		T
Engelmann's spike rush	*Eleocharis engelmannii*	P		SC
Love grass	*Eragrostis capillaris*	P		SC
Small love grass	*Eragrostis pilosa*	P		SC
Tinted spurge	*Euphorbia commutata*	P		T
Stiff gentian	*Gentianella quinquefolia*	P		T
Great Lakes marsh	Great Lakes marsh	C		
Kentucky coffee tree	*Gymnocladus dioicus*	P		SC
Whiskered sunflower	*Helianthus hirsutus*	P		SC
Swamp rose mallow	*Hibiscus moscheutos*	P		SC
Goldenseal	*Hydrastis canadensis*	P	3C	T
Gentian-leaved St. John's wort	*Hypericum gentianoides*	P		SC
Twinleaf	*Jeffersonia diphylla*	P		SC
Two-flowered rush	*Juncus biflorus*	P		SC
Short-fruited rush	*Juncus brachycarpus*	P		T
Vasey's rush	*Juncus vaseyi*	P		T
Water willow	*Justicia americana*	P		T
Lake plain oak openings	Lake plain oak openings	C		
Alkaline wet prairie, Midwest type	Lake plain wet prairie	C		
Alkaline tallgrass prairie, Midwest type	Lake plain wet mesic prairie	C		
Wavy-rayed lamp mussel	*Lampsilis fasciola*	I		T
False pimpernel	*Lindernia anagallidea*	P		SC
Virginia flax	*Linum virginianum*	P		T
Seedbox	*Ludwigia alternifolia*	P		T

TABLE 3.4

CURRENT LIST OF RECEPTORS DESIGNATED AS SPECIAL STATUS FOR WAYNE COUNTY, MI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Common Name	Scientific Name	Type	Federal Status	State Status
Appressed bog clubmoss	*Lycopodium appressum*	P		T
Rich forest, central Midwest type	Mesic southern forest	C		
Wing-stemmed monkey flower	*Mimulus alatus*	P		T
American lotus	*Nelumbo lutea*	P		T
Pugnose shiner	*Notropis anogenius*	A		SC
Northern madtom	*Noturus stigmosus*	A		E
Round hickorynut	*Obovaria subrotunda*	I		E
Pugnose minnow	*Opsopoeodus emiliae*	A		T
Ginseng	*Panax quinquefolius*	P	3C	T
Small-fruited panic grass	*Panicum microcarpon*	P		SC
Channel darter	*Percina copelandi*	A		T
Orange- or yellow-fringed orchid	*Platanthera ciliaris*	P		T
Prairie fringed orchid	*Platanthera leucophaea*	P	LT	E
Cross-leaved milkwort	*Polygala cruciata*	P		SC
Yellow-flowered leafcup	*Polymnia uvedalia*	P		T
Meadow beauty	*Rhexia virginica*	P		SC
Prairie rose	*Rosa setigera*	P		SC
Tooth cup	*Rotala ramosior*	P		SC
Hairy ruellia	*Ruellia humilis*	P		T
Arrowhead	*Sagittaria montevidensis*	P		T
Canadian burnet	*Sanguisorba canadensis*	P		T
Clinton's bulrush	*Scirpus clintonii*	P		T
Tall nut rush	*Scleria triglomerata*	P		SC
Fire pink	*Silene virginica*	P		T
Compass plant	*Silphium laciniatum*	P		T
Cup plant	*Silphium perfoliatum*	P		T
Salamander mussel	*Simpsoniconcha ambigua*	I	C2	E

TABLE 3.4

CURRENT LIST OF RECEPTORS DESIGNATED AS SPECIAL STATUS FOR WAYNE COUNTY, MI
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Common Name	Scientific Name	Type	Federal Status	State Status
Massasauga	*Sistrurus catenatus catenatus*		C2	SC
Blue-eyed grass	*Sisyrinchium hastile*	P		X
Smooth carrion flower	*Smilax herbacea*	P		SC
Southern flood plain forest	Southern flood plain forest	C		
Forster's tern	*Sterna forsteri*	A		SC
Common tern	*Sterna hirundo*	A	C2	T
Trailing wild bean	*Strophostyles helvula*	P		SC
Waxy meadow rue	*Thalictrum revolutum*	P		T
Prairie trillium	*Trillium recurvatum*	P		T
Bean villosa	*Villosa fabalis*	I	C2	E
Wild rice	*Zizania aquatica var aquatica*	P		T

Source: Michigan Natural Features Inventory (December 1994) produced by the Michigan Department of Natural Resources Wildlife Division.

Type Codes

A = Vertebrate animal.
C = Plant community.
G = Geological feature.
I = Invertebrate animal.
N = Nonvascular plant.
O = Other feature (champion tree, rockery).
P = Vascular plant.

Status Codes

E or LE = Endangered.
T or LT = Threatened.
SC = Special Concern (rare, may become E or T in future).
C1 = E or T considered appropriate but not yet officially proposed.
C2 = E or T may be appropriate but more information is needed.
3C = Not currently being considered for listing.
Px = Proposed status.
X = Probably extirpated.
LECT = The element is listed as endangered in part of its range and threatened in the rest of its range.

TABLE 3.5

SUMMARY OF HABITAT SUITABILITY INDEX (HSI) VALUES
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Indicator Species	Score Categories	East Plant	West Plant	West Brine Field
White-tailed deer	Food SI	0.00	0.60	0.75
	Cover SI	0.00	0.20	1.00
	Total HSI (lowest requisite value)	**0.00**	**0.20**	**0.75**
Raccoon	Breeding SI	0.00	0.00	0.00
	Food SI	0.60	0.60	0.60
	Water	1.00	1.00	1.00
	Total HSI (lowest life requisite value)	**0.00**	**0.00**	**0.00**
Muskrat	Breeding SI	0.00	0.00	0.35
	Bank soil type	0.00	NA	0.20
	Bank stability	1.00	NA	0.50
	Food SI	0.00	0.00	0.00
	Cover SI	0.00	0.00	0.03
	Emergent canopy cover	0.00	0.00	0.00
	Wood - % cover	0.00	0.00	0.10
	Water SI	1.00	0.75	1.00
	Water permanence	1.00	0.50	1.00
	Water current	1.00	1.00	1.00
	Total HSI (lowest life requisite value)	**0.00**	**0.00**	**0.00**
Meadow vole	Food/Cover SI	0.43	0.13	0.70
	Herbs - % cover	0.50	0.10	1.00
	Herbs - height	0.40	0.10	0.10
	Grasses	0.30	0.10	1.00
	Soil moisture	0.50	0.20	0.70
	Total HSI	**0.43**	**0.13**	**0.70**
Field sparrow	Cover SI	0.50	0.24	0.55
	Shrub - % cover	0.70	0.30	1.00
	Shrub - height	0.70	0.60	0.60
	Grasses - % cover	0.40	0.20	1.00
	Herbs - height	0.50	0.50	0.50
	Total HSI	**0.50**	**0.24**	**0.55**

SI = Suitability index

TABLE 3.6

SOIL SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria: / *Superscript Designation:*		*EPA Region 5 Soil Screening Level R9 Industrial PRG* *r*	*Part 201 Industrial and Commercial II, III, and IV Groundwater Contact Protection Criteria (GCPC)* *c*	*Part 201 Industrial and Commercial II, III, and IV Soil Volatilzation to Indoor Inhalation Criteria (SVIIC)* *i*	*Part 201 Industrial and Commercial II, III, and IV Infinite Source Volatile Soil Inhalation Criteria (VSIC)* *o*	*Part 201 Indistrial and Commercial II, III, and IV Particulate Soil Inhalation Criteria (PSIC)* *p*	*Part 201 Industrial and Commercial II - Direct Contact Criteria (DCC)* *d*	*Background Metals* *b*	*Ecological Data Quality Level (EDQL)* *e*
Parameters	*Units*								
TCL - Semi-Volatile Organics									
2,4-Dichlorophenol	mg/kg	2000	960	NLV	NLV	2300000	1800	--	87.5
2-Methylnaphthalene	mg/kg	--	5500	ID	ID	ID	40000	--	3.24
2-Methylphenol	mg/kg	34000	--	--	--	--	--	--	40.4
Benzo(a)pyrene	mg/kg	0.26	NLL	NLV	NLV	1900	10	--	1.52
benzo(b)fluoranthene	mg/kg	2.6	NLL	NLV	NLV	ID	100	--	59.8
Benzo(g,h.I)perylene	mg/kg	--	NLL	NLV	NLV	350000	9100	--	119
benzo(k)fluoranthene	mg/kg	26	NLL	NLV	NLV	ID	1000	--	148
Chrysene	mg/kg	7.2	NLL	ID	ID	ID	10000	--	4.73
Fluoranthene	mg/kg	27000	730	1000000	890000	4100000	180000	--	122
Indeno(1,2,3-CD)pyrene	mg/kg	2.6	NLL	NLV	NLV	ID	100	--	109
N-Nitrosodiphenylamine	mg/kg	390	700	NLV	NLV	ID	12000	--	0.54514
Naphthalene	mg/kg	240	2100	470	350	88000	80000	--	0.09939
Phenanthrene	mg/kg	--	1100	3300	11	2900	8000	--	45.7
Phenol	mg/kg	100000	12000	NLV	NLV	18000000	12000	--	120
Pyrene	mg/kg	100	480	1000000	780000	2900000	110000	--	78.5
TAL - Metals									
Aluminum, total	mg/kg	--	1000000	NLV	NLV	ID	660000	15,006	--
Arsenic, total	mg/kg	2.4	2000	NLV	NLV	910	61	10.76	5.7
Barium, total	mg/kg	100000	1000000	NLV	NLV	150000	250000	187.3	1.04
Beryllium, total	mg/kg	1.1	1000000	NLV	NLV	590	3100	1.56	1.06
Calcium, total	mg/kg	--	--	--	--	--	--	159356	--
Chromium, total	mg/kg	450	1000000	NLV	NLV	150000	1000000	38.01	0.4
Cobalt, total	mg/kg	97000	48000	NLV	NLV	5900	18000	11.08	0.14033
Copper, total	mg/kg	63000	1000000	NLV	NLV	59000	140000	32*	0.3132
Iron, total	mg/kg	--	1000000	NLV	NLV	ID	1000000	56847	--
Lead, total	mg/kg	400	ID	NLV	NLV	44000	900	21*	0.05373
Magnesium, total	mg/kg	--	1000000	NLV	NLV	2900000	1000000	16389	--
Manganese, total	mg/kg	--	180000	NLV	NLV	1500	170000	1334	--
Mercury, total	mg/kg	510	47	NLV	NLV	ID	1100	0.13*	0.1
Nickel, total	mg/kg	34000	1000000	NLV	NLV	16000	270000	40.98	13.6
Potassium, total	mg/kg	--	--	--	--	--	--	5033	--
Selenium, total	mg/kg	8500	78000	NLV	NLV	59000	18000	1.57	0.02765
Sodium, total	mg/kg	--	1000000	NLV	NLV	ID	1000000	2103	--
Thallium, total	mg/kg	120	15000	NLV	NLV	ID	240	1.02	0.05692
Vanadium, total	mg/kg	12000	1000000	NLV	NLV	ID	10000	46.38	1.59
Zinc, total	mg/kg	100000	1000000	NLV	NLV	ID	1000000	83.97	6.62

TABLE 3.6

SOIL SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria: / *Superscript Designation:*		*EPA Region 5 Soil Screening Level R9 Industrial PRG* *r*	*Part 201 Industrial and Commercial II, III, and IV Groundwater Contact Protection Criteria (GCPC)* *c*	*Part 201 Industrial and Commercial II, III, and IV Soil Volatilzation to Indoor Inhalation Criteria (SVIIC)* *i*	*Part 201 Industrial and Commercial II, III, and IV Infinite Source Volatile Soil Inhalation Criteria (VSIC)* *o*	*Part 201 Indistrial and Commercial II, III, and IV Particulate Soil Inhalation Criteria (PSIC)* *p*	*Part 201 Industrial and Commercial II - Direct Contact Criteria (DCC)* *d*	*Background Metals* *b*	*Ecological Data Quality Level (EDQL)* *e*
Parameters	Units								
Appendix 9 - General Chemistry									
Sulfide, total	mg/kg	--	--	--	--	--	--	--	0.00358
Appendix 9 - Metals									
Aluminum, total	mg/kg	--	1000000	NLV	NLV	ID	660000	15,006	--
Arsenic, total	mg/kg	2.4	2000	NLV	NLV	910	61	10.76	5.7
Barium, total	mg/kg	100000	1000000	NLV	NLV	150000	250000	187.3	1.04
Beryllium, total	mg/kg	1.1	1000000	NLV	NLV	590	3100	1.56	1.06
Cadmium, total	mg/kg	850	230000	NLV	NLV	2200	4100	1.82	0.00222
Chromium, total	mg/kg	450	1000000	NLV	NLV	150000	1000000	38.01	0.4
Cobalt, total	mg/kg	97000	48000	NLV	NLV	5900	18000	11.08	0.14033
Copper, total	mg/kg	63000	1000000	NLV	NLV	59000	140000	32*	0.3132
Lead, total	mg/kg	400	ID	NLV	NLV	44000	900	21*	0.05373
Mercury, total	mg/kg	510	47	NLV	NLV	ID	1100	0.13*	0.1
Nickel, total	mg/kg	34000	1000000	NLV	NLV	16000	270000	40.98	13.6
Selenium, total	mg/kg	8500	78000	NLV	NLV	59000	18000	1.57	0.02765
Thallium, total	mg/kg	120	15000	NLV	NLV	ID	240	1.02	0.05692
Tin, total	mg/kg	100000	--	--	--	--	--	0.81	7.62
Vanadium, total	mg/kg	12000	1000000	NLV	NLV	ID	10000	46.38	1.59
Zinc, total	mg/kg	100000	1000000	NLV	NLV	ID	1000000	83.97	6.62
Appendix 9 - Pesticides									
Delta-BHC	mg/kg	--	--	--	--	--	--	--	9.94
Appendix 9 - Dioxins/Furans (TEQ)									
2,3,7,8-TCDD (TEQ value)	µg/kg	0.024	NLL	NLV	NLV	89	0.99	--	0.000199
Appendix 9 - Semi-Volatile Organics									
2-Methylnaphthalene	mg/kg	--	5500	ID	ID	ID	40000	--	3.24
2-Methylphenol	mg/kg	34000	--	--	--	--	--	--	40.4
3&4-Methylphenol	mg/kg	3400	--	--	--	--	--	--	--
Benzo(a)pyrene	mg/kg	0.26	NLL	NLV	NLV	1900	10	--	1.52
Benzo(b)fluoranthene	mg/kg	2.6	NLL	NLV	NLV	ID	100	--	59.8
Benzo(g,h,i)perylene	mg/kg	--	NLL	NLV	NLV	350000	9100	--	119
Benzo(k)fluoranthene	mg/kg	26	NLL	NLV	NLV	ID	1000	--	148
Bis(2-ethylhexyl)phthalate	mg/kg	140	NLL	NLV	NLV	890000	10000	--	0.92594
Dibenzo(a,h)anthracene	mg/kg	0.26	NLL	NLV	NLV	ID	10	--	18.4
Dibenzofuran	mg/kg	140	ID	ID	ID	ID	ID	--	--
Diphenylamine	mg/kg	17000	--	--	--	--	--	--	1.01

TABLE 3.6

SOIL SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria: / *Superscript Designation:*		*EPA Region 5 Soil Screening Level R9 Industrial PRG* *r*	*Part 201 Industrial and Commercial II, III, and IV Groundwater Contact Protection Criteria (GCPC)* *c*	*Part 201 Industrial and Commercial II, III, and IV Soil Volatilzation to Indoor Inhalation Criteria (SVIIC)* *i*	*Part 201 Industrial and Commercial II, III, and IV Infinite Source Volatile Soil Inhalation Criteria (VSIC)* *o*	*Part 201 Indistrial and Commercial II, III, and IV Particulate Soil Inhalation Criteria (PSIC)* *p*	*Part 201 Industrial and Commercial II - Direct Contact Criteria (DCC)* *d*	*Background Metals* *b*	*Ecological Data Quality Level (EDQL)* *e*
Parameters	*Units*								
Appendix 9 - Semi-Volatile Organics (Cont'd)									
Indeno(1,2,3-CD)pyrene	mg/kg	2.6	NLL	NLV	NLV	ID	100	--	109
N-Nitrosodiethylamine	mg/kg	0.013	--	--	--	--	--	--	0.06933
N-Nitrosodiphenylamine	mg/kg	390	700	NLV	NLV	ID	12000	--	0.54514
Naphthalene	mg/kg	240	2100	470	350	88000	80000	--	0.09939
Phenanthrene	mg/kg	--	1100	3300	11	2900	8000	--	45.7
Phenol	mg/kg	100000	12000	NLV	NLV	18000000	12000	--	120
Pyrene	mg/kg	100	480	1000000	780000	2900000	110000	--	78.5
Appendix 9 - Volatile Organics									
1,2-Dichloroethene (total)	mg/kg	270	--	--	--	--	--	--	--
2-Butanone	mg/kg	27000	27000	27000	35000	29000000	27000	--	89.6
4-Methyl-2-pentanone	mg/kg	2800	2700	2700	53000	60000000	2700	--	443
Acetone	mg/kg	8800	110000	110000	160000	170000000	110000	--	2.5
Carbondisulfide	mg/kg	24	280	140	1600	21000000	280	--	0.09412
Ethylbenzene	mg/kg	230	140	140	11000	29000000	140	--	5.16
Methylene chloride	mg/kg	18	2300	240	700	8300000	2300	--	4.05
Tetrachloroethene	mg/kg	17	88	60	600	6800000	88	--	9.92
Toluene	mg/kg	880	250	250	3300	12000000	250	--	5.45
Trichloroethene	mg/kg	7	500	37	260	2300000	500	--	12.4
Xylenes (total)	mg/kg	320	150	150	54000	130000000	150	--	10

TABLE 3.7

GROUNDWATER SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria: / *Superscript Designation:*		*EPA Region 5 Groundwater Screening Level Level - MCL/R9 PRG* *r*	*Part 201 Industrial-Commercial - Groundwater Surface Water Interface Criteria (GSI)* *g*	*Part 201 Industrial & Commercial II, III & IV Groundwater Volatilization to Indoor Air Inhalation Criteria (GVIIC)* *i*	*Part 201 Industrial-Commercial - Groundwater Contact Criteria (GCC)* *c*	*Part 201 Industrial-Commercial - Flammability and Explosivity Screening Level (FESL)* *f*	*Part 201 Industrial-Commercial - Acute Inhalation Screening Level (AISL)* *a*	*Background Metals - North of Huntington Drain* *n*	*Background Metals - South of Huntington Drain* *s*
Parameters	*Units*								
Appendix 9 - Metals									
Antimony, total	mg/L	0.015	ID	NLV	68	ID	ID	0.016 U	0.0208 J
Arsenic, soluble	mg/L	0.000045	0.15	NLV	4.3	ID	ID	0.0016 U	0.0016 U
Arsenic, total	mg/L	0.000045	0.15	NLV	4.3	ID	ID	0.0088	0.0292
Barium, soluble	mg/L	2.6	1.33	NLV	14000	ID	ID	0.8390	0.0528
Barium, total	mg/L	2.6	1.33	NLV	14000	ID	ID	0.1390	0.452
Beryllium, total	mg/L	0.000016	0.033	NLV	290	ID	ID	0.0005	0.0029
Cadmium, soluble	mg/L	0.018	0.0025	NLV	190	ID	ID	0.0026	0.0066 J
Cadmium, total	mg/L	0.018	0.0025	NLV	190	ID	ID	0.0039	0.0108
Chromium, soluble	mg/L	--	0.12	NLV	290000	ID	ID	0.0017 U	0.0017 U
Chromium, total	mg/L	--	0.12	NLV	290000	ID	ID	0.0160	0.0931
Cobalt, soluble	mg/L	2.2	0.1	NLV	2400	ID	ID	0.365 J	0.0164
Cobalt, total	mg/L	2.2	0.1	NLV	2400	ID	ID	0.0229 J	0.0624
Copper, soluble	mg/L	1.4	0.022	NLV	7400	ID	ID	0.0017 U	0.0021 J
Copper, total	mg/L	1.4	0.022	NLV	7400	ID	ID	0.0164	0.111 J
Lead, soluble	mg/L	0.004	0.014	NLV	ID	ID	ID	0.0065 U	0.0065 U
Lead, total	mg/L	0.004	0.014	NLV	ID	ID	ID	0.0230	0.0728
Mercury, total	mg/L	0.011	0.0000013	NLV	0.056	ID	ID	0.0001 U	0.00027
Nickel, soluble	mg/L	0.73	0.13	NLV	74000	ID	ID	0.0078	0.0532
Nickel, total	mg/L	0.73	0.13	NLV	74000	ID	ID	0.0318	0.155
Selenium, soluble	mg/L	0.05**	0.005	NLV	970	ID	ID	0.0140	0.014 U
Thallium, total	mg/L	0.002**	0.0037	NLV	13	ID	ID	0.0016 U	0.008 U
Tin, total	mg/L	22	--	--	--	--	--	0.0087 U	0.0087 U
Vanadium, soluble	mg/L	0.26	0.012	NLV	970	ID	ID	0.0017 U	0.0017U
Vanadium, total	mg/L	0.26	0.012	NLV	970	ID	ID	0.0184	0.0999
Zinc, soluble	mg/L	11	0.29	NLV	110000	ID	ID	0.0036	0.0034
Zinc, total	mg/L	11	0.29	NLV	110000	ID	ID	0.0504	0.282
Appendix 9 - Semi-Volatile Organics									
bis(2-ethylhexyl)phthalate	mg/L	0.0048	0.032	NLV	0.32	NA	0.34	--	--
Appendix 9 - Volatile Organics									
Acetone	mg/L	0.61	1.7	1000000	31000	7500	1000000	--	--
Chloroform	mg/L	0.00016	0.17	180	150	ID	ID	--	--

TABLE 3.8

SURFACE WATER SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria:		*Surface Water Ecological Data Quality Level (SW EDQL)*
Superscript Designation:		*e*
Parameters	*Units*	
Appendix 9 - Metals		
Arsenic, soluble	mg/L	0.053
Barium, soluble	mg/L	5
Barium, total	mg/L	5
Cadmium, soluble	mg/L	0.00066
Copper, soluble	mg/L	0.005
Copper, total	mg/L	0.005
Selenium, soluble	mg/L	0.005
Vanadium, total	mg/L	0.019
Appendix 9 - Semi-Volatile Organics		
Bis(2-Ethylhexyl)phthalate	mg/L	0.0021

TABLE 3.9

SEDIMENT SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

		Sediment Ecological Data Quality Level (SD EDQL)
Criteria:		
Superscript Designation:		*e*
Parameters	*Units*	
Appendix 9 - General Chemistry		
Cyanide, total	mg/kg	0.0001
Sulfide, total	mg/kg	--
Appendix 9 - Metals		
Aluminum, total	mg/kg	--
Arsenic, total	mg/kg	5.9
Barium, total	mg/kg	--
Beryllium, total	mg/kg	--
Cadmium, total	mg/kg	0.596
Chromium, total	mg/kg	26
Cobalt, total	mg/kg	50
Copper, total	mg/kg	16
Lead, total	mg/kg	31
Mercury, total	mg/kg	0.174
Nickel, total	mg/kg	16
Selenium, total	mg/kg	--
Silver, total	mg/kg	0.5
Thallium, total	mg/kg	--
Tin, total	mg/kg	--
Vanadium, total	mg/kg	--
Zinc, total	mg/kg	120
Appendix 9 - Pesticides		
4,4'-DDD	mg/kg	0.00553
4,4'-DDE	mg/kg	0.00142
4,4'-DDT	mg/kg	0.00119
Aldrin	mg/kg	0.002
Alpha-chlordane	mg/kg	--
Gamma-chlordane	mg/kg	--
Isodrin	mg/kg	0.05516
Kepone	mg/kg	0.00331
Appendix 9 - Dioxins/Furans (TEQ)		
2,3,7,8-TCDD (TEQ value)	µg/kg	0.0033

TABLE 3.9

SEDIMENT SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

		Sediment Ecological Data Quality Level (SD EDQL)
Criteria:		
Superscript Designation:		*e*
Parameters	*Units*	
Appendix 9 - Semi-Volatile Organics		
2-Methylnaphthalene	mg/kg	0.0202
Acenaphthene	mg/kg	0.00671
Acenaphthylene	mg/kg	0.00587
Anthracene	mg/kg	0.0469
Benzo(a)Anthracene	mg/kg	0.0317
Benzo(a)pyrene	mg/kg	0.0319
Benzo(b)fluoranthene	mg/kg	10.4
Benzo(g,h,i)perylene	mg/kg	0.17
Benzo(k)fluoranthene	mg/kg	0.24
Bis(2-ethylhexyl)phthalate	mg/kg	0.182
Butylbenzylphthalate	mg/kg	4.19
Chrysene	mg/kg	0.0571
Di-n-butylphthalate	mg/kg	0.1105
Dibenzo(a,h)anthracene	mg/kg	0.00622
Dibenzofuran	mg/kg	1.52
Fluoranthene	mg/kg	0.1113
Fluorene	mg/kg	0.0212
Indeno(1,2,3-CD)pyrene	mg/kg	0.2
Naphthalene	mg/kg	0.0346
Phenanthrene	mg/kg	0.0419
Pyrene	mg/kg	0.053
Appendix 9 - Volatile Organics		
Methylene chloride	mg/kg	1.26

TABLE 3.10

WASTE SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria: / *Superscript Designation:*		*EPA Region 5 Soil Screening Level R9 Industrial PRG* *r*	*Part 201 Industrial and Commercial II, III, and IV Groundwater Contact Protection Criteria (GCPC)* *c*	*Part 201 Industrial and Commercial II, III, and IV Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC)* *i*	*Part 201 Industrial and Commercial II, III, and IV Infinite Source Volatile Soil Inhalation Criteria (VSIC)* *o*	*Part 201 Industrial and Commercial II, III, and IV Particulate Soil Inhalation Criteria (PSIC)* *p*	*Part 201 Industrial and Commercial II, III, and IV Direct Contact Criteria (DCC)* *d*	*Background Metals* *b*	*Ecological Data Quality Level (EDQL)* *e*
Parameters	*Units*								
TCL - Semi-Volatile Organics									
1,2,4-Trichlorobenzene	mg/kg	5500	1100	1100	34000	11000000	1100	--	11.1
1,2-Dichlorobenzene	mg/kg	700	210	210	46000	44000000	210	--	2.96
1,3-Dichlorobenzene	mg/kg	860	51	ID	ID	ID	170	--	37.7
1,4-Dichlorobenzene	mg/kg	8.5	140	100	260	570000	2900	--	0.54559
2,2'-Oxybis(1-Chloropropane)	mg/kg	27	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	mg/kg	68000	9100	NLV	NLV	10000000	110000	--	14.1
2,4,6-Trichlorophenol	mg/kg	170	200	NLV	NLV	1300000	5000	--	9.94
2,4-Dichlorophenol	mg/kg	2000	960	NLV	NLV	2300000	1800	--	87.5
2,4-Dimethylphenol	mg/kg	14000	10000	NLV	NLV	2100000	56000	--	0.01
2,4-Dinitrophenol	mg/kg	1400	--	--	--	--	--	--	0.06086
2,4-Dinitrotoluene	mg/kg	1400	170	NLV	NLV	20000	340	--	1.28
2,6-Dinitrotoluene	mg/kg	680	--	--	--	--	--	--	0.03283
2-Chloronaphthalene	mg/kg	110	--	--	--	--	--	--	0.01218
2-Chlorophenol	mg/kg	370	1900	ID	ID	ID	6900	--	0.24266
2-Methylnaphthalene	mg/kg	--	5500	ID	ID	ID	40000	--	3.24
2-Methylphenol	mg/kg	34000	--	--	--	--	--	--	40.4
2-Nitroaniline	mg/kg	41	--	--	--	--	--	--	74.1
2-Nitrophenol	mg/kg	--	1600	NLV	NLV	ID	3100	--	1.6
3,3'-Dichlorobenzidine	mg/kg	4.2	4.6	NLV	NLV	8200	47	--	0.64636
3-Nitroaniline	mg/kg	--	--	--	--	--	--	--	3.16
4,6-Dinitro-2-Methylphenol	mg/kg	--	190	NLV	NLV	ID	390	--	0.14408
4-Bromophenyl-phenylether	mg/kg	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	mg/kg	--	3000	NLV	NLV	ID	22000	--	7.95
4-Chloroaniline	mg/kg	2700	--	--	--	--	--	--	1.1
4-Chlorophenyl-phenylether	mg/kg	--	--	--	--	--	--	--	--
4-Methylphenol	mg/kg	3400	--	--	--	--	--	--	163
4-Nitroaniline	mg/kg	--	--	--	--	--	--	--	21.9
4-Nitrophenol	mg/kg	--	--	--	--	--	--	--	5.12
Acenaphthene	mg/kg	110	970	350000	97000	6200000	200000	--	682
Acenaphthylene	mg/kg	--	440	3000	2700	1000000	8000	--	682
Anthracene	mg/kg	5.7	41	1000000	1600000	29000000	1000000	--	1480
Benzo(a)anthracene	mg/kg	2.6	NLL	NLV	NLV	ID	100	--	5.21
Benzo(a)pyrene	mg/kg	0.26	NLL	NLV	NLV	1900	10	--	1.52

TABLE 3.10

WASTE SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria: / *Superscript Designation:*		*EPA Region 5 Soil Screening Level R9 Industrial PRG* *r*	*Part 201 Industrial and Commercial II, III, and IV Groundwater Contact Protection Criteria (GCPC)* *c*	*Part 201 Industrial and Commercial II, III, and IV Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC)* *i*	*Part 201 Industrial and Commercial II, III, and IV Infinite Source Volatile Soil Inhalation Criteria (VSIC)* *o*	*Part 201 Industrial and Commercial II, III, and IV Particulate Soil Inhalation Criteria (PSIC)* *p*	*Part 201 Industrial and Commercial II, III, and IV Direct Contact Criteria (DCC)* *d*	*Background Metals* *b*	*Ecological Data Quality Level (EDQL)* *e*
Parameters	*Units*								
TCL - Semi-Volatile Organics (Cont'd)									
Benzo(b)fluoranthene	mg/kg	2.6	NLL	NLV	NLV	ID	100	--	59.8
Benzo(g,h,i)perylene	mg/kg	--	NLL	NLV	NLV	350000	9100	--	119
Benzo(k)fluoranthene	mg/kg	26	NLL	NLV	NLV	ID	1000	--	148
Bis(2-chloroethoxy)methane	mg/kg	--	--	--	--	--	--	--	0.30209
Bis(2-chloroethyl)ether	mg/kg	0.097	110	44	13	12000	89	--	23.7
Bis(2-ethylhexyl)phthalate	mg/kg	140	NLL	NLV	NLV	890000	10000	--	0.92594
Butylbenzylphthalate	mg/kg	930	310	NLV	NLV	21000000	310	--	0.23889
Carbazole	mg/kg	--	820	NLV	NLV	ID	3700	--	--
Chrysene	mg/kg	7.2	NLL	ID	ID	ID	10000	--	4.73
Di-n-butylphthalate	mg/kg	68000	760	NLV	NLV	1500000	760	--	0.14979
di-n-octylphthalate	mg/kg	10000	140000	NLV	NLV	ID	28000	--	709
Dibenzo(a,h)anthracene	mg/kg	0.26	NLL	NLV	NLV	ID	10	--	18.4
Dibenzofuran	mg/kg	140	ID	ID	ID	ID	ID	--	--
Diethylphthalate	mg/kg	100000	740	NLV	NLV	1500000	740	--	24.8
Dimethylphthalate	mg/kg	100000	790	NLV	NLV	1500000	790	--	734
Fluoranthene	mg/kg	27000	730	1000000	890000	4100000	180000	--	122
Fluorene	mg/kg	90	890	1000000	150000	4100000	130000	--	122
Hexachlorobenzene	mg/kg	1.2	8.2	220	56	8500	51	--	0.19878
Hexachlorobutadiene	mg/kg	24	350	350	460	180000	350	--	0.03976
Hexachlorocyclopentadiene	mg/kg	4600	720	ID	ID	ID	720	--	0.75537
Hexachloroethane	mg/kg	140	110	79	660	100000	1100	--	0.59634
Indeno(1,2,3-CD)pyrene	mg/kg	2.6	NLL	NLV	NLV	ID	100	--	109
Isophorone	mg/kg	2000	2400	NLV	NLV	8200000	2400	--	139
N-Nitrosodi-n-propylamine	mg/kg	0.27	7.2	NLV	NLV	2000	8.3	--	0.54368
N-Nitrosodiphenylamine	mg/kg	390	700	NLV	NLV	ID	12000	--	0.54514
Naphthalene	mg/kg	240	2100	470	350	88000	80000	--	0.09939
Nitrobenzene	mg/kg	94	220	490	4600	1500000	490	--	1.31
Pentachlorophenol	mg/kg	7.9	4.3	NLV	NLV	130000	390	--	0.11927
Phenanthrene	mg/kg	--	1100	3300	11	2900	8000	--	45.7
Phenol	mg/kg	100000	12000	NLV	NLV	18000000	12000	--	120
Pyrene	mg/kg	100	480	1000000	780000	2900000	110000	--	78.5

TABLE 3.10

WASTE SCREENING LEVELS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria: / *Superscript Designation:*		*EPA Region 5 Soil Screening Level R9 Industrial PRG* *r*	*Part 201 Industrial and Commercial II, III, and IV Groundwater Contact Protection Criteria (GCPC)* *c*	*Part 201 Industrial and Commercial II, III, and IV Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC)* *i*	*Part 201 Industrial and Commercial II, III, and IV Infinite Source Volatile Soil Inhalation Criteria (VSIC)* *o*	*Part 201 Industrial and Commercial II, III, and IV Particulate Soil Inhalation Criteria (PSIC)* *p*	*Part 201 Industrial and Commercial II, III, and IV Direct Contact Criteria (DCC)* *d*	*Background Metals* *b*	*Ecological Data Quality Level (EDQL)* *e*
Parameters	*Units*								
Appendix 9 - General Chemistry									
Sulfide, total	mg/kg	--	--	--	--	--	--	--	0.00358
Appendix 9 - Metals									
Aluminum, total	mg/kg	--	1000000	NLV	NLV	ID	660000	15006	--
Arsenic, total	mg/kg	2.4	2000	NLV	NLV	910	61	10.76	5.7
Barium, total	mg/kg	100000	1000000	NLV	NLV	150000	250000	187.26	1.04
Beryllium, total	mg/kg	1.1	1000000	NLV	NLV	590	3100	1.56	1.06
Cadmium, total	mg/kg	850	230000	NLV	NLV	2200	4100	1.82	0.00222
Chromium, total	mg/kg	450	1000000	NLV	NLV	150000	1000000	38.01	0.4
Cobalt, total	mg/kg	97000	48000	NLV	NLV	5900	18000	11.08	0.14033
Copper, total	mg/kg	63000	1000000	NLV	NLV	59000	140000	32*	0.3132
Lead, total	mg/kg	400	ID	NLV	NLV	44000	900	21*	0.05373
Mercury, total	mg/kg	510	47	NLV	NLV	ID	1100	0.13*	0.1
Nickel, total	mg/kg	34000	1000000	NLV	NLV	16000	270000	40.98	13.6
Selenium, total	mg/kg	8500	78000	NLV	NLV	59000	18000	1.57	0.02765
Thallium, total	mg/kg	120	15000	NLV	NLV	ID	240	1.02	0.05692
Tin, total	mg/kg	100000	--	--	--	--	--	0.81	7.62
Vanadium, total	mg/kg	12000	1000000	NLV	NLV	ID	10000	46.38	1.59
Zinc, total	mg/kg	100000	1000000	NLV	NLV	ID	1000000	83.97	6.62
Appendix 9 - Dioxins/Furans (TEQ)									
2,3,7,8-TCDD (TEQ Value)	µg/kg	0.024	NLL	NLV	NLV	89	0.99	--	0.000199
Appendix 9 - Volatile Organics									
N-Nitrosodiphenylamine	mg/kg	390	700	NLV	NLV	ID	12000	--	0.54514
Phenol	mg/kg	100000	12000	NLV	NLV	18000000	12000	--	120
2-Butanone	mg/kg	27000	27000	27000	35000	29000000	27000	--	89.6
Acetone	mg/kg	8800	110000	110000	160000	170000000	110000	--	2.5
Benzene	mg/kg	1.4	220	8.4	45	470000	400	--	0.25462
Carbon disulfide	mg/kg	24	280	140	1600	21000000	280	--	0.09412
Ethylbenzene	mg/kg	230	140	140	11000	29000000	140	--	5.16
Iodomethane	mg/kg	--	--	--	--	--	--	--	1.23
Methylene chloride	mg/kg	18	2300	240	700	8300000	2300	--	4.05
Xylenes (total)	mg/kg	320	150	150	54000	130000000	150	--	10

TABLE 3.11

RCRA SCREENING LEVELS FOR CHARACTERISTIC
HAZARDOUS WASTE DETERMINATION
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Criteria:		*RCRA Level*
Superscript Designation:		*t*
Parameters	*Units*	
TCLP - Semi-Volatile Organics		
1,4-Dichlorobenzene	mg/L	7.5
2,4,5-Trichlorophenol	mg/L	400.0
2,4,6-Ttrichlorophenol	mg/L	2.0
2,4-Dinitrotoluene	mg/L	0.1
2-Methylphenol	mg/L	200.0
3&4-Methylphenol	mg/L	200.0
Hexachlorobenzene	mg/L	0.13
Hexachlorobutadiene	mg/L	0.5
Hexachloroethane	mg/L	3.0
Nitrobenzene	mg/L	2.0
Pentachlorophenol	mg/L	100.0
Pyridine	mg/L	5.0
Appendix 9 - General Chemistry		
Flashpoint	deg f	$\leq$ 140
pH	ph	$\leq$ 2 or $\geq$ 12.5
Appendix 9 - Metals		
Arsenic, total	mg/L	5.0
Barium, total	mg/L	100.0
Cadmium, total	mg/L	1.0
Chromium, total	mg/L	5.0
Lead, total	mg/L	5.0
Selenium, total	mg/L	1.0
Appendix 9 - Volatile Organics		
2-Butanone	mg/L	200.0

TABLE 3.12

CRITERIA TABLE NOTES
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

NOTES

U	-	Not detected above the reporting limit.
J	-	Qualified as an estimated value.
UJ	-	Quantitation limit qualified as an estimated value.
NJ	-	Tentatively identified compound approximate concentration.
IP	-	Development of generic GSI value in progress.
NA	-	Criterion is not available.
ID	-	Inadequate data to develop criterion.
NLL	-	Chemical is not likely to leach.
NLV	-	Chemical is not likely to volatilize.
R	-	Rejected as a result of data validation.
--	-	Not analyzed
*	-	Site-specific background criteria lower than statewide default background criteria. Therefore, statewide default background value used.
**	-	For risk-based screening of constituents in groundwater, EPA maximum contaminant levels (MCLs) have been adopted as groundwater RBSLs. However, MCLs exist for less than 100 chemicals. For constituents that do not have a MCL, the EPA Region 9 PRG value is used. (MCLs denoted with a "**").

SUPERSCRIPTS

[ ]	-	Value exceeds associated criteria.
r	-	**Soil/Waste:** EPA Soil Screening Levels- Industrial Region 9 PRG **Groundwater:** EPA Groundwater Screening Levels – MCL/Region 9 PRG
g	-	**Groundwater:** Part 201 Residential And Industrial-Commercial - Groundwater Surface Water Interface Criteria (GSI)
i	-	**Soil/Waste:** Part 201: Industrial and Commercial II, III, and IV - Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC) **Groundwater:** Part 201 Industrial & Commercial II, III & IV Groundwater Volatilization to Indoor Air Inhalation Criteria (GVIIC)
o	-	**Soil/Waste:** Part 201 Industrial and Commercial II, III, and IV - Infinite Source (Outdoor) Volatile Soil Inhalation Criteria (VSIC)
d	-	**Soil/Waste:** Part 201 Industrial and Commercial II - Direct Contact Criteria (DCC)
p	-	**Soil/Waste:** Part 201 Industrial and Commercial II, III, and IV - Particulate Soil Inhalation Criteria (PSIC)
c	-	**Soil/Waste:** Part 201 Residential and Commercial I - Groundwater Contact Protection Criteria (GCPC) **Groundwater:** Part 201 Residential And Industrial-Commercial - Groundwater Contact Criteria (GCC)
f	-	**Groundwater:** Part 201 Residential And Industrial-Commercial - Flammability and Explosivity Screening Level
a	-	**Groundwater:** Part 201 Residential And Industrial-Commercial - Acute Inhalation Screening Level
n	-	**Groundwater:** Background Metals - North of Huntington Drain
s	-	**Groundwater:** Background Metals - South of Huntington Drain
b	-	**Soil/Waste:** Background Metals
e	-	**Soil/Sediment/Surface water:** Ecological Data Quality Level (EDQL)
t	-	**TCLP samples:** RCRA level

TABLE 4.1

SOILS BACKGROUND METALS CONCENTRATIONS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Parameter	*Regional Background (mg/kg)*			*Sample Concentrations (mg/kg)*				*Arithmetic Mean*	*Standard Deviation*	*95% Upper Tolerance Limit*
	Min	*Max*	*Mean*							
ALUMINUM *	5,490	11,000	8,369	8,720	8,640	8,380	5,830	7,893	1,383	15,006
ANTIMONY	< 0.025	18	6.3	1.8	1.5	1.6	- -	1.4	0.51	5.3
ARSENIC	2	39	12.1	6.1	4.9	6.0	- -	5.7	0.67	10.8
BARIUM	6.8	291	91.9	91.0	65.3	65.4	- -	73.90	14.81	187.3
BERYLLIUM	< 0.10	1.3	0.5	0.73	0.49	0.65	- -	0.62	0.12	1.6
CADMIUM	0.1	3.5	1	0.56	0.32	0.65	- -	0.51	0.17	1.8
CALCIUM *	*100*	*280,000*	*6,300*	78,300	106,000	86,300	73,800	86,100	14,238	159,356
CHROMIUM	3.9	53	23.6	21.2	16.2	17.7	- -	18.4	2.6	38.0
COBALT	5.1	13	9.5	7.7	6.8	6.8	- -	7.1	0.52	11.1
COPPER	7.7	52	19.2	21.0	21.7	21.3	- -	21.3	0.35	24.0
IRON *	16,300	22,800	20,212	19,500	21,200	33,000	27,200	25,225	6,146	56,847
LEAD	2.5	26	10.9	12.4	10.0	10.7	- -	11.0	1.2	20.5
MAGNESIUM *	*50*	*50,000*	*4,600*	12,900	13,100	14,000	12,500	13,125	634	16,389
MANGANESE *	170	500	387.7	448	363	736	501	512	160	1,334
MERCURY	0.01	0.16	0.05	0.03 U	0.02 U	0.02 U	- -	0.01**	0.0029	0.1 ***
NICKEL	4	53	26.1	26.8	22.8	23.3	- -	24.3	2.2	41.0
POTASSIUM *	*50*	*37,000*	*12,000*	2,660	2,490	2,340	1,440	2,233	544	5,033
SELENIUM	0.12	0.7	0.38	0.17 U	0.79 U	0.16 U	- -	0.19**	0.18	1.6
SILVER	0.1	3.1	0.99	0.18 U	0.14 U	0.17 U	- -	0.08**	0.01	0.5 ***
SODIUM *	*<500*	*50,000*	*7,800*	566	985	581	1,040	793	255	2,103
THALLIUM	< 0.05	<1.50	1.9	0.27	0.14 U	0.14 U	- -	0.14**	0.12	1.0
TIN	NA	NA	5.2	0.87 U	0.67 U	0.84U	- -	0.40**	0.05	0.8
VANADIUM	12	50	25	28.7	23.5	26.7	- -	26.3	2.6	46.4
ZINC	32	120	52.6	53.9	58.9	51.4	- -	54.7	3.8	84.0

Notes:

1) * Background from clay unit samples collected at ATOFINA Chemicals, Inc. East Plant, Riverview, Michigan
2) ** For values with U qualifiers (non-detect), one half the detection limit used for calculation of mean
3) *** Using 1/2 of the detection limit in the calculation, the 95% UTL is less than MDEQ detection limit, therefore the background defaults to the MDEQ Target Quantitation Limit (consistent with procedure used in MDEQ ERD Operational Memo #18).
4) All background data from MDEQ Operational Memorandum #15 except antimony, beryllium, calcium, magnesium, potassium, sodium, thallium, and vanadium which are from A. Chiasson and J. Dragun. 1991. Elements in North American Soils. Hazardous Materials Control Resources Institute, Greenbelt, MD.
5) Values in italics are from eastern US soils - all others are from Michigan Erie Glacial Lobe clay.
6) U = not detected above the associated limit.

TABLE 4.2

GROUNDWATER BACKGROUND METALS CONCENTRATIONS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

	North of Hunt. Drain (MW-001)	*South of Hunt. Drain (Highest value - MW-005 and MW-007)*
SOLUBLE (mg/L)		
ANTIMONY	0.016 U	0.016 U
ARSENIC	0.0016 U	0.0016 U
BARIUM	0.8390	0.0528
BERYLLIUM	0.0004 U	0.0004 U
CADMIUM	0.0026	0.0066 J
CHROMIUM	0.0017 U	0.0017 U
COBALT	0.365 J	0.0164
COPPER	0.0017 U	0.0021 J
LEAD	0.0065 U	0.0065 U
MERCURY	0.0001 U	0.0001 U
NICKEL	0.0078	0.0532
SELENIUM	0.0140	0.014 U
SILVER	0.0018 U	0.0018 U
THALLIUM	0.0016 U	0.0080
TIN	0.0087 U	0.0087 U
VANADIUM	0.0017 U	0.0017U
ZINC	0.0036	0.0124
TOTAL (mg/L)		
ANTIMONY	0.016 U	0.0208 J
ARSENIC	0.0088	0.0292
BARIUM	0.1390	0.452
BERYLLIUM	0.0005	0.0029
CADMIUM	0.0039	0.0108
CHROMIUM	0.0160	0.0931
COBALT	0.0229 J	0.0624
COPPER	0.0164	0.111 J
LEAD	0.0230	0.0728
MERCURY	0.0001 U	0.00027
NICKEL	0.0318	0.155
SELENIUM	0.014 U	0.014 U
SILVER	0.0018 U	0.0018 U
THALLIUM	0.0016 U	0.008 U
TIN	0.0087 U	0.0087 U
VANADIUM	0.0184	0.0999
ZINC	0.0504	0.282

Notes:
U = Not detected at the associated detection limit
J = Estimated value

TABLE 4.3

SUMMARY OF DETECTED COMPOUNDS IN BACKGROUND SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*06SB01*	*06SB02*	*06SB03*
Sample ID:		*EA01-BF-06SB01-02401*	*EA01-BF-06SB02-02401*	*EA01-BF-06SB03-02401*
Sample Depth:		*10-12*	*10-12*	*10-12*
SWMU:		*BKGD*	*BKGD*	*BKGD*
Sample Date:		*10/12/96*	*10/13/96*	*10/14/96*
Parameters	*Units*			
Appendix 9 - General Chemistry				
SULFIDE, TOTAL	mg/kg	35.3[e]	27.8 U	24.5 U
Appendix 9 - Metals				
Aluminum, total	mg/kg	1.8 J	1.5 J	1.6 R
Arsenic, total	mg/kg	6.1 J	4.9 J	6 J
Barium, total	mg/kg	91	65.3	65.4
Beryllium, total	mg/kg	0.73	0.49	0.65
Cadmium, total	mg/kg	0.56	0.32	0.65
Chromium, total	mg/kg	21.2	16.2	17.7
Cobalt, total	mg/kg	7.7	6.8	6.8
Copper, total	mg/kg	21	21.7	21.3
Lead, total	mg/kg	12.4	10	10.7
Nickel, total	mg/kg	26.8	22.8	23.3
Thallium, total	mg/kg	0.27 J	0.14 U	0.14 U
Vanadium, total	mg/kg	28.7	23.5	26.7
Zinc, total	mg/kg	53.9	58.9	51.4
Appendix 9 - Pesticides				
Delta-BHC	mg/kg	0.0019	0.0011	0.0015
Appendix 9 - Semi-Volatile Organics				
BIS(2-Ethylhexyl)phthalate	mg/kg	0.38 U	0.38 U	0.11 J
Phenanthrene	mg/kg	0.38 U	0.38 J	0.38 U
Appendix 9 - Volatile Organics				
Acetone	mg/kg	0.68 J	0.041 J	0.02 J
Tetrachloroethene	mg/kg	0.001 J	0.006 U	0.006 U

TABLE 4.4

SUMMARY OF DETECTED COMPOUNDS IN BACKGROUND GROUNDWATER
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*MW001*	*MW005*	*MW007*
Sample ID:		*EA01-BF-MW001-01*	*EA01-BF-MW005-01*	*EA01-BF-MW007-01*
Sample Depth:		*0-0*	*0-0*	*0-0*
SWMU:		*BKGD*	*BKGD*	*BKGD*
Sample Date:		*11/20/96*	*11/21/96*	*11/21/96*
Parameters	*Units*			
Appendix 9 - Metals				
Antimony, total	mg/L	--	0.0208 J	--
Arsenic, total	mg/L	0.0088	0.0272	0.0292
Barium, soluble	mg/L	0.0839	0.0528	0.0243
Barium, total	mg/L	0.139	0.344	0.452
Beryllium, total	mg/L	0.0005	0.0024	0.0029
Cadmium, soluble	mg/L	0.0026	0.0059	0.0066 J
Cadmium, total	mg/L	0.0039	0.0108	0.0052 J
Chromium, total	mg/L	0.016	0.0718	0.0931
Cobalt, soluble	mg/L	0.0365 J	0.0164	0.0085
Cobalt, total	mg/L	0.0229 J	0.0624	0.0518
Copper, soluble	mg/L	--	0.0021 J	--
Copper, total	mg/L	0.0164	0.0862 J	0.111 J
Lead, total	mg/L	0.023	0.0728	0.0496
Mercury, total	mg/L	0.0001 U	0.00025	0.00027
Nickel, soluble	mg/L	0.0078	0.0532	0.0264
Nickel, total	mg/L	0.0318	0.141	0.135
Vanadium, total	mg/L	0.0184	0.082	0.0999
Zinc, soluble	mg/L	0.0036	0.0124	0.0034
Zinc, total	mg/L	0.0504	0.224	0.282
Appendix 9 - Semi-Volatile Organics				
Bis(2-ethylhexyl)phthalate	mg/L	0.01 J^r	--	0.01 J^r
Appendix 9 - Volatile Organics				
Acetone	mg/L	0.01 U	--	0.015 J

TABLE 4.5

SUMMARY OF DETECTED COMPOUNDS IN SWMU 1 WASTE
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*01WM01*
Sample ID:		*EA01-BF-01WM01-00601*
Sample Depth:		*2.5-3*
SWMU:		*01*
Sample Date:		*10/12/96*
Parameters	*Units*	
TCL - Semi-Volatile Organics		
Naphthalene	mg/kg	**140 J[e]**
Phenol	mg/kg	**1000 J[e]**
Appendix 9 - General Chemistry		
Sulfide, total	mg/kg	**154[e]**
Appendix 9 - Metals		
Aluminum, total	mg/kg	1.3 J
Arsenic, total	mg/kg	1.7 J
Barium, total	mg/kg	14.4
Beryllium, total	mg/kg	0.04
Chromium, total	mg/kg	2.4
Cobalt, total	mg/kg	0.96
Copper, total	mg/kg	14.2
Lead, total	mg/kg	8 J
Mercury, total	mg/kg	**0.14[be]**
Nickel, total	mg/kg	21.1
Tin, total	mg/kg	0.81
Vanadium, total	mg/kg	2.7
Zinc, total	mg/kg	21
Appendix 9 - Semi-Volatile Organics		
Phenol	mg/kg	**1200 J[e]**

TABLE 4.6

SUMMARY OF SWMU 1 WASTE RCRA CHARACTERISTICS AND TCLP ANALYSIS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*01WM01*
Sample ID:		*EA01-BF-01WM01-00601*
Sample Depth:		*2.5-3*
SWMU:		*01*
Sample Date:		*10/12/1996*
Parameters	*Units*	
TCLP - General Chemistry		
Flashpoint	deg f	200 +
pH	ph	8
TCLP - Metals		
Arsenic, total	mg/L	0.0375
Barium, total	mg/L	1.15
Chromium, total	mg/L	0.0169
Lead, total	mg/L	0.0412

TABLE 4.7

SUMMARY OF DETECTED COMPOUNDS IN SWMU 1 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		01SB03	01SB03	01SB03	01SB05	01SB05	01SB07	01SB07	01SB13	01SB14	01SB14	01SB16
Sample ID:		EA01-BF-01SB03-02401	EA01-BF-01SB03-03401	EA01-BF-01SB03-03402	EA02-BF-01SB05-00801	EA02-BF-01SB05-01801	EA02-BF-01SB07-00601	EA02-BF-01SB07-01801	EA02-BF-01SB13-04001	EA02-BF-01SB14-00801	EA02-BF-01SB14-02001	EA02-BF-01SB16-00601
Sample Depth:		10-12	15-17	15-17	2-4	7-9	1-3	7-9	18-20	2-4	8-10	1-3
SWMU:		01	01	01	01	01	01	01	01	01	01	01
Sample Date:		11/6/96	11/6/96	11/6/96 Dupl.	10/12/99	10/12/99	10/12/99	10/12/99	10/25/99	10/18/99	10/18/99	10/18/99
Parameters	Units											
TCL - Semi-Volatile Organics												
Phenanthrene	mg/kg	1.9 U	0.044 J	0.062 J	0.39 U	0.37 U	0.38 U	0.37 U	0.38 U	0.37 U	0.37 U	21 U
Phenol	mg/kg	0.69 J	0.41 J	0.37 U	0.39 U	0.37 U	0.38 U	0.37 U	0.38	0.37 U	0.37 U	21 U
TAL - Metals												
Aluminum, total	mg/kg	--	--	--	11000	8280	16700[b]	5860	5860	11300	6630	19900[b]
Arsenic, total	mg/kg	--	--	--	7.2 J	7.1	11.0[be]	7.0	6.0	5.8	6.2	8.3
Barium, total	mg/kg	--	--	--	142 J	65.5	83.5	32.5	44.9	100	49.1	132
Calcium, total	mg/kg	--	--	--	86200	93300	4600	98500	85000	99000	128000	11200
Chromium, total	mg/kg	--	--	--	18.7	14.1 J	27.3	11.1	11.5	17.7	12.1	32.0
Cobalt, total	mg/kg	--	--	--	9.6 J	7.4	15.7[be]	7.1	7.2	8.0 J	5.6	15.1[be]
Copper, total	mg/kg	--	--	--	21.2 J	19.9	25.8	19.8	16.3	16.8	20.0	27.1
Iron, total	mg/kg	--	--	--	21700	17400 J	29800	15500	15300	17800 J	15500	32700
Lead, total	mg/kg	--	--	--	9.2 J	8.2	12.1	7.5	7.8	7.3	8.0	12.2
Magnesium, total	mg/kg	--	--	--	14600 J	14600	6530	14200	18100[b]	13000	13500	8980
Manganese, total	mg/kg	--	--	--	349	402 J	662	356	348	387 J	316	482
Nickel, total	mg/kg	--	--	--	28.3 J	20.6 J	47.4[be]	20.6	21.2	22.1	18.6	45.2[be]
Potassium, total	mg/kg	--	--	--	1490 J	2330	2340	1390	1670	2610	1720	2910
Selenium, total	mg/kg	--	--	--	0.73 J	0.56 U	0.98 J	0.56 U	0.57 U	0.56 U	0.56 U	0.62 U
Thallium, total	mg/kg	--	--	--	1.2 U	1.1 U	1.2 U	1.1 U	1.7[be]	1.1 U	1.1 U	1.2 U
Vanadium, total	mg/kg	--	--	--	24.0	19.8	39.4	13.6	14.2	24.7	15.6	40.8
Zinc, total	mg/kg	--	--	--	55.8 J	50.1 J	84.2 J[be]	46.8 J	43.5	49.8	51.1	82.1
Appendix 9 - General Chemistry												
Sulfide, total	mg/kg	38.3	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Metals												
Aluminum, total	mg/kg	1.4 R	--	--	--	--	--	--	--	--	--	--
Arsenic, total	mg/kg	5.4 J	--	--	--	--	--	--	--	--	--	--
Barium, total	mg/kg	48.8	--	--	--	--	--	--	--	--	--	--
Beryllium, total	mg/kg	0.6	--	--	--	--	--	--	--	--	--	--
Cadmium, total	mg/kg	0.32	--	--	--	--	--	--	--	--	--	--
Chromium, total	mg/kg	15.2	--	--	--	--	--	--	--	--	--	--
Cobalt, total	mg/kg	4.4	--	--	--	--	--	--	--	--	--	--
Copper, total	mg/kg	20.8	--	--	--	--	--	--	--	--	--	--
Lead, total	mg/kg	10.5	--	--	--	--	--	--	--	--	--	--
Nickel, total	mg/kg	19.2	--	--	--	--	--	--	--	--	--	--
Thallium, total	mg/kg	0.23 J	--	--	--	--	--	--	--	--	--	--
Vanadium, total	mg/kg	21.5	--	--	--	--	--	--	--	--	--	--
Zinc, total	mg/kg	50.3 J	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Semi-Volatile Organics												
Diphenylamine	mg/kg	0.11 J	--	--	--	--	--	--	--	--	--	--
Naphthalene	mg/kg	0.054 J	--	--	--	--	--	--	--	--	--	--
Phenol	mg/kg	640[e]	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Volatile Organics												
1,2-Dichloroethene (total)	mg/kg	0.011	--	--	--	--	--	--	--	--	--	--
2-Butanone	mg/kg	0.037	--	--	--	--	--	--	--	--	--	--

TABLE 4.8

SUMMARY OF DETECTED COMPOUNDS IN SWMU 1 GROUNDWATER (MW-006)
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*MW006*
Sample ID:		*EA01-BF-MW006-01*
Sample Depth:		*0-0*
SWMU:		*01*
Sample Date:		*11/20/96*
Parameters	*Units*	
Appendix 9 - Metals		
Arsenic, total	mg/L	0.0132
Barium, soluble	mg/L	0.0422
Barium, total	mg/L	0.19
Beryllium, total	mg/L	0.0019
Cadmium, soluble	mg/L	0.0026
Cadmium, total	mg/L	0.0028
Chromium, total	mg/L	0.0545
Cobalt, total	mg/L	0.0305
Copper, total	mg/L	0.0582
lead, soluble	mg/L	**0.0075**[rs]
Lead, total	mg/L	0.0202 J
Mercury, total	mg/L	0.00025
Nickel, soluble	mg/L	0.0188
Nickel, total	mg/L	0.0967
Tin, total	mg/L	**0.014**[s]
Vanadium, total	mg/L	0.0689
Zinc, soluble	mg/L	0.0017
Zinc, total	mg/L	0.151
Appendix 9 - Semi-Volatile Organics		
bis(2-ethylhexyl)phthalate	mg/L	**0.01 J**[r]

TABLE 4.9

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 WASTE
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*03WM01*	*03WM02*	*03WM03*
Sample ID:		*EA01-BF-03WM01-00401*	*EA01-BF-03WM02-00601*	*EA01-BF-03WM03-01201*
Sample Depth:		*1.5-2*	*2.5-3*	*5.5-6*
SWMU:		*03*	*03*	*03*
Sample Date:		*11/5/96*	*11/5/96*	*11/6/96*
Parameters	*Units*			
TCL - Semi-Volatile Organics				
1,2,4-Trichlorobenzene	mg/kg	0.94 R	1500 U	2 U
1,2-Dichlorobenzene	mg/kg	0.94 R	1500 U	2 U
1,3-Dichlorobenzene	mg/kg	0.94 R	1500 U	2 U
1,4-Dichlorobenzene	mg/kg	0.94 R	1500 U	2 U
2,2'-Oxybis(1-Chloropropane)	mg/kg	0.94 R	1500 U	2 U
2,4,5-Trichlorophenol	mg/kg	2.3 R	3700 U	5.1 U
2,4,6-Trichlorophenol	mg/kg	0.94 R	1500 U	2 U
2,4-Dichlorophenol	mg/kg	0.94 R	1500 U	2 U
2,4-Dimethylphenol	mg/kg	0.94 R	1500 U	2 U
2,4-Dinitrophenol	mg/kg	2.3 R	3700 U	5.1 U
2,4-Dinitrotoluene	mg/kg	0.94 R	1500 U	2 U
2,6-Dinitrotoluene	mg/kg	0.94 R	1500 U	2 U
2-Chloronaphthalene	mg/kg	0.94 R	1500 U	2 U
2-Chlorophenol	mg/kg	0.94 R	1500 U	2 U
2-Methylnaphthalene	mg/kg	0.94 R	1500 U	2 U
2-Methylphenol	mg/kg	0.94 R	1500 U	2 U
2-Nitroaniline	mg/kg	2.3 R	3700 U	5.1 U
2-Nitrophenol	mg/kg	0.94 R	1500 U	2 U
3,3'-Dichlorobenzidine	mg/kg	0.94 R	1500 U	2 U
3-Nitroaniline	mg/kg	2.3 R	3700 U	5.1 U
4,6-Dinitro-2-methylphenol	mg/kg	2.3 R	3700 U	5.1 U
4-Bromophenyl-phenylether	mg/kg	0.94 R	1500 U	2 U
4-Chloro-3-methylphenol	mg/kg	0.94 R	1500 U	2 U
4-Chloroaniline	mg/kg	0.94 R	1500 U	2 U
4-Chlorophenyl-phenylether	mg/kg	0.94 R	1500 U	2 U
4-Methylphenol	mg/kg	0.94 R	1500 U	2 U
4-Nitroaniline	mg/kg	2.3 R	3700 U	5.1 U
4-Nitrophenol	mg/kg	2.3 R	3700 U	5.1 U
Acenaphthene	mg/kg	0.94 R	1500 U	2 U
Acenaphthylene	mg/kg	0.94 R	1500 U	2 U
Anthracene	mg/kg	0.3 J	1500 U	2 U
Benzo(a)anthracene	mg/kg	0.96 J	1500 U	0.34 J
Benzo(a)pyrene	mg/kg	0.67 J[r]	1500 U	0.47 J[r]
Benzo(b)fluoranthene	mg/kg	0.99 J	1500 U	0.84 J
Benzo(g,h,i)perylene	mg/kg	0.56 J	1500 U	0.35 J
Benzo(k)fluoranthene	mg/kg	0.56 J	1500 U	0.34 J
Bis(2-Chloroethoxy)methane	mg/kg	0.94 R	1500 U	2 U
Bis(2-Chloroethyl)ether	mg/kg	0.94 R	1500 U	2 U
Bis(2-Ethylhexyl)phthalate	mg/kg	0.19 J	1500 U	3.4[c]
Butylbenzylphthalate	mg/kg	0.21 J	1500 U	2 U
Carbazole	mg/kg	0.94 R	1500 U	2 U

TABLE 4.9

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 WASTE
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*03WM01*	*03WM02*	*03WM03*
Sample ID:		*EA01-BF-03WM01-00401*	*EA01-BF-03WM02-00601*	*EA01-BF-03WM03-01201*
Sample Depth:		*1.5-2*	*2.5-3*	*5.5-6*
SWMU:		*03*	*03*	*03*
Sample Date:		*11/5/96*	*11/5/96*	*11/6/96*
Parameters	*Units*			
TCL - Semi-Volatile Organics (Cont'd)				
Chrysene	mg/kg	1.2 J	1500 U	0.41 J
Di-n-Butylphthalate	mg/kg	0.94 R	1500 U	2 U
Di-n-octylphthalate	mg/kg	0.94 R	1500 U	2 U
Bibenzo(a,h)anthracene	mg/kg	0.17 J	1500 U	2 U
Dibenzofuran	mg/kg	0.94 R	1500 U	2 U
Diethylphthalate	mg/kg	0.94 R	1500 U	2 U
Dimethylphthalate	mg/kg	0.94 R	1500 U	2 U
Fluoranthene	mg/kg	1.5 J	1500 U	0.68 J
Fluorene	mg/kg	0.1 J	1500 U	2 U
Hexachlorobenzene	mg/kg	0.94 R	1500 U	2 U
Hexachlorobutadiene	mg/kg	0.94 R	1500 U	2 U
Hexachlorocyclopentadiene	mg/kg	0.94 R	1500 U	2 U
Hexachloroethane	mg/kg	0.94 R	1500 U	2 U
Indeno(1,2,3-CD)pyrene	mg/kg	0.76 J	1500 U	0.47 J
Isophorone	mg/kg	0.94 R	1500 U	2 U
N-Nitrosodi-n-propylamine	mg/kg	0.94 R	1500 U	2 U
N-Nitrosodiphenylamine	mg/kg	0.94 R	1500 U	2 U
Naphthalene	mg/kg	0.94 R	1500 U	2 U
Nitrobenzene	mg/kg	0.94 R	1500 U	2 U
Pentachlorophenol	mg/kg	2.3 R	3700 U	5.1 U
Phenanthrene	mg/kg	0.98 J	1500 U	0.33 J
Phenol	mg/kg	0.94 R	36 J	2 U
Pyrene	mg/kg	2 J	1500 U	0.47 J
Appendix 9 - Metals				
Arsenic, total	mg/kg	--	1.7 J	--
Barium, total	mg/kg	--	25.5	--
Beryllium, total	mg/kg	--	0.08	--
Cadmium, total	mg/kg	--	1 J	--
Chromium, total	mg/kg	--	6.1 J	--
Cobalt, total	mg/kg	--	0.55	--
Copper, total	mg/kg	--	9.2	--
Lead, total	mg/kg	--	**21.6 J[b,e]**	--
Mercury, total	mg/kg	--	**0.36[b,e]**	--
Nickel, total	mg/kg	--	5	--
Selenium, total	mg/kg	--	0.39	--
Thallium, total	mg/kg	--	0.24	--
Tin, total	mg/kg	--	**1.5[b]**	--
Vanadium, total	mg/kg	--	2.7	--
Zinc, total	mg/kg	--	**90.8 J[b,e]**	--
Appendix 9 - Dioxins/Furans (TEQ)				
2,3,7,8-TCDD (TEQ value)	µg/kg	--	**0.01685 J[c]**	--
Appendix 9 - Semi-Volatile Organics				
Phenol	mg/kg	--	57 J	--
Appendix 9 - Volatile Organics				
2-Butanone	mg/kg	--	0.14	--
Acetone	mg/kg	--	0.9 J	--
Xylenes (total)	mg/kg	--	0.008 J	--

TABLE 4.10

SUMMARY OF SWMU 3 WASTE RCRA CHARACTERISTICS AND TCLP ANALYSIS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*03WM02*
Sample ID:		*EA01-BF-03WM02-00601*
Sample Depth:		*2.5-3*
SWMU:		*03*
Sample Date:		*11/5/1996*
Parameters	*Units*	
TCLP - General Chemistry		
FLASHPOINT	deg f	200 +
PH	ph	10.5
TCLP - Metals		
ARSENIC, TOTAL	mg/L	0.0397
BARIUM, TOTAL	mg/L	0.24 J
CHROMIUM, TOTAL	mg/L	0.003

TABLE 4.11

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*BTP3-17*	*BTP3-17*	*BTP3-18*	*BTP3-18*	*BTP3-21*	*BTP3-21*	*BTP3-22*	*BTP3-23*	*BTP3-24*	*BTP3-25*	*BTP3-25*
Sample ID:		*EA02-BF-BTP3-17-00601*	*EA02-BF-BTP3-17-01601*	*EA02-BF-BTP3-18-00601*	*EA02-BF-BTP3-18-01601*	*EA02-BF-BTP3-21-00601*	*EA02-BF-BTP3-21-01601*	*EA02-BF-BTP3-22-01401*	*EA02-BF-BTP3-23-01401*	*EA02-BF-BTP3-24-01401*	*EA02-BF-BTP3-25-01401*	*EA02-BF-BTP3-25-01402*
Sample Depth:		*1-3*	*6-8*	*1-3*	*6-8*	*1-3*	*6-8*	*5-7*	*5-7*	*5-7*	*5-7*	*5-7*
SWMU:		*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*
Sample Date:		*12/13/99*	*12/13/99*	*12/14/99*	*12/14/99*	*12/14/99*	*12/14/99*	*12/14/99*	*12/14/99*	*12/14/99*	*12/14/99*	*12/14/99 Dupl.*
Parameters	*Units*											
TCL - Semi-Volatile Organics												
2,4-Dichlorophenol	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
2-Methylnaphthalene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
2-Methylphenol	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Benzo(a)pyrene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Benzo(b)fluoranthene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Benzo(g,hi)perylene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Benzo(k)fluoranthene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Chrysene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Fluoranthene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Indeno(1,2,3-CD)pyrene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
N-Nitrosodiphenylamine	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Naphthalene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Phenanthrene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Phenol	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
Pyrene	mg/kg	0.4 U	0.38 U	0.36 U	0.37 U	0.38 U	0.36 U	0.39 U	0.43 U	0.4 U	0.39 U	0.38 U
TAL - Metals												
Aluminum, total	mg/kg	**17800[b]**	10200	8330	7370	11700	8270	9980	12500	8650	12500	12500
Arsenic, total	mg/kg	9.7	6.2	8.2	7.4	9.7	8.0	9.0	**21.7[rbc]**	**11.4[rbc]**	10.2	10.0
Barium, total	mg/kg	94.3	69.8	44.6	63.3	77.1	51.2	132	155	80.3	131	125
Beryllium, total	mg/kg	0.63	0.58 U	0.55 U	0.56 U	0.57 U	0.55 U	0.59 U	0.71	0.61 U	0.58 U	0.58 U
Calcium, total	mg/kg	4010	63800	78600	99800 J	31700	81100	3940	4290	2840	3200	3340
Chromium, total	mg/kg	27.3	17.7	13.6	13.4 J	18.9	13.9	16.2	21.3	15.6	20.0	20.2
Cobalt, total	mg/kg	11.0	8.8	8.6	7.3 J	8.8	8.8	10.1	**22.1[bc]**	9.3	**12.6[bc]**	**12.5[bc]**
Copper, total	mg/kg	26.3	19.2	22.9	19.0	**32.1[bc]**	22.3	24.9	16.1	11.6	17.9	18.4
Iron, total	mg/kg	29000	18600	18600	18300 J	22100	18700	26800	**63200[b]**	26000	30200	29700
Lead, total	mg/kg	12.1	7.9	9.2	8.8 J	**29.7[bc]**	9.4	11.1	15.4	9.5	13.1	13.1
Magnesium, total	mg/kg	4570	**16600[b]**	9760 J	13200 J	6140 J	9990 J	3930 J	3390 J	2580 J	3420 J	3540 J
Manganese, total	mg/kg	419	432	459	381 J	381	408	**1350[b]**	**2010[pb]**	772	**1810[pb]**	**1860[pb]**
Mercury, total	mg/kg	0.12 U	0.12 U	0.11 U	0.11 U	**0.17[bc]**	0.11 U	0.12 U	0.13 U	0.12 U	0.12 U	0.12 U
Nickel, total	mg/kg	36.2	27.8	24.4	21.8 J	27.2	23.8	28.9	31.5	19.5	36.5	34.9
Potassium, total	mg/kg	1700	2150	1350	1480	1480	1360	1890	1430	1150	1830	1930
Sodium, total	mg/kg	605 U	578 U	551 U	557 U	575 U	550 U	589 U	647 U	608 U	585 U	582 U
Vanadium, total	mg/kg	38.5	26.4	19.6	18.0	26.2	18.9	26.0	39.3	22.2	32.1	32.5
Zinc, total	mg/kg	70.9	46.8	58.1	59.9 J	**129[bc]**	59.2	76.5	**111[bc]**	65.5	76.4	76.4

TABLE 4.11

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Parameters	Units	Sample Location: BTP3-17 / Sample ID: EA02-BF-BTP3-17-00601 / Sample Depth: 1-3 / SWMU: 03 / Sample Date: 12/13/99	BTP3-17 / EA02-BF-BTP3-17-01601 / 6-8 / 03 / 12/13/99	BTP3-18 / EA02-BF-BTP3-18-00601 / 1-3 / 03 / 12/14/99	BTP3-18 / EA02-BF-BTP3-18-01601 / 6-8 / 03 / 12/14/99	BTP3-21 / EA02-BF-BTP3-21-00601 / 1-3 / 03 / 12/14/99	BTP3-21 / EA02-BF-BTP3-21-01601 / 6-8 / 03 / 12/14/99	BTP3-22 / EA02-BF-BTP3-22-01401 / 5-7 / 03 / 12/14/99	BTP3-23 / EA02-BF-BTP3-23-01401 / 5-7 / 03 / 12/14/99	BTP3-24 / EA02-BF-BTP3-24-01401 / 5-7 / 03 / 12/14/99	BTP3-25 / EA02-BF-BTP3-25-01401 / 5-7 / 03 / 12/14/99	BTP3-25 / EA02-BF-BTP3-25-01402 / 5-7 / 03 / 12/14/99 Dupl.
Appendix 9 - Metals												
Aluminum, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Arsenic, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Barium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Beryllium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Cadmium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Chromium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Cobalt, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Copper, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Lead, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Mercury, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Nickel, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Selenium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Thallium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Tin, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Vanadium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Zinc, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Dioxins/Furans (TEQ)												
2,3,7,8-TCDD (TEQ value)	µg/kg	--	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Semi-Volatile Organics												
2-Methylnaphthalene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,I)perylene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,30CD)pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Phenol	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Volatile Organics												
2-Butanone	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Methylene chloride	mg/kg	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.11

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*BTP3-26*	*BTP3-39*	*BTP3-39*	*BTP3-39*	*BTP3-42*	*BTP3-42*	*BTP3-46*	*BTP3-46*	*BTP3-49*	*BTP3-49*	*BTP3-50*
Sample ID:		*EA02-BF-BTP3-26-00601*	*EA02-BF-BTP3-39-00601*	*EA02-BF-BTP3-39-01401*	*EA02-BF-BTP3-39-01401*	*EA02-BF-BTP3-42-00601*	*EA02-BF-BTP3-42-01401*	*EA02-BF-BTP3-46-00601*	*EA02-BF-BTP3-46-01405*	*EA02-BF-BTP3-49-00601*	*EA02-BF-BTP3-49-01401*	*EA02-BF-BTP3-50-00601*
Sample Depth:		*1-3*	*1-3*	*5-7*	*5-7*	*1-3*	*5-7*	*1-3*	*5-7*	*1-3*	*5-7*	*1-3*
SWMU:		*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*
Sample Date:		*12/14/99*	*12/14/99*	*12/14/99*	*12/14/99*	*12/15/99*	*12/15/99*	*12/15/99*	*12/15/99*	*12/15/99*	*12/15/99*	*12/15/99*
				Lab Dupl.								
Parameters	*Units*											
TCL - Semi-Volatile Organics												
2,4-Dichlorophenol	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
2-Methylnaphthalene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
2-Methylphenol	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
Benzo(a)pyrene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.45[r]
Benzo(b)fluoranthene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.54
Benzo(g,hi)perylene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
Benzo(k)fluoranthene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
Chrysene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
Fluoranthene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.54
Indeno(1,2,3-CD)pyrene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
N-Nitrosodiphenylamine	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
Naphthalene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
Phenanthrene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
Phenol	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.44 U
Pyrene	mg/kg	0.43 U	0.4 U	--	0.39 U	0.38 U	0.37 U	0.37 U	0.37 U	0.4 U	0.4 U	0.47
TAL - Metals												
Aluminum, total	mg/kg	12100	12900	--	12000	9040	7970	7870	8100	**16800[b]**	**15600[b]**	7920
Arsenic, total	mg/kg	8.6	**14.1[rbe]**	--	10.5	5.7	5.9	5.7	6.7	7.0	**11.2[rbe]**	**15.6[rbe]**
Barium, total	mg/kg	106	106	--	143	81.1	90.6	47.4	53.5	115	83.7	115
Beryllium, total	mg/kg	0.65 U	0.6 U	--	0.59 U	0.58 U	0.56 U	0.56 U	0.55 U	0.63	0.61 U	0.67 U
Calcium, total	mg/kg	4490	3690	--	3810	105000	101000	103000	95400	4030	3840	3590
Chromium, total	mg/kg	19.5	21.3	--	20.9	15.7 J	13.4	13.1	13.7	24.8	25.0	23.5
Cobalt, total	mg/kg	9.9	**12.3[be]**	--	**18.8[be]**	9.2 J	7.7	6.7	6.8	9.7	10.8	6.4 J
Copper, total	mg/kg	15.5	14.0	--	10.9	21.5	17.2	16.8	19.4	20.7	19.1	**147[be]**
Iron, total	mg/kg	23800	33900	--	29500	17600 J	15700	15500	16600	26200	32900	56600
Lead, total	mg/kg	15.7	16.0	--	13.2	11.7 J	7.9	7.3	7.7	13.9	14.3	**157[be]**
Magnesium, total	mg/kg	3350 J	3160 J	--	3460 J	13900 J	14400	12000	14000 J	4280	4120	3400
Manganese, total	mg/kg	1280	1050	--	**2930[pb]**	430 J	435	344	344	371	285	328
Mercury, total	mg/kg	0.13 U	0.12 U	--	0.12 U	0.12 U	0.11 U	0.11 U	0.11 U	0.12 U	0.12 U	**0.14[be]**
Nickel, total	mg/kg	26.7	23.4	--	31.6	23.8 J	20.5	20.4	20.3	29.5	31.0	**41.2[be]**
Potassium, total	mg/kg	1510	2110	--	1300	1810	1780	1220	1870	1930	1790	1290
Sodium, total	mg/kg	645 U	599 U	--	589 U	577 U	561 U	564 U	553 U	612 U	611 U	1350
Vanadium, total	mg/kg	25.9	33.8	--	25.2	20.8	18.4	16.5	19.2	34.0	40.5	24.6
Zinc, total	mg/kg	**107[be]**	**92.3[be]**	--	**106[be]**	52.9 J	60.3	58.2	53.8	**89.1[be]**	**87.7[be]**	**315[be]**

TABLE 4.11

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*BTP3-26*	*BTP3-39*	*BTP3-39*	*BTP3-39*	*BTP3-42*	*BTP3-42*	*BTP3-46*	*BTP3-46*	*BTP3-49*	*BTP3-49*	*BTP3-50*
Sample ID:		*EA02-BF-BTP3-26-00601*	*EA02-BF-BTP3-39-00601*	*EA02-BF-BTP3-39-01401*	*EA02-BF-BTP3-39-01401*	*EA02-BF-BTP3-42-00601*	*EA02-BF-BTP3-42-01401*	*EA02-BF-BTP3-46-00601*	*EA02-BF-BTP3-46-01405*	*EA02-BF-BTP3-49-00601*	*EA02-BF-BTP3-49-01401*	*EA02-BF-BTP3-50-00601*
Sample Depth:		*1-3*	*1-3*	*5-7*	*5-7*	*1-3*	*5-7*	*1-3*	*5-7*	*1-3*	*5-7*	*1-3*
SWMU:		*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*
Sample Date:		*12/14/99*	*12/14/99*	*12/14/99*	*12/14/99*	*12/15/99*	*12/15/99*	*12/15/99*	*12/15/99*	*12/15/99*	*12/15/99*	*12/15/99*
				Lab Dupl.								
Parameters	*Units*											
Appendix 9 - Metals												
Aluminum, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Arsenic, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Barium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Beryllium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Cadmium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Chromium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Cobalt, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Copper, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Lead, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Mercury, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Nickel, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Selenium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Thallium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Tin, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Vanadium, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Zinc, total	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Dioxins/Furans (TEQ)												
2,3,7,8-TCDD (TEQ value)	µg/kg	--	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Semi-Volatile Organics												
2-Methylnaphthalene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo(g,h,I)perylene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,30CD)pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Phenol	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Pyrene	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Appendix 9 - Volatile Organics												
2-Butanone	mg/kg	--	--	--	--	--	--	--	--	--	--	--
Methylene chloride	mg/kg	--	--	--	--	--	--	--	--	--	--	--

TABLE 4.11

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*BTP3-51*	*BTP3-52*	*BTP3-52*	*03SB01*	*03SB01*	*03SB02*	*03SB02*	*03SB03*	*03SB03*
Sample ID:		*EA02-BF-BTP3-51-00601*	*EA02-BF-BTP3-52-00601*	*EA02-BF-BTP3-52-01601*	*EA01-BF-03SB01-00801*	*EA01-BF-03SB01-01801*	*EA01-BF-03SB02-01001*	*EA01-BF-03SB02-01401*	*EA01-BF-03SB03-01601*	*EA01-BF-03SB03-02401*
Sample Depth:		*1-3*	*1-3*	*6-8*	*2-4*	*7-9*	*3-5*	*5-7*	*6-8*	*10-12*
SWMU:		*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*
Sample Date:		*12/15/99*	*12/15/99*	*12/15/99*	*11/5/96*	*11/5/96*	*11/5/96*	*11/5/96*	*11/6/96*	*11/6/96*
Parameters	*Units*									
TCL - Semi-Volatile Organics										
2,4-Dichlorophenol	mg/kg	0.41 U	0.37 U	0.37 U	0.37 U	0.38 U	1.9 U	0.38 U	0.093 J	0.42 U
2-Methylnaphthalene	mg/kg	0.41 U	0.37 U	0.37 U	0.37 U	0.38 U	0.64 J	0.38 U	0.44 U	0.42 U
2-Methylphenol	mg/kg	0.41 U	0.37 U	0.37 U	0.37 U	0.38 U	0.28 J	0.38 U	0.44 U	0.42 U
Benzo(a)pyrene	mg/kg	0.41 U	0.37 U	0.37 U	0.046 J	0.38 U	0.39 J[r]	0.38 U	0.44 U	0.42 U
Benzo(b)fluoranthene	mg/kg	0.41 U	0.37 U	0.37 U	0.066 J	0.38 U	0.55 J	0.38 U	0.062 J	0.42 U
Benzo(g,hi)perylene	mg/kg	0.41 U	0.37 U	0.37 U	0.37 U	0.38 U	0.28 J	0.38 U	0.44 U	0.42 U
Benzo(k)fluoranthene	mg/kg	0.41 U	0.37 U	0.37 U	0.37 U	0.38 U	0.25 J	0.38 U	0.44 U	0.42 U
Chrysene	mg/kg	0.41 U	0.37 U	0.37 U	0.074 J	0.38 U	1.9 U	0.38 U	0.44 U	0.42 U
Fluoranthene	mg/kg	0.41 U	0.37 U	0.37 U	0.092 J	0.38 U	1.9 U	0.38 U	0.049 J	0.42 U
Indeno(1,2,3-CD)pyrene	mg/kg	0.41 U	0.37 U	0.37 U	0.37 U	0.38 U	0.36 J	0.38 U	0.44 U	0.42 U
N-Nitrosodiphenylamine	mg/kg	0.41 U	0.37 U	0.37 U	1.2[e]	0.38 U	1.9 U	0.38 U	0.44 U	0.42 U
Naphthalene	mg/kg	0.41 U	0.37 U	0.37 U	0.37 U	0.38 U	37[e]	0.38 U	0.44 U	0.42 U
Phenanthrene	mg/kg	0.41 U	0.37 U	0.37 U	0.14 J	0.38 U	1 J	0.38 U	0.44 U	0.42 U
Phenol	mg/kg	0.41 U	0.37 U	0.37 U	0.37 U	0.38 U	1.4 J	0.38 U	0.92	0.42 U
Pyrene	mg/kg	0.41 U	0.37 U	0.37 U	0.079 J	0.38 U	0.91 J	0.38 U	0.047 J	0.42 U
TAL - Metals										
Aluminum, total	mg/kg	12500	11400	6580	--	--	--	--	--	--
Arsenic, total	mg/kg	12.5[rbe]	8.0	6.6	--	--	--	--	--	--
Barium, total	mg/kg	66.4	50.8	44.2	--	--	--	--	--	--
Beryllium, total	mg/kg	0.63 U	0.57 U	0.55 U	--	--	--	--	--	--
Calcium, total	mg/kg	2910	5040	90200	--	--	--	--	--	--
Chromium, total	mg/kg	20.8	19.0	12.0	--	--	--	--	--	--
Cobalt, total	mg/kg	11.6[be]	9.1	9.9	--	--	--	--	--	--
Copper, total	mg/kg	22.7	23.2	20.4	--	--	--	--	--	--
Iron, total	mg/kg	31000	23500	16200	--	--	--	--	--	--
Lead, total	mg/kg	15.1	12.2	9.3	--	--	--	--	--	--
Magnesium, total	mg/kg	4290	4620	13700	--	--	--	--	--	--
Manganese, total	mg/kg	391	342	460	--	--	--	--	--	--
Mercury, total	mg/kg	0.13 U	0.11 U	0.11 U	--	--	--	--	--	--
Nickel, total	mg/kg	28.4	29.6	25.4	--	--	--	--	--	--
Potassium, total	mg/kg	1340	1880	1250	--	--	--	--	--	--
Sodium, total	mg/kg	627 U	568 U	554 U	--	--	--	--	--	--
Vanadium, total	mg/kg	35.5	24.6	15.5	--	--	--	--	--	--
Zinc, total	mg/kg	68.7	66.9	54.6	--	--	--	--	--	--

TABLE 4.11

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*BTP3-51*	*BTP3-52*	*BTP3-52*	*03SB01*	*03SB01*	*03SB02*	*03SB02*	*03SB03*	*03SB03*
Sample ID:		*EA02-BF-BTP3-51-00601*	*EA02-BF-BTP3-52-00601*	*EA02-BF-BTP3-52-01601*	*EA01-BF-03SB01-00801*	*EA01-BF-03SB01-01801*	*EA01-BF-03SB02-01001*	*EA01-BF-03SB02-01401*	*EA01-BF-03SB03-01601*	*EA01-BF-03SB03-02401*
Sample Depth:		*1-3*	*1-3*	*6-8*	*2-4*	*7-9*	*3-5*	*5-7*	*6-8*	*10-12*
SWMU:		*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*	*03*
Sample Date:		*12/15/99*	*12/15/99*	*12/15/99*	*11/5/96*	*11/5/96*	*11/5/96*	*11/5/96*	*11/6/96*	*11/6/96*
Parameters	*Units*									
Appendix 9 - Metals										
Aluminum, total	mg/kg	--	--	--	--	--	1.9 J	--	--	--
Arsenic, total	mg/kg	--	--	--	--	--	10.7 J	--	--	--
Barium, total	mg/kg	--	--	--	--	--	155	--	--	--
Beryllium, total	mg/kg	--	--	--	--	--	0.84	--	--	--
Cadmium, total	mg/kg	--	--	--	--	--	0.95 J	--	--	--
Chromium, total	mg/kg	--	--	--	--	--	21.3 J	--	--	--
Cobalt, total	mg/kg	--	--	--	--	--	3.9	--	--	--
Copper, total	mg/kg	--	--	--	--	--	**46[be]**	--	--	--
Lead, total	mg/kg	--	--	--	--	--	**218 J[be]**	--	--	--
Mercury, total	mg/kg	--	--	--	--	--	**1.6[be]**	--	--	--
Nickel, total	mg/kg	--	--	--	--	--	**42.1[be]**	--	--	--
Selenium, total	mg/kg	--	--	--	--	--	0.84	--	--	--
Thallium, total	mg/kg	--	--	--	--	--	0.19 J	--	--	--
Tin, total	mg/kg	--	--	--	--	--	**8.3[be]**	--	--	--
Vanadium, total	mg/kg	--	--	--	--	--	15.7	--	--	--
Zinc, total	mg/kg	--	--	--	--	--	**145 J[be]**	--	--	--
Appendix 9 - Dioxins/Furans (TEQ)										
2,3,7,8-TCDD (TEQ value)	µg/kg	--	--	--	--	--	**0.03468 J[re]**	--	--	--
Appendix 9 - Semi-Volatile Organics										
2-Methylnaphthalene	mg/kg	--	--	--	--	--	0.45 J	--	--	--
2-Methylphenol	mg/kg	--	--	--	--	--	0.39 J	--	--	--
Benzo(a)pyrene	mg/kg	--	--	--	--	--	**0.84[r]**	--	--	--
Benzo(b)fluoranthene	mg/kg	--	--	--	--	--	0.66 J	--	--	--
Benzo(g,h,I)perylene	mg/kg	--	--	--	--	--	0.45 J	--	--	--
Benzo(k)fluoranthene	mg/kg	--	--	--	--	--	0.35 J	--	--	--
Dibenzo(a,h)anthracene	mg/kg	--	--	--	--	--	0.12 J	--	--	--
Dibenzofuran	mg/kg	--	--	--	--	--	0.083 J	--	--	--
Indeno(1,2,30CD)pyrene	mg/kg	--	--	--	--	--	0.54 J	--	--	--
Naphthalene	mg/kg	--	--	--	--	--	**10[e]**	--	--	--
Phenol	mg/kg	--	--	--	--	--	1.5	--	--	--
Pyrene	mg/kg	--	--	--	--	--	0.83	--	--	--
Appendix 9 - Volatile Organics										
2-Butanone	mg/kg	--	--	--	--	--	2.6 J	--	--	--
Methylene chloride	mg/kg	--	--	--	--	--	0.51 J	--	--	--

TABLE 4.12

SUMMARY OF DETECTED COMPOUNDS IN SWMU 3 GROUNDWATER (MW-002/003)
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*MW002*	*MW003*	*MW003*	*MW003*	*MW003*
Sample ID:		*EA01-BF-MW002-01*	*EA01-BF-MW003-01*	*EA01-BF-MW003-02*	*EA01-BF-MW003-01*	*EA01-BF-MW003-02*
Sample Depth:		*0-0*	*0-0*	*0-0*	*0-0*	*0-0*
SWMU:		*03*	*03*	*03*	*03*	*03*
Sample Date:		*11/20/96*	*11/21/96*	*11/21/96*	*11/23/96*	*11/23/96*
				Dupl		Dupl
Parameters	*Units*					
Appendix 9 - Metals						
Antimony, total	mg/L	0.016 U	**0.0189 J[m]**	0.016 U	--	--
Arsenic, soluble	mg/L	**0.007[m]**	--	--	0.0016 U	**0.0019[m]**
Arsenic, total	mg/L	**0.0384[m]**	**0.0405[m]**	**0.0162[m]**	--	--
Barium, soluble	mg/L	0.149	--	--	0.0934	0.0822
Barium, total	mg/L	**0.52[n]**	**0.706[n]**	**0.275[n]**	--	--
Beryllium, total	mg/L	**0.0027[m]**	**0.0048[m]**	**0.0017[m]**	--	--
Cadmium, soluble	mg/L	**0.0033[gn]**	--	--	0.0021 U	0.0025
Cadmium, total	mg/L	0.0029	0.0029	0.0021 U	--	--
Chromium, soluble	mg/L	**0.0026[n]**	--	--	0.0017 U	0.0017 U
Chromium, total	mg/L	**0.0959[n]**	**0.143[gn]**	**0.0409[n]**	--	--
Cobalt, soluble	mg/L	0.054	--	--	0.0202	0.0121
Cobalt, total	mg/L	**0.156[gn]**	**0.154[gn]**	**0.0492[n]**	--	--
Copper, soluble	mg/L	**0.0028 J[n]**	--	--	0.0015 U	0.0015 U
Copper, total	mg/L	**0.107 J[gn]**	**0.16 J[gn]**	**0.0457[gn]**	--	--
lead, soluble	mg/L	0.0013 U	--	--	0.002 J	0.0045 J
Lead, total	mg/L	**0.103[rgn]**	**0.106[rgn]**	**0.0298[rgn]**	--	--
Mercury, total	mg/L	**0.00027[gn]**	**0.00027[gn]**	0.0001 U	--	--
Nickel, soluble	mg/L	**0.0086[n]**	--	--	**0.009[n]**	0.0067 U
Nickel, total	mg/L	**0.117[n]**	**0.208[gn]**	**0.0613[n]**	--	--
Selenium, soluble	mg/L	0.014 U	--	--	0.0018 U	0.0031 J
Thallium, total	mg/L	**0.0022 J[m]**	**0.0019 J[n]**	0.0016 U	--	--
Vanadium, soluble	mg/L	**0.0034[n]**	--	--	**0.0018[n]**	0.0017 U
Vanadium, total	mg/L	**0.103[gn]**	**0.157[gn]**	**0.049[gn]**	--	--
Zinc, soluble	mg/L	**0.0041[n]**	--	--	0.0124 U	**0.0329[n]**
Zinc, total	mg/L	**0.327[gn]**	**0.446[gn]**	**0.145[n]**	--	--
Appendix 9 - Semi-Volatile Organics						
Bis(2-ethylhexyl)phthalate	mg/L	**0.01 J[r]**	**0.01 J[r]**	**0.01 J[r]**	--	--
Appendix 9 - Volatile Organics						
Acetone	mg/L	0.014 J	0.01 U	0.01 U	--	--
Chloroform	mg/L	**0.005[r]**	0.005 U	0.005 U	--	--

TABLE 4.13

SUMMARY OF DETECTED COMPOUNDS IN SWMU 4 WASTE
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*04WM01*	*04WM01*	*04WM02*
Sample ID:		*EA01-BF-04WM01-00601*	*EA01-BF-04WM01-00602*	*EA01-BF-04WM02-00601*
Sample Depth:		*2.5-3*	*2.5-3*	*2.5-3*
SWMU:		*04*	*04*	*04*
Sample Date:		*11/6/96*	*11/6/96*	*11/7/96*
			Dupl.	
Parameters	*Units*			
TCL - Semi-Volatile Organics				
N-Nitrosodiphenylamine	mg/kg	1800 J[rce]	2000 J[rce]	1800 U
Naphthalene	mg/kg	100 J[e]	96 J[e]	730 J[rioe]
Phenol	mg/kg	14000 J[cde]	17000 J[cde]	9800 J[e]
Appendix 9 - General Chemistry				
Sulfide, total	mg/kg	135[e]	58.4[e]	--
Appendix 9 - Metals				
Aluminum, total	mg/kg	1.8 R	3.1 J	--
Arsenic, total	mg/kg	9.9 J	11.8 J[rbe]	--
Barium, total	mg/kg	177	120	--
Beryllium, total	mg/kg	0.37	0.59	--
Cadmium, total	mg/kg	0.44	0.7	--
Chromium, total	mg/kg	20.2 J	10.4 J	--
Cobalt, total	mg/kg	15.5 J[be]	5	--
Copper, total	mg/kg	184 J[be]	39.3 J[be]	--
Lead, total	mg/kg	199 J[be]	76.3 J[be]	--
Mercury, total	mg/kg	1.1[be]	0.85[be]	--
Nickel, total	mg/kg	393 J[be]	87.1 J[be]	--
Tin, total	mg/kg	2.1[b]	1.7[b]	--
Vanadium, total	mg/kg	8.5	9.8	--
Zinc, total	mg/kg	156 J[be]	127 J[be]	--
Appendix 9 - Dioxins/Furans (TEQ)				
2,3,7,8-TCDD (TEQ value)	µg/kg	--	0.00525 J[e]	--
Appendix 9 - Semi-Volatile Organics				
N-Nitrosodiphenylamine	mg/kg	460 J[re]	1200 J[rce]	--
Phenol	mg/kg	6900 J[e]	9800 J[e]	--
Appendix 9 - Volatile Organics				
2-Butanone	mg/kg	13 J	7 J	--
Benzene	mg/kg	2 U	0.46 J[e]	--
Carbon disulfide	mg/kg	34 J[re]	34 J[re]	--
Ethylbenzene	mg/kg	0.8 J	0.97 J	--
Iodomethane	mg/kg	3.9 U	0.85 J	--
Methylene chloride	mg/kg	6 J[e]	5.8 J[e]	--

TABLE 4.14

SUMMARY OF SWMU 4 WASTE RCRA CHARACTERISTICS AND TCLP ANALYSIS
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*04WM01*	*04WM01*
Sample ID:		*EA01-BF-04WM01-00601*	*EA01-BF-04WM01-00602*
Sample Depth:		*2.5-3*	*2.5-3*
SWMU:		*04*	*04*
Sample Date:		*11/6/1996*	*11/6/1996*
			Dupl.
Parameters	*Units*		
TCLP - Semi-Volatile Organics			
1,4-Dichlorobenzene	mg/L	0.05 U	0.05 R
2,4,5-Trichlorophenol	mg/L	0.04 U	0.04 R
2,4,6-Trichlorophenol	mg/L	0.03 U	0.03 R
2,4-Dinitrotoluene	mg/L	0.02 U	0.02 R
2-Methylphenol	mg/L	0.2 J	0.06 R
3&4-Methylphenol	mg/L	1.3 J	0.03 R
Hexachlorobenzene	mg/L	0.03 U	0.03 R
Hexachlorobutadiene	mg/L	0.08 U	0.08 R
Hexachloroethane	mg/L	0.07 U	0.07 R
Nitrobenzene	mg/L	0.04 U	0.04 R
Pentachlorophenol	mg/L	0.06 U	0.06 R
Pyridine	mg/L	0.5 U	0.5 R
TCLP - General Chemistry			
Flashpoint	deg f	200 +	200 +
pH	ph	8.4	9.1
TCLP - Metals			
Arsenic, total	mg/L	0.103	0.147
Barium, total	mg/L	0.0014 J	0.0277 J
Cadmium, total	mg/L	0.0037	0.0021 U
Chromium, total	mg/L	0.0046	0.0071
Lead, total	mg/L	0.0292 J	0.0214 R
Selenium total	mg/L	0.0372	0.0241
TCLP - Volatile Organics			
2-Butanone	mg/L	0.56 J	0.62 J

TABLE 4.15

SUMMARY OF DETECTED COMPOUNDS IN SWMU 4 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*BTP4-11*	*BTP4-11*	*BTP4-12*	*BTP4-12*	*BTP4-13*	*BTP4-13*	*BTP4-14*	*04SB01*	*04SB01*	*04SB01*	*04SB02*	*04SB03*
Sample ID:		*EA02-BF-BTP4-11-00801*	*EA02-BF-BTP4-11-01601*	*EA02-BF-BTP4-12-00801*	*EA02-BF-BTP4-12-01601*	*EA02-BF-BTP4-13-00801*	*EA02-BF-BTP4-13-01601*	*EA02-BF-BTP4-14-01001*	*EA01-BF-04SB01-02001*	*EA01-BF-04SB01-02002*	*EA01-BF-04SB01-03201*	*EA02-BF-04SB02-01605*	*EA02-BF-04SB03-03401*
Sample Depth:		*2-4*	*6-8*	*2-4*	*6-8*	*2-4*	*6-8*	*4-5*	*8-10*	*8-10*	*14-16*	*4-8*	*15-17*
SWMU:		*04*	*04*	*04*	*04*	*04*	*04*	*04*	*04*	*04*	*04*	*04*	*04*
Sample Date:		*12/13/99*	*12/13/99*	*12/13/99*	*12/13/99*	*12/13/99*	*12/13/99*	*12/13/99*	*11/6/96*	*11/6/96* Dupl.	*11/6/96*	*10/21/99*	*10/25/99*
Parameters	*Units*												
TCL - Semi-Volatile Organics													
N-Nitrosodiphenylamine	mg/kg	0.37 U	0.37 U	0.4 U	0.34 U	0.4 U	0.38 U	320 U	1.9 U	1.9 U	0.27 J	0.37 U	0.36 U
Phenol	mg/kg	0.37 U	0.37 U	0.4 U	0.34 U	0.4 U	0.38 U	3900[c]	660[c]	680[c]	2.4	0.37 U	0.36 U
TAL - Metals													
Aluminum, total	mg/kg	10900	11000	12900	7110	15200	7150	12200	--	--	--	8810	8930
Arsenic, total	mg/kg	11.3[bc]	13.3[bc]	10.8	7.1	7.7	5.2	10.6	--	--	--	6.8	5.9
Barium, total	mg/kg	78.1	75.5	84.0	55.1	92.5	58.2	95.8	--	--	--	79.4 J	24.8
Calcium, total	mg/kg	61600	47600	25800	85000	39500	102000	35800	--	--	--	90300	136000
Chromium, total	mg/kg	18.4	18.4	22.4	12.8	22.6	12.8	16.5	--	--	--	14.7 J	16.3
Cobalt, total	mg/kg	16.3[bc]	9.0	10.3	6.9	10.2	8.6	8.5	--	--	--	9.7 J	8.6
Copper, total	mg/kg	22.6	22.0	24.0	20.9	24.6	18.5	72.5[bc]	--	--	--	20.2	19.0
Iron, total	mg/kg	23700	26300	26000	17000	24800	15600	32100	--	--	--	19300	17200
Lead, total	mg/kg	19.9	23.6[bc]	11.1	8.5	11.9	7.4	95.5[bc]	--	--	--	9.5	9.1
Magnesium, total	mg/kg	12700	11800	11100	13900	8390	14400	16100	--	--	--	12600	24200[b]
Manganese, total	mg/kg	912	383	486	351	366	417	403	--	--	--	434	383
Mercury, total	mg/kg	0.11 U	0.11 U	0.12 U	0.1 U	0.12 U	0.11 U	0.69[bc]	--	--	--	0.11 U	0.11 U
Nickel, total	mg/kg	36.9	24.8	35.0	20.1	28.6	20.7	93.5[bc]	--	--	--	23.0 J	26.1
Potassium, total	mg/kg	1970	2110	1560	1690	2370	1410	1240	--	--	--	1910	2750
Selenium, total	mg/kg	0.57 U	0.56 U	0.61 U	0.52 U	0.6 U	0.57 U	0.77 U	--	--	--	0.57 U	1.0
TAL - Metals (Cont'd)													
Sodium, total	mg/kg	566 U	562 U	606 U	520 U	604 U	569 U	2450[b]	--	--	--	567 U	551 U
Thallium, total	mg/kg	1.4[bc]	1.3[bc]	1.2 U	1.0 U	1.2 U	1.1 U	1.5 U	--	--	--	1.1 U	1.5[bc]
Vanadium, total	mg/kg	30.0	29.3	31.8	18.0	32.9	17.3	17.9	--	--	--	20.7 J	21.6
Zinc, total	mg/kg	66.6	65.9	67.2	49.8	59.4	47.1	108[bc]	--	--	--	52.7	56.1
Appendix 9 - General Chemistry													
Sulfide, total	mg/kg	--	--	--	--	--	--	--	45.8	43.9	--	--	--
Appendix 9 - Metals													
Aluminum, total	mg/kg	--	--	--	--	--	--	--	1.4 R	1.5 R	--	--	--
Arsenic, total	mg/kg	--	--	--	--	--	--	--	6.4 J	7.6 J	--	--	--
Barium, total	mg/kg	--	--	--	--	--	--	--	58.1	67.6	--	--	--
Beryllium, total	mg/kg	--	--	--	--	--	--	--	0.51	0.58	--	--	--
Cadmium, total	mg/kg	--	--	--	--	--	--	--	0.35	0.25	--	--	--
Chromium, total	mg/kg	--	--	--	--	--	--	--	14.3	15.3	--	--	--
Cobalt, total	mg/kg	--	--	--	--	--	--	--	6.9	7.4	--	--	--
Copper, total	mg/kg	--	--	--	--	--	--	--	20.8	23.1	--	--	--
Lead, total	mg/kg	--	--	--	--	--	--	--	11.2	12	--	--	--
Nickel, total	mg/kg	--	--	--	--	--	--	--	21.6	22.1	--	--	--
Selenium, total	mg/kg	--	--	--	--	--	--	--	0.16 U	0.21 J	--	--	--
Thallium, total	mg/kg	--	--	--	--	--	--	--	0.21 J	0.15 U	--	--	--
Vanadium, total	mg/kg	--	--	--	--	--	--	--	19.4	22.1	--	--	--
Zinc, total	mg/kg	--	--	--	--	--	--	--	51.1 J	55.9 J	--	--	--
Appendix 9 - Semi-Volatile Organics													
Naphthalene	mg/kg	--	--	--	--	--	--	--	0.37 U	0.16 J[c]	--	--	--
Phenol	mg/kg	--	--	--	--	--	--	--	590 J[c]	2.5 J	--	--	--
Appendix 9 - Volatile Organics													
2-Butanone	mg/kg	--	--	--	--	--	--	--	0.15	0.19	--	--	--

TABLE 4.16

SUMMARY OF DETECTED COMPOUNDS IN SWMU 4 GROUNDWATER (MW-004)
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*MW004*
Sample ID:		*EA01-BF-MW004-01*
Sample Depth:		*0-0*
SWMU:		*04*
Sample Date:		*11/20/96*
Parameters	*Units*	
Appendix 9 - Metals		
Arsenic, total	mg/L	0.0124
Barium, soluble	mg/L	0.0437
Barium, total	mg/L	0.115
Beryllium, total	mg/L	0.00051
Cadmium, soluble	mg/L	0.0032
Cadmium, total	mg/L	0.0027
Chromium, total	mg/L	0.0238
Cobalt, soluble	mg/L	0.01
Cobalt, total	mg/L	0.0376
Copper, total	mg/L	0.0258
Lead, total	mg/L	0.0304
Nickel, Soluble	mg/L	0.0246
Nickel, total	mg/L	0.0481
Tin, total	mg/L	**0.0108**[s]
Vanadium, total	mg/L	**0.0025**[s]
Vanadium, total	mg/L	0.0254
Zinc, soluble	mg/L	0.0084
Zinc, total	mg/L	0.0828
Appendix 9 - Semi-Volatile Organics		
Bis(2-ethylhexyl)phthalate	mg/L	**0.01 J**[r]

TABLE 4.17

SUMMARY OF DETECTED COMPOUNDS IN AREA 7 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*07SB01*	*07SB02*
Sample ID:		*EA01-BF-07SB01-00601*	*EA01-BF-07SB02-00601*
Sample Depth:		*1-3*	*1-3*
SWMU:		*07*	*07*
Sample Date:		*11/7/96*	*11/7/96*
Parameters	*Units*		
TAL - Metals			
Aluminum, total	mg/kg	--	--
Arsenic, total	mg/kg	--	--
Barium, total	mg/kg	--	--
Calcium, total	mg/kg	--	--
Chromium, total	mg/kg	--	--
Cobalt, total	mg/kg	--	--
Copper, total	mg/kg	--	--
Iron, total	mg/kg	--	--
Lead, total	mg/kg	--	--
Magnesium, total	mg/kg	--	--
Manganese, total	mg/kg	--	--
Nickel, total	mg/kg	--	--
Potassium, total	mg/kg	--	--
Selenium, total	mg/kg	--	--
Vanadium, total	mg/kg	--	--
Zinc, total	mg/kg	--	--
Appendix 9 - Semi-Volatile Organics			
3&4-Methylphenol	mg/kg	1.4	0.4 U
N-Nitrosodiethylamine	mg/kg	0.4 U	**0.78 J[re]**
N-Nitrosodiphenylamine	mg/kg	0.4 U	0.047 J
Appendix 9 - Volatile Organics			
1,2-Dichloroethene (total)	mg/kg	0.006 U	1.3
2-Butanone	mg/kg	1	4.7
4-Methyl-2-pentanone	mg/kg	0.012 U	0.037 J
Carbon disulfide	mg/kg	0.006 U	0.053 J
Ethylbenzene	mg/kg	0.006 U	0.01 J
Tetrachloroethene	mg/kg	0.036 J	0.016 J
Toluene	mg/kg	0.022 J	0.22 J
Trichloroethene	mg/kg	0.007 J	0.012 J
xylenes (total)	mg/kg	0.006 U	0.048 J

TABLE 4.17

SUMMARY OF DETECTED COMPOUNDS IN AREA 7 SOIL
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*07SB03*	*07SB03*
Sample ID:		*EA02-BF-07SB03-02801*	*EA02-BF-07SB03-02802*
Sample Depth:		*12-14*	*12-14*
SWMU:		*07*	*07*
Sample Date:		*10/18/99*	*10/18/99*
			Dupl.
Parameters	*Units*		
TAL - Metals			
Aluminum, total	mg/kg	7420	6580
Arsenic, total	mg/kg	6.6	6.2
Barium, total	mg/kg	65.9	54.0
Calcium, total	mg/kg	102000	148000
Chromium, total	mg/kg	13.6	12.0
Cobalt, total	mg/kg	8.2	7.1
Copper, total	mg/kg	20.1	17.1
Iron, total	mg/kg	16100	14500
Lead, total	mg/kg	8.0	7.4
Magnesium, total	mg/kg	15800	15500
Manganese, total	mg/kg	408	389
Nickel, total	mg/kg	22.7	20.1
Potassium, total	mg/kg	2180	2030
Selenium, total	mg/kg	0.87	0.58
Vanadium, total	mg/kg	17.8	16.1
Zinc, total	mg/kg	47.7	42.2
Appendix 9 - Semi-Volatile Organics			
3&4-Methylphenol	mg/kg	--	--
N-Nitrosodiethylamine	mg/kg	--	--
N-Nitrosodiphenylamine	mg/kg	--	--
Appendix 9 - Volatile Organics			
1,2-Dichloroethene (total)	mg/kg	--	--
2-Butanone	mg/kg	--	--
4-Methyl-2-pentanone	mg/kg	--	--
Carbon disulfide	mg/kg	--	--
Ethylbenzene	mg/kg	--	--
Tetrachloroethene	mg/kg	--	--
Toluene	mg/kg	--	--
Trichloroethene	mg/kg	--	--
xylenes (total)	mg/kg	--	--

TABLE 4.18

SUMMARY OF DETECTED COMPOUNDS IN HUNTINGTON DRAIN SURFACE WATER
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		05SW01	05SW02	05SW02	05SW03
Sample ID:		EA01-BF-05SW01-01	EA01-BF-05SW02-01	EA01-BF-05SW02-02	EA01-BF-05SW03-01
SWMU:		HUNT.DRAIN	HUNT.DRAIN	HUNT.DRAIN	HUNT.DRAIN
Sample Date:		10/27/1996	10/27/1996	10/27/1996 Dupl.	10/27/1996
Parameters	*Units*				
Appendix 9 - Metals					
Arsenic, soluble	mg/L	0.0013 U	0.0013 U	0.0021	0.0015
Barium, soluble	mg/L	0.0418	0.0558	0.0538	0.0525
Barium, total	mg/L	0.0435	0.0588	0.0553	0.0523
Cadmium, soluble	mg/L	0.0021 U	0.0022 J[e]	0.0021 U	0.0021 U
Copper, soluble	mg/L	0.0022	0.0015 U	0.0015 U	0.0015 U
Copper, total	mg/L	0.0026	0.0026	0.0024	0.0021
Selenium, soluble	mg/L	0.0021 J	0.0019	0.0018 U	0.0018 U
Vanadium, total	mg/L	0.0017 U	0.002	0.0017 U	0.0017 U
Appendix 9 - Semi-Volatile Organics					
Bis(2-Ethylhexyl)phthalate	mg/L	0.01 U	0.01 J[e]	0.01 J[e]	0.01 U

TABLE 4.19

SUMMARY OF DETECTED COMPOUNDS IN HUNTINGTON DRAIN SEDIMENT
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*05SD01*	*05SD02*	*05SD02*	*05SD03*
Sample ID:		*EA01-BF-05SD01-01*	*EA01-BF-05SD02-01*	*EA01-BF-05SD02-02*	*EA01-BF-05SD03-01*
Sample Depth:		*0-0.5*	*0-0.5*	*0-0.5*	*0-0.5*
SWMU		*HUNT.DRAIN*	*HUNT.DRAIN*	*HUNT.DRAIN*	*HUNT.DRAIN*
Sample Date		*10/27/1996*	*10/27/1996*	*10/27/1996* Dupl.	*10/27/1996*
Parameters	*Units*				
Appendix 9 - General Chemistry					
Cyanide, total	mg/kg	0.31 U	0.54 U	0.66 J*	6.6 J*
Sulfide, total	mg/kg	223	2610 J	1420 J	1510
Appendix 9 - Metals					
Aluminum, total	mg/kg	1.4 R	6.2 J	3 J	2.4 J
Arsenic, total	mg/kg	3.5 J	11.4 J*	11.5 J*	13.2 J*
Barium, total	mg/kg	30.6	183	169	79.2
Beryllium, total	mg/kg	0.58	1.4	0.93	1.1
Cadmium, total	mg/kg	0.63*	0.32	1.2*	1.8*
Chromium, total	mg/kg	11.2	37.6*	28.4*	30.7*
Cobalt, total	mg/kg	1.8	19.5	11.7	8.5
Copper, total	mg/kg	10.9	30.8*	37*	93.7*
Lead, total	mg/kg	161 J*	135 J*	219 J*	112 J*
Mercury, total	mg/kg	0.05 J	0.14 J	0.14 J	0.12 J
Nickel, total	mg/kg	6	40.7*	35.6*	29.9*
Selenium, total	mg/kg	0.2 J	0.7 J	0.44 J	1.2 J
Silver, total	mg/kg	0.16 U	1.4*	0.84*	0.68*
Thallium, total	mg/kg	0.16 U	0.29	0.21	0.24 U
Tin, total	mg/kg	0.78 U	1.3 U	0.94 U	3.8
Vanadium, total	mg/kg	8	53.5	34	34.1
Zinc, total	mg/kg	77.7	263*	267*	325*
Appendix 9 - Pesticides					
4,4'-DDD	mg/kg	0.023 J*	0.25*	0.18*	0.05 J*
4,4'-DDE	mg/kg	0.0073 J*	0.012 J*	0.11 U	0.14 U
4,4'-DDT	mg/kg	0.092 U	0.043 J*	0.11 U	0.14 U
ALDRIN	mg/kg	0.046 U	0.038 J*	0.056 U	0.07 U
Alpha-chlordane	mg/kg	0.0073 J	0.04 J	0.022 J	0.0094 J
Gamma-chlordane	mg/kg	0.017 J	0.032 J	0.038 J	0.017 J
Isodrin	mg/kg	0.046 U	0.0066 J	0.011	0.07 U
Kepone	mg/kg	0.092 U	0.72*	0.66*	0.14 U
Appendix 9 - Dioxins/Furans (TEQ)					
2,3,7,8-TCDD (TEQ value)	µg/kg	0.00375 J*	0.01937 J*	0.00575 J*	0.00175 J
Appendix 9 - Semi-Volatile Organics					
2-Methylnaphthalene	mg/kg	0.38 U	0.25 J*	0.066 J*	0.12 J*
Acenaphthene	mg/kg	0.089 J*	0.23 J*	0.12 J*	0.24 J*
Acenaphthene	mg/kg	0.065 J*	0.6 U	0.46 U	0.59 U
Anthracene	mg/kg	0.29 J*	0.53 J*	0.45 J*	0.78*
Benzo(a)anthracene	mg/kg	1.4 J*	1.9 J*	1.4 J*	1.8 J*
Benzo(a)pyrene	mg/kg	1.4*	2.1*	1.3*	1.6*

TABLE 4.19

SUMMARY OF DETECTED COMPOUNDS IN HUNTINGTON DRAIN SEDIMENT
WEST BRINE FIELD
ATOFINA CHEMICALS, INC.
RIVERVIEW, MICHIGAN

Sample Location:		*05SD01*	*05SD02*	*05SD02*	*05SD03*
Sample ID:		*EA01-BF-05SD01-01*	*EA01-BF-05SD02-01*	*EA01-BF-05SD02-02*	*EA01-BF-05SD03-01*
Sample Depth:		*0-0.5*	*0-0.5*	*0-0.5*	*0-0.5*
SWMU		*HUNT.DRAIN*	*HUNT.DRAIN*	*HUNT.DRAIN*	*HUNT.DRAIN*
Sample Date		*10/27/1996*	*10/27/1996*	*10/27/1996*	*10/27/1996*
				Dupl.	
Parameters	*Units*				
Appendix 9 - Semi-Volatile Organics (Cont'd)					
Benzo(b)fluoranthene	mg/kg	1.8	3.2	2	2.5
Benzo(g,h,i)perylene	mg/kg	0.84 J[e]	1.6 J[e]	1 J[e]	1.1 J[e]
Benzo(k)fluoranthene	mg/kg	0.84[e]	1.2 J[e]	0.68 J[e]	0.92[e]
Bis(2-ethylhexyl)phthalate	mg/kg	0.74 J[e]	2.9 J[e]	1.5 J[e]	1.9 J[e]
Butylbenzylphthalate	mg/kg	0.5 J	0.6 U	0.46 U	0.17 J
Chrysene	mg/kg	1.6[e]	2.7[e]	1.7[e]	2.3[e]
Dibenzo(a,h)anthracene	mg/kg	0.21 J[e]	0.38 J[e]	0.24 J[e]	0.29 J[e]
Dibenzofuran	mg/kg	0.078 J	0.11 J	0.11 J	0.18 J
Di-n-butylphthalate	mg/kg	0.38 U	0.6 U	0.13 J[e]	0.11 J
Fluoranthene	mg/kg	1.9[e]	2.8[e]	2.7[e]	3.6[e]
Fluorene	mg/kg	0.12 J[e]	0.17 J[e]	0.17 J[e]	0.23 J[e]
Indeno(1,2,3-CD)pyrene	mg/kg	0.95[e]	1.9[e]	1.2[e]	1.5[e]
Naphthalene	mg/kg	0.38 U	0.074 J[e]	0.064 J[e]	0.097 J[e]
Phenanthrene	mg/kg	1.2[e]	2[e]	1.7[e]	1.7[e]
Pyrene	mg/kg	2.3[e]	5.1 J[e]	3 J[e]	4.2[e]
Appendix 9 - Volatile Organics					
Methylene chloride	mg/kg	0.009	0.014	0.007	0.009 U

APPENDIX J

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

Setting the Standards for Innovative
Environmental Solutions

FEB 20

HUMAN HEALTH AND ECOLOGICAL

RISK ASSESSMENTS FOR THE

ATOFINA CHEMICALS, INC.

RIVERVIEW, MICHIGAN WEST BRINE FIELD PROPERTY

February 19, 2002

Prepared for:

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Executive Summary

Human health and ecological risk assessments were conducted for ATOFINA Chemical Inc.'s (ATOFINA Chemicals) Riverview, Michigan West Brine Field property to determine if residual chemicals pose unacceptable hazards or risks to potential human or ecological receptors at the site. Based on conceptual site models developed during previous phases of the site assessment process (Weston, 1999), appropriate and realistic human and ecological exposure scenarios were developed. Human receptors included hypothetical future maintenance workers, office workers, construction workers, utility trench workers, and trespassers. Ecological receptors included the white-tailed deer, the meadow vole, and the American robin.

Data from the site were tabulated into a database and analyzed for descriptive statistics such as minimum, mean, and maximum concentrations, *95%* upper confidence limit of the mean (95% UCL), and distribution type *(e.g.,* noinial, lognoiuial, *etc.),* among others. Surface soil data were considered to be at a depth of one to three feet, based on the available sample collection intervals. Subsurface data were considered from one to fourteen feet below ground surface (bgs). For both the human health and ecological risk assessments, if a constituent was not detected in a given medium *(e.g.,* surface soil), that constituent was eliminated from further analysis.

For the human health risk assessment, site data were screened against US EPA Region IX Preliminary Remediation Goals (PRGs). Criteria were selected for screening based on the chosen receptors and their respective potential exposures to residual chemicals at the site. Maximum concentrations of chemicals in surface and subsurface soils were screened against Industrial Soil PRGs to account for maintenance worker, construction worker, trespasser, and indirect office worker exposures. Tap Water **PRGs** were used as a conservative screening measure for a groundwater volatilization to indoor air inhalation scenario for an office worker and for utility trench worker and construction worker groundwater direct contact exposures. For instances in which **PRGs** were not available, Michigan Part 201 Cleanup Criteria were used. The Michigan criteria used for soils were the Direct Contact Industrial and Commercial II Screening Levels while the Industrial & Commercial II, III & IV Drinking Water Criteria were used for groundwater. If a chemical's maximum concentration exceeded any of the aforementioned screening criterion, it was retained for further quantitative evaluation in the risk assessment. If a chemical's maximum concentration was less than a screening criteria, that chemical was dropped from the quantitative analyses associated with the potential exposures represented by the screening criterion.

Exposures to construction workers, maintenance workers, adolescent trespassers, office workers, and utility trench workers were estimated based on paradigms from widely accepted US EPA guidance documents. Exposure parameters were extracted from US EPA or MDEQ guidance or were developed for site-specific scenarios where published values were not available or realistic. Subchronic exposures were considered to be less than seven years whereas chronic exposures were considered to be greater than seven years, in accordance with US EPA risk assessment guidance.

Toxicity indices, reference doses (RfDs) and cancer slope factors (CSFs), were retrieved from a hierarchy of sources including US EPA's Integrated Risk Information System (IRIS), Health Effects Summary Tables (HEAST), and National Center for Environmental Assessment (NCEA). If published toxicity values did not exist for a given constituent, provisional values were developed using published toxicity data (such as No Observed Adverse Effect Levels) and US EPA-accepted methodology for the derivation of toxicity benchmarks.

The results of the exposure assessment and toxicity characterization were combined to estimate hazard indices and cancer risk levels for the receptors hypothetically accessing the site in the future. Hazard and risk calculations were summed for each exposure route and then summed again for each exposure pathway by receptor. The risk characterization revealed no estimated cancer risk levels exceeding the 1^{x} Q benchmark for the construction worker, trespasser, office worker, and utility trench worker scenarios. The maintenance worker scenario resulted in a risk level of $3x10^{5}$. This risk level is solely attributable to the presence of a single detection of n-nitrosodiethylamine in soil in SWMU-7. Upon the pending remediation of SWMU-7, risks to the maintenance worker will fall below lxi 0. No total hazard indices exceeded the 1.0 *cle* minimis benchmark.

For the ecological risk assessment (ERA), surface soil, sediment, and surface water analytical data were used as the basis for statistical and ecological exposure analysis and were screened against appropriate US EPA Region *5* Ecological Data Quality Levels (EDQLs). Soil EDQLs were used for comparison with shallow-depth soil concentrations, however these benchmarks were not available for all COPCs. In the absence of soil EDQLs, values developed by Oak Ridge National Laboratory (ORNL) were used for comparative purposes. If the maximum concentration of a constituent was greater than the applicable benchmark, or if a screening criterion was not available, the constituent was retained for quantitative exposure assessment.

Exposure routes for the white-tailed deer included ingestion of surface water and vegetation, as well as incidental ingestion of soil and sediment. Exposure routes for the meadow vole included incidental soil and sediment ingestion, surface water ingestion, and ingestion of plants. Exposure routes for the American robin included incidental ingestion of soil and sediment, ingestion of surface water, ingestion of terrestrial invertebrates, and ingestion of vegetation. The use of conservative exposure assumptions for each of these receptors resulted in estimated exposures representative and sufficiently protective of other species comprising their respective trophic guilds.

Characteristics of terrestrial and semi-aquatic ecological receptors such as habitat needs, food preference, reproductive cycles, seasonal activities such as migration, and selective use of resources influenced constituent exposure. These factors were utilized in the formulation of an exposure assessment equation that estimated a mass-specific, time-weighted average intake for each medium or food source.

No unacceptable risk was predicted to individual white-tailed deer from residual constituent levels in West Brine Field sediment or surface water. Similarly, no unacceptable risk to individuals was predicted from incidental soil ingestion. Risk to individual deer is indicated

from ingesting upland vegetation. This risk is attributable to phenol in surface soil. No unacceptable risks were estimated for the deer population as a whole.

Hazard indices (HIs) developed for the soil ingestion exposure pathway suggested a potential risk to individual meadow voles. Potential population-level effects to meadow voles may be incurred resulting from ingestion of soil-dwelling vegetation. Risk from this pathway stems primarily from the presence of phenol.

For individual American robins, HIs exceeded unity for the soil, soil invertebrate, and vegetation ingestion pathways. Vegetation ingestion risk to robin populations is attributable primarily to phenol in surface soils. Thallium and phenol contribute to the majority of the risk to robin populations from the soil invertebrate ingestion pathway. Detectable levels of thallium in site-related surface soils, however, were below background levels.

Hazards from aluminum in soils to ecological receptors were considered negligible based on the low bioavailability of this metal as well as the comparability of West Brine Field concentrations to typical concentrations from undisturbed soils across the United States. Likewise, risks associated with zinc and chromium are also considered to be negligible, given that elemental concentrations at the West Brine Field site are at levels near or below typical concentrations found across the United States.

1.0 Introduction

Human health and ecological risk assessments were conducted for ATOFINA Chemicals' Riverview, Michigan West Brine Field property (site) to determine if unacceptable hazards or risks are potentially posed to humans or ecological receptors by residual chemicals detected at the site. The risk assessments considered both current and hypothetical future land-use scenarios. Currently, the 92-acre West Brine Field is a virtually undeveloped, slightly-to-highly vegetated, vacant lot (Weston, 1999) surrounded by a 7-foot high chain-link fence. Access to the site is restricted to authorized ATOFINA Chemicals personnel (Weston, 1999).

A majority of the residual chemicals detected at the West Brine Field were located within the Solid Waste Management Units (SWMUs) 1, 3, and 4, and Area 7. The SWMUs were formerly landfills used for the disposal of amyiphenol filter cake and drummed residue produced during amylphenol production in other areas of the Riverview plant. Area 7 was characterized because of observations of odiferous, stained, and disturbed soils (Weston, 1997). The total combined area of SWMUs 1, 3, and 4, and Area 7 is approximately 2.4 acres.

SWN'IU 2, a former landfill area in the southern part of the site, was subject to remedial activities in 1994 and 1995 and is no longer considered an area of concern.

2.0 Human Health Risk Assessment

The human health risk assessment for the West Brine Field was conducted in accordance with appropriate United States Environmental Protection Agency (US EPA) guidance documents. Consistent with the US EPA *Guidelines for Exposure Assessment (US* EPA, 1992), conservative but realistic, site-specific assumptions were used for those exposure parameters where default assumptions did not accurately characterize potential exposures at the site. Appropriate justification for the use of site-specific exposure assumptions is included in this report.

The four basic phases of a human health risk assessment are as follows:

1. Data evaluation - the process of analyzing site data relevant to potential human health and ecological impacts. The Data Evaluation includes a statistical analysis of the data in various media and selection of constituents of potential concern (COPCs);

2. Exposure assessment - the identification of relevant receptor populations and exposure parameters, the calculation of exposure-point concentrations, and the estimation of average daily intakes for each site-related receptor of possible concern;

3. Toxicity assessment - the deteiiiiination of appropriate toxicity values to be used in quantifying risks for the COPCs selected for quantitative risk assessment. The most relevant and appropriate Reference Doses (RfDs) and Cancer Slope Factors (CSFs) are deteiiiiined;

4. Risk characterization - a comparison of estimated daily chemical intake levels with acceptable daily intake levels (RfDs) to generate quantitative expressions of hazard (for noncarcinogens) and the upper limits of probability of causing cancer (for carcinogens).

Each of these phases in discussed in detail below.

2.1 Data Evaluation

Validated laboratory data were compiled into a database representing the results of historical sampling activities at the site. Data subsets representing potential current and hypothetical future exposures were extracted from the database for statistical analysis. For the construction worker scenario, soils down to 14 feet below ground surface (bgs) were extracted as a subset of the data because it was anticipated that construction workers might contact soils to a depth of 14 feet during excavation-like activities. For the maintenance worker scenario, soils down to three feet bgs were extracted as a data subset. It was assumed that maintenance activities such as landscaping could create exposures to soils down to three feet bgs. Soils down to three feet were also used for the trespasser scenario. For hypothetical future office workers, soil data down to 14 feet bgs were extracted and analyzed for a vapor-intrusion-into-indoor-air scenario. Construction workers were evaluated for dermal contact with groundwater while utility trench workers were assumed to be exposed to shallow groundwater (pooled in a utility trench) both through dermal contact and via inhalation of VOC vapors.

Each receptor-specific data set was then analyzed statistically using SiteStat, a commercially available software package, to calculate the total number of samples analyzed for a given constituent, the number of times that constituent was detected, the frequency of detection (%), minimum detected value, arithmetic mean, logarithmic mean, maximum detected value, standard error of the mean, the *95%* upper confidence limit of the mean concentration *(95%* UCL), the logarithmic *95%* UCL, and a distributional analysis of the data *(i.e.,* utilizing goodness-of-fit statistical tests to determine whether the data are distributed normally or lognoiiiially) for each constituent.

Samples from the various media at a site undergo laboratory analyses that are designed to measure the concentrations of the various constituents in the environment. As a result of the analytical procedures used, some samples may contain constituents reported as non-detect. As a highly conservative measure for chemicals detected at least once in a given medium, samples reported as non-detect were assumed to contain concentrations equivalent to one-half of the sample detection limit in accordance with US EPA (1989b) guidance. This assumption prevents any bias

that may result from the inclusion of the sample as a detection at the detection limit or exclusion of the sample as non-detected. Results of the statistical analyses for constituents detected in each of the data sets (soils down to 14 feet, surface soils, and groundwater) are presented in Tables 1 through 3.

2.1.1 Elevated Detection Limits

Sometimes a sample may be reported as nondetect for a specific chemical but the detection limit for that chemical is unusually elevated. Elevated detection limits can result from laboratory practices *(e.g.,* dilutions) undertaken to address chemical or sample interference during analysis. In some cases, these detection limits may be elevated to the point where they exceed screening criteria but the sample is still reported as nondetect and treated thusly during the risk assessment process. Actual concentrations of chemicals in these samples may be less than typical detection limits, thus, treating them as nondetect in a risk assessment may be appropriate. Conversely, chemicals in these samples may be present at concentrations near the elevated detection limit (exceeding screening criteria) and so treating them as nondetect may underestimate associated risks and the potential for adverse health affects. For this latter reason, these samples should not be ignored, but addressed from a risk assessment perspective.

Tables 4 and *5* list chemicals that were not detected in any soil or groundwater sample analyzed, respectively (0% detected at the site), the maximum detection limits of those chemicals, and applicable screening criteria. Tables 4 and 5 identify those chemicals with detection limits less than the screening criteria, those chemicals with detection limits greater than the screening criteria, and those chemicals without screening criteria.

In some cases, a laboratory does not have the ability to quantify chemical concentrations at levels less than those of potential concern (such as screening benchmarks). Quantitatively evaluating hazards and/or risks for these chemicals with no positive detections is neither feasible nor appropriate because there is no evidence that the chemical is even present. Otherwise, phantom risk quantification could theoretically be generated for virtually any chemical, whether it is actually present at the site or not. Furthermore, assuming a concentration of one-half the

detection limit has such a high degree of uncertainty that the results would essentially provide no meaningful information on which to base remedial decisions. Established regulatory policy *recognizes these limitations. US EPA's Risk Assessment Guidance for Superfund; Human health Evaluation Manual, Part A* (1989b) states:

> After considering the discussion provided in the above subsections, generally eliminate those chemicals that have not been detected in any sample of a particular medium...
>
> The outcome of this step is a data set that only contains chemicals for which positive data *(i.e.*, analytical results for which measurable concentrations are reported) are available in at least one sample from each medium. Unless otherwise indicated, assume at this point in the evaluation of data that positive data to which no uncertainties are attached concerning either the assigned identity of the chemical the reported concentration *(i.e.*, data that are not "tentative," "uncertain," or "qualitative") are appropriate for use in the quantitative risk assessment.

Therefore, there are basically three proposed criteria that may be applied to evaluating chemicals that were not detected in a given medium, as listed on Tables 4 and *5.*

1. Constituents that were subjected to analysis and not positively detected, but the maximum reported detection limit is below a screening benchmark should be eliminated from any further evaluation. Even if present, these constituents would not pose a potential health problem of any significance.

2. Chemicals that were not detected and for which there are no screening criteria or risk reference doses (RfDs) or other means of quantitatively evaluating risk or hazard should be eliminated and discussed in the uncertainty section of the report. There is insufficient information on these chemicals to make any conclusions regarding their presence, concentration, or potential hazard risk.

3. Chemicals that were not positively detected but with detection limits that exceed screening criteria may be further evaluated qualitatively under certain circumstances. Chemicals in this category may be eliminated from further consideration if the following

criteria exist: a review of historical operations indicates that the chemical in question was never utilized, produced, or disposed on site; the chemical was not detected in any other media; the chemical is not a likely breakdown product of parent chemicals that have been detected in site-related samples; the chemical is not a member of a class of compounds *(e.g.*, chlorinated dibenzodioxins or polycyclic aromatic amines, which almost always occur as mixtures of congeners or chemical analogues). Chemicals may also be reviewed to determine the fate and transport characteristics along with site-specific features that may preclude their presence in one medium *(e.g.*, groundwater) even though they have been positively identified in another medium. Under such conditions, chemicals may be eliminated from further evaluation.

Tables 4 and 5 list those chemical constituents that were not detected in any soil or groundwater samples, respectively. Where the maximum reported detection limits for chemicals are lower than screening levels (bullet 1 above), there is essentially no effect on the uncertainty of the estimated risks and hazards because even if these chemicals were present the additional hazard or risk would be insignificant.

Similar arguments can be made for those constituents with an elevated SQL which exceeds a screening benchmark (bullet 3 above). In these cases, the detection limits would not enable a determination of either the presence of a compound or the extent of potential hazard and/or risk. It is possible that some of these chemicals are present at levels of concern and would contribute to some extent to the overall estimates of total hazards and/or risks. As a consequence this increases the uncertainty of the overall estimates and could result in an underestimation of risks.

The same argument applies to those nondetected chemical constituents where no screening criteria exist (bullet 2 above). However, unless it is known that the maximum possible concentration *(i.e.*, the highest detection limit) represented a potential concentration of concern, it cannot be known whether hazards and/or risks could possibly be underestimated. It can be stated that the possible presence of these chemicals will not result in an overestimation of hazards and/or risks.

It may be noted that the potential for underestimating risks and the overall uncertainty in the quantitative estimations is not likely to be substantial as a result of the possible presence of *chemicals reported as nondetect. US EPA's Risk Assessment Guidance for Superfund: Human health evaluation manual, Part A* (1989b), states:

> Chemicals that are infrequently detected may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal practices. Consider the chemical as a candidate for elimination from the quantitative risk assessment if: (1) it is detected infrequently in one or perhaps two environmental media, (2) it is not detected in any other sampled media or at high concentrations, and (3) there is no reason to believe that the chemical may be present.

For the vast number of nondetected chemicals reported in Tables 4 and *5* there is, in fact, no reason to presume their presence nor is there a history of use or disposal. Consequently, the contribution to the overall uncertainty is likely to be comparatively minor relative to other sources of uncertainty that can either result in over- or under-estimation of total hazards and/or **risks.**

2.1.2 COPC Screening

Once the statistical analyses were complete, a selection process ensued to determine which constituents were to be evaluated quantitatively in the risk assessment as COPCs. Constituents not detected in any sample *(i.e.,* a detection frequency of 0%) were eliminated from further risk evaluation. During the screening process, constituents without the appropriate published US EPA Region IX (or MDEQ) screening criteria, as described below, were conservatively retained for quantitative analysis. In each instance, constituents with maximum detected concentrations less than the screening criteria were eliminated from further consideration. Constituents with maximum detected concentrations greater than the screening criteria were retained for quantitative analysis in the risk assessment. The COPC selection process was conducted as follows.

For the construction worker scenario, potential exposures to soils included incidental ingestion, dermal contact, inhalation of fugitive dusts, and inhalation of volatile organic compound (VOC) vapors in the ambient air. Additionally, the hypothetical future office worker may be exposed to VOC vapors emanating from subsurface soil into indoor air. For these scenarios, the maximum concentrations of constituents detected in soils from 0 to 14 feet bgs were compared to US EPA Region IX Preliminary Remediation Goals (PRGs) for Industrial Soil.. In cases where a Region IX PRG was not available for a chemical, MDEQ Part 201 Direct Contact Industrial and Commercial II Screening Levels were used. COPCs identified in soil for the construction worker included 2,3,7,8-TCDD TEQ, arsenic, benzo(a)pyrene, naphthalene, n-nitrosodiethylamine, and n-nitrosodiphenylamine. Naphthalene, being a VOC, was the only COPC in soil identified for the office worker scenario. This screening process is presented on Table 1.

Dermal, oral, and inhalation exposures to soil were assumed for the adolescent trespasser and hypothetical future maintenance worker scenarios. Trespassers and maintenance workers, however, were only assumed to contact surface soils (defined for this site as soils *0-3* feet bgs). Surface soil data were screened against US EPA Region IX Industrial Soil PRGs. In cases where a Region **IX PRG** was not available for a chemical, MDEQ Part 201 Direct Contact Industrial and Commercial II Screening Levels were used. COPCs identified for maintenance worker and adolescent trespasser hypothetical scenarios were arsenic, benzo(a)pyrene, naphthalene, n-nitrosodiethylamine, and n-nitrosodiphenylamine. . This screening process is presented on Table 2.

The hypothetical future office worker may be exposed to VOC vapors emanating from groundwater and infiltrating into an office building. In addition, a construction worker was evaluated for dci _____ IHal contact with groundwater while a utility trench worker may be exposed to groundwater both directly (dermal contact) and indirectly (inhalation of VOC vapors). To address these exposures, maximum detected concentrations in groundwater were conservatively screened against US EPA Region IX PROs for tap water (drinking water criteria) for the construction worker, office worker, and utility trench worker scenarios. For inhalation exposures,

chloroform was identified as the only COPC in groundwater for the office worker and utility trench worker scenarios. For direct contact with groundwater by a construction worker and utility trench worker, the following constituents were identified as COPCs: antimony, arsenic, cadmium, chromium, lead, and bis(2-ethylhexyl)phthalate. Lead was retained as a COPC due to the lack of a Region IX or MDEQ screening value. A statistical summary of groundwater data and the screening process are presented in Table 3.

2.1.3 Tentatively Identified Compounds (TICs)

Some organic compounds detected in soils at the West Brine Field were not conclusively identified by the analytical laboratory and were therefore reported as TICs. US EPA Region *5* has requested (February 2001 Memo) that ATOF1NA Chemicals provide a more detailed analysis of the uncertainty surrounding the reported concentrations of TICs at the site including an analysis of any potential risks posed to human and ecological receptors from potential exposures to TICS . According to regulatory guidance (US EPA, 1989b), when both the identity and concentrations of TICs are highly uncertain, and when a resource intensive quantification of TIC concentrations is not practical, a qualitative analysis of TICs is appropriate. As both of these criteria reflect the nature of TICs reported at the site, a qualitative assessment of West Brine Field TICs is underway. This assessment, to be presented in the forthcoming Corrective Measures Study (CMS), will include the examination of a number of factors including: detection frequency; spatial distribution; concentration levels; and toxicology.

2.1.4 Dioxins

Use of the toxicity equivalence factor (TEF) method (US EPA, 1989a) is the current regulatory-preferred procedure for assessing the risks associated with exposures to complex mixtures of chlorinated dibenzo-p-dioxins and dibenzofurans (CDDs and CDFs). The I-TEF/89 approach outlined in Part II of US EPA, 1989a, indicates that the TEF method should be performed solely on the 2,3,7,8-substituted CDD/CDF congeners according to the following rationale:

> During the past two years [relative to the publication of EPA-TEF/87 methodology], scientists have gathered additional data indicating that nearly all of the 210 CDDs/CDFs can

> be found at very low levels in many parts of the environment. However, it appears that the 2,3,7,8-substituted CDD/CDF congeners are selectively absorbed andlor retained in higher animals; e.g., fish, humans, and other mammals. That is, of the CDDs/CDFs detected in a variety of tissues from these sources, the 2,3,7,8-substituted CDD/CDF congeners clearly predominate over the non-2,3,7,8-substituted congeners. This is true even when the source of the CDDs/CDFs is relatively low in the concentration of 2,3,7,8-substituted congeners.
>
> The environmental concern of the Agency rests primarily with long-term exposures. It is the 2,3,7,8-substituted congeners that seem to pose the greatest long-term potential, since the non-2,3,7,8-substituted congeners appear to be either not absorbed or quickly eliminated by biological systems. Therefore, in the interest of keeping the TEF system as simple as possible, attention is focused exclusively on 2,3,7,8-substituted congeners in the I-TEF/89 scheme.

A thorough review of the West Brine Field CDD/CDF sample analysis data has revealed that soil, sediment, surface water, and groundwater samples were analyzed only for 2,3,7,8-TCDD and total homologue groups *(e.g.,* Total TCDDs, Total PeCDDs, Total HxCDFs, Total TCDFs, Total PeCDFs, and Total HxCDFs). This analysis does not differentiate between 2,3,7,8-substituted and non-2,3,7,8-substituted CDD/CDF congeners, therefore the true contribution of the 2,3,7,8-substituted congeners is unknown. Though 2,3,7,8-TCDD was reported as nondetect in every sample it was analyzed for, certain homologue group total values were detected in a few samples. In an effort to quantify potential risks associated with exposures to dioxin/furan compounds given the lack of congener-specific data from the West Brine Field, TEF calculations were performed using total homologue group results based on the best available technique presented in Part I of the I 989a US EPA interim guidance document. This guidance states:

> In cases where only the concentration of homologous groups is known, *i.e.,* no isomer-specific data are available, different approaches are possible. One could assume that the occurrence of each of the congeners in the mixture has equal probability. For instance, 2,3,7,8-TCDD is one of 22 possible TCDDs and would constitute about 4% of a mixture of isomers occurring with equal probability.

Assuming that all congeners are represented equally in each sample may result in an overestimation of risk, especially in light of evidence indicating that 2,3,7,8-TCDD, the most toxic dioxin congener by several orders of magnitude, is not detected at the site. To provide

some quantitative estimation of risk given the significant limitations in analytical data for the West Brine Field, toxicity equivalent (TEQ) values based on total homologue group results were used in the risk assessment.

2.2 Exposure Assessment

The objective of the exposure assessment is to estimate the type, magnitude, frequency, and duration of exposures to site-related COPCs. The exposure assessment incorporates the identification of exposed populations, potential pathways of exposure, and estimates of COPC intakes for specific exposure routes. Reasonable estimates of exposures were developed for both current and hypothetical future land-use assumptions. Standard US EPA or MDEQ exposure assumptions and site-specific data were applied to each pathway. V/here published parameter values were not appropriate or available, provisional values were derived using best professional judgment. The use of published and provisional parameter values is discussed in detail in later sections.

The following pathways, receptors, and routes of exposure were conservatively considered to be a comprehensive assessment of potential risks under current and future site-use conditions and were quantitatively addressed in this assessment. These exposure scenarios were based on the conceptual site model provided in the RFI Work Plan — Phase TI (Weston, 1999) for the West Brine Field.

- Hypothetical future construction worker dermal exposure to soils;
- Hypothetical future construction worker incidental ingestion of soils;
- Hypothetical future construction worker inhalation of fugitive dusts and VOC vapors;
- Hypothetical future construction worker dermal exposure to groundwater;
- Hypothetical future maintenance worker dermal exposure to surface soils;
- Hypothetical future maintenance worker incidental ingestion of surface soils;
- Hypothetical future maintenance worker inhalation of fugitive dusts and VOC vapors;
- Hypothetical adolescent trespasser dermal exposure to surface soils;
- Hypothetical adolescent trespasser incidental ingestion of surface soils;

- Hypothetical adolescent trespasser inhalation of fugitive dusts and VOC vapors;
- Hypothetical future office worker indoor inhalation of VOC vapors emanating from soil;
- Hypothetical future office worker indoor inhalation of VOC vapors emanating from groundwater;
- Hypothetical utility trench worker dermal exposure to groundwater; and
- Hypothetical utility trench worker inhalation of VOC vapors emanating from groundwater.

Chemical exposure/intake is expressed as the amount of the agent at the exchange boundaries of an organism *(i.e.,* skin, lungs, gut) that is available for systemic absorption. An applied dose is defined as the amount of a chemical (usually measured in milligrams, or mg) at absorption barriers such as skin, lung, digestive tract, available for absorption per unit of body weight (usually expressed in units of kilogram, or kg) of the receptor. An absorbed dose can be defined as the amount of chemical which penetrates the exchange boundaries. If the exposure occurs over time, the total exposure can be divided by the time period of interest to obtain an average exposure rate *(e.g.,* mg/kg-day). The general equation, as defined by US EPA (1989b), for estimating a time-weighted average intake is:

$$\text{Intake (mg/kg - day)} \quad \frac{\text{CxIRxEFxED}}{\text{BWxAT}} \qquad \textbf{[Equation 1]}$$

where:

C	=	chemical exposure-point concentration *(e.g.,* mg/m^3 air);
IR	=	intake rate *(e.g.,* mg/day);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight of exposed individual (kg); and
AT	=	averaging time (period over which exposure is averaged, usually measured in days).

Table 6 presents exposure parameters utilized in the intake equations for each exposure scenario. The general exposure parameters and variations applied to the intake equation for each exposure pathway are discussed below.

The exposure-point concentration (C) is the concentration of a chemical that is anticipated to be contacted by a receptor accessing the site. In accordance with US EPA guidance (1989b), the lesser of the maximum detected concentration and the 95% UCL (or lognormal 95% UCL where the data distribution can be described as lognormal) was selected as the exposure-point concentration for direct contact exposure routes (oral and dermal). For inhalation scenarios, the exposure-point concentration was derived by converting the soil concentration to a chemical concentration in air (either in the form of VOC vapors or entrained onto fugitive dust). A more detailed description of this process is provided later in this report.

2.2.1 General Parameters

Several of the exposure parameters listed in Equation 1 remained consistent throughout the `risk` assessment, regardless of exposure pathway. These parameters were exposure frequency (EF), exposure duration (ED), body weight (BW), and averaging time for both carcinogenic (ATc) and noncarcinogenic effects (ATn).

The EF describes the number of times per year an event is likely to occur and is expressed in units of days/year, shifts/year, or events/year. Variables such as weather, vacation time, sick days, and institutional controls often aid in determining reasonable and realistic average exposure frequencies.

For the construction worker scenario, a reasonable maximum EF of *45* days was used based on best professional judgement. This value represents 9 work weeks of construction activities that result in direct soil contact. This is a very conservative estimate in that the phases of construction that occur in or close to the soil *(e.g.,* excavation, foundation pouring, *etc.)* generally occur over only a few weeks until a different crew of individuals with specialized skills arrive for the successive phases *(e.g.,* framing, roofing, *etc.).*

At the request of the US EPA (2001), an EF of 250 shifts per year was used for the maintenance worker scenario. This value is a common US EPA default EF for commercial/industrial

occupational scenarios (US EPA, 1991) and assumes 5-day work weeks for 50 weeks per year. This EF is conservative in that it does not consider those portions of the year when the ground is frozen or covered with snow, or when the weather is too inclement to perform routine outdoor maintenance activities.

The office worker scenario used an EF of 245 days/year as recommended by the MDEQ (1998a).

A value of 24 days/year was used for the trespasser scenario for soil exposures. This value, based on professional judgment, represents visits to the Site twice a week during the *3* warmest months of the year.

For the utility trench worker scenario, an EF of 10 days was conservatively used based on best professional judgement. This value represents two entire work weeks of activities in a utility trench that result in direct groundwater contact and vapor inhalation. For construction workers, an EF of *5* days was used to represent potential contact with groundwater during relatively short initial stage of construction activities.

The exposure duration (ED) parameter in the intake equation depicts the number of years during which an exposure event is likely to occur. Factors affecting this parameter include variables such as age of receptor, population mobility, and occupational mobility. Exposure durations of less than seven years typically correspond to subchronic exposures while those greater than seven years are typically considered chronic exposures (US EPA, 1989b).

The construction worker and utility trench worker scenarios used a subchronic ED of one year. At the request of the US EPA,(2001), the maintenance worker scenario used an ED of 25 years (US EPA, 1991). The office worker scenario used an ED of21 years as recommended in MDEQ guidance (1998b). The trespasser scenario assumed an ED of 6 years, accounting for the years between the ages of 12 and 18.

The body weight (BW) used for the adult exposures assessed in this report was a common US EPA default value of 70 kg (US EPA, 1991). The body weight for adolescent trespassers was estimated to be *56* kg. This value was based on body weight data for children between the ages of 12 and 18 as provided in US EPA's *Exposure Factors Handbook* (1997).

The averaging time (AT) parameter is the period over which exposure is averaged. For human health cancer risk calculations, the AT value prorates a total cumulative dose over a lifetime. The US EPA takes the position that any single exposure to a carcinogen, no matter how minute, has been associated with some risk of cancer. That is, no dose is considered to be without some level of risk, although at very low doses the risk may be infinitesimally small (US EPA *Risk Assessment Guidance for Superfund, Part A*, 1989b). The AT value for each receptor is the product of a 365-day year and a 70-year life span, equaling *25,550* days, to derive an average daily intake over an entire lifetime.

The AT used for noncarcinogenic effects is the product of a 365-day year and the exposure duration *(i.e.*, AT = *365* days *x* ED). Because the ED parameter is receptor-specific, the AT is as well. The AT values used in this assessment were *365* days for construction workers and utility trench workers, 7665 days for office workers, 9125 for the maintenance workers, and 2190 days for trespassers.

2.2.2 Route-Specific Parameters

Several parameters utilized in the general intake equation vary depending on the route of exposure. Additional exposure route-specific parameters are also included into the general equation to account for the physiology involved in mimicking a chemical's release from the environment to or uptake through human exchange boundaries *(e.g.*, skin, lungs, *etc.)*. For inhalation exposures, sophisticated models were employed to convert the concentration of chemical in soil to a concentration in air that can then be inhaled. These models and the route-specific exposure parameters are discussed below.

2.2.2.1 Deriiial Exposure

Three additional factors are incorporated into the general intake equation to estimate intake resulting from dermal exposure to chemicals in soil. These factors are skin surface area exposed, soil adherence factor, and absorption factor.

Skin Surface Area

The MDEQ recommends an exposed skin surface area of 2570 cm^2 for commercial/industrial workers (maintenance or construction). This value assumes that a worker is wearing a short-sleeved shirt and long pants, and has hair or a hat covering part of his/her head. The MDEQ value represents an average as does the adult body weight of 70 kg with which skin surface area is highly correlated. An exposed skin surface area of 2570 cm^2 was used in this assessment for construction workers, maintenance workers, and utility trench workers.

The trespasser skin surface area was estimated to be 4,381 cm^2. This value is based on total skin surface area data provided in US EPA's *Exposure Factors Handbook* (1997) for children. The mean total skin surface area for children between the ages of 12 and 18 was 15,758 cm^2. The face, hands, forearms, and lower legs were assumed to be exposed; these body parts comprise 27.8% of the total skin surface area (US EPA, 1997), or 4,381 cm^2.

Adherence Factors

Until recently, the US EPA-recommended default for soil adherence on skin ranged from 0.2 to 1.0 mg/cm^2 for the entire exposed surface area, without consideration of the type of activity (US *EPA Dermal Exposure Assessment: Principles and Applications,* 1992). However, the data from which that range was derived were primarily the result of indirect measurements, artificial activities, and sampling of hands only. A more recent study has presented the results of direct measurement of soil loading on skin surfaces before and after normal occupational and recreational activities that might result in soil contact (Kissel *ci' al.,* 1996a). A five-order of magnitude range (roughly i0 to ^{102} mg/cm^2) was reported for observed activity-related hand loadings. That report indicated that hand loadings within the range of 0.2 to 1 mg/cm^2 were produced by activities in which there was vigorous soil contact *(e.g.,* rugby, fainiing); but for

activities in which there was less soil contact (e.g., soccer, professional grounds maintenance), loadings substantially less than 0.2 mg/cm^2 were found on hands and other body parts. Kissel *et at.* (1996a) concluded that, because non-hand loadings attributable to higher contact activities exceeded hand loadings resulting from lower contact activities, hand data from limited activities cannot be used as a conservative predictor of loadings that might occur on other body surfaces without regard to activity. Furthermore, because exposures are activity-dependent, dermal exposure to soil should be quantified using data describing human behavior (e.g., type of activity, frequency, duration, including interval before bathing, clothing worn, etc.). The US EPA *Exposure Factors Handbook* (US EPA, 1996) takes the same posture and states:

> These generalizations suggest that changes are needed to the recommendations in US EPA, 1992, regarding soil adherence. The earlier recommendations made suggested applying an average of 0.2 to 1.0 mg/cm^2 to the entire exposed skin surface area without consideration of the type of activity. The new studies suggest a more site-specific approach is needed which considers the type of activity and uses different estimates for different regions of the body. Further research is needed to reach final conclusions about how such recommendations should be made. Meanwhile, assessors can use the data presented in Table 4-12 [summary of Kissel *et at.* (1996a)] to select adherence values for activities which best match those of the population being assessed.

The most recent version of the *Exposure Factors Handbook* (1997) goes on to state:

> In consideration, of these general observations and the recent data from Kissel *et at.* (1996a, 1996b), this document recommends a new approach for estimating soil adherence to skin. First use Table 6-12 [Summary of Field Studies, Kissel *et at.,* 1996a] to select the activity which best approximates the exposure scenario of concern. Next, use Table 6-13 [Mean Soil Adherence by Activity and Body Region, Kissel *et at.,* 1996a] to select soil loadings on exposed skin surfaces which correspond to the activity of interest. This table contains soil loading estimates for various body parts. The estimates were derived from soil adherence measurements of body parts of individuals engaged in specific activities described in Table 6-12. These results provide the best estimate of central loadings, but are based on limited data. Therefore, they have a high degree of uncertainty such that considerable judgment must be used when selecting them for an assessment.

Subsequently, for this analysis, activity-specific soil adherence factors (AFs) for construction workers, maintenance workers, and trespassers were calculated based on data presented by

Kissel *et* at. (1996) for irrigation installers, groundskeepers, and soccer players, respectively, as presented below.

		Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Activity**	**Hands**	**Arms**	**Face**	**Legs**
Construction Workers	Irrigation Installers	0.19	0.18	0.0063	NA
Maintenance Workers	Grounds Keepers	0.030-0.15	0.0021 - 0.023	0.0021 -0.01	NA
Trespassers	Soccer Players	0.035-0.11	0.0011 - 0.0043	0.012 - 0.016	0.0081 -0.03 1

Soil adherence factors were calculated by normalizing each body part-specific soil adherence value with regard to the percentage of total body surface area occupied by the respective body part. Surface area percentages for hands, forearms, and face are 4.2, *5.7,* and 3.0 percent, respectively. These percentages are based on the skin surface areas for each body part presented by MDEQ (1998b) and assume a total body skin surface area of 20,000 cm^2 (US EPA, 1997). Those body parts comprise 12.9 percent of the total body surface area. The normalized values for all body parts of interest were added, and the sum was divided by the total percentage of body surface area occupied by the parts. For example, the soil adherence factor for the construction worker (using the irrigation installer soil adherence data tabulated above) was calculated as follows:

$$AF = \frac{(0.19 \times 0.042) + (0.18 \times 0.057) + (0.03 \times 0.0063)}{0.129} = 0.143 \text{ mg/cm}^2$$

This same procedure was used to calculate the adherence factor for the maintenance worker using the groundskeeper data tabulated above:

$$= \frac{(0.09 \times 0.042) + (0.013 \times 0.057) + (0.001 \times 0.128) \pm (0.0061 \times 0.03)}{0.129} = 0.036 \text{ m/cm}^2$$

Likewise, the soil adherence factor for the adolescent trespasser scenario was calculated based on data presented by Kissel *et al*. (1996b) for soccer players. This calculation assumed 27.8% of the total skin surface area was exposed for contact as presented in the Skin Surface Area subsection above.

$$AF = \frac{(0.052 \times 0.0725) + (0.059 \times 0.0027) + (0.128 \times 0.0195) + (0.039 \times 0.014)}{0.278} = 0.025 \text{ mg/cm}^2$$

Absorption Factors

Another exposure factor necessary to estimate dose and, therefore, risk via dermal contact with soils containing COPCs is the absorption factor (ABS) of the specific constituent from soil. In general, the skin provides an effective barrier to environmental toxins. For purposes of this assessment, values for dermal absorption as recommended by MDEQ (1 998b) were adopted. These values were 10% (0.1) for volatiles and 1% (0.01) for semi volatiles and inorganic compounds.

Permeability Constant

The permeability constant, used for dermal exposures to groundwater for utility trench workers and construction workers, accounts for the movement of a constituent dissolved in water through the skin, across the stratum corneum, and into the blood stream. Kp values (usually expressed in cm/hour) for the constituents examined in this assessment were obtained from US EPA *Dermal Exposure Assessment: Principles and Applications* (1992a). For values not available in US EPA *Dermal Exposure Assessment* (1992a), the Kp value was calculated using the equations provided by the US EPA in the same document.

Exposure Time

Since the dermal permeability of chemicals in water is dependent on time (with Kp being expressed in cm/hour), an exposure time (ET) parameter must be included in the intake equation for dermal exposures to surface water. A reasonable maximum ET of 4 hours/day was used for construction and utility trench workers.

2.2.2.2 Incidental Ingestion

An ingestion rate is used for the intake parameter, IR, in Equation I for ingestion exposures. For hypothetical future construction workers, a soil ingestion rate of 480 mg/day was used at the request of the US EPA (2001). This value was extracted from US EPA's *Exposure Factors Handbook* (1997). The hypothetical adolescent trespasser and hypothetical future maintenance worker scenarios used a soil ingestion rate of 50 mg/day as extracted from MDEQ guidance (1998b).

2.2.2.3 Inhalation

In addition to converting a chemical's soil concentration to a concentration in air that may be inhaled, the intake equation for inhalation exposures includes the use of an inhalation rate. The inhalation rate for the hypothetical future construction worker, maintenance worker, and utility worker scenarios was extracted from US EPA guidance (1991). This guidance recommends a value of 20 m^3/workshift. For the adolescent trespasser and office worker scenarios, an inhalation rate of 10 m^3/event or workshift was used. This inhalation rate is consistent with MDEQ guidance (1998a) and represents moderate activity while on the job.

2.2.3 Concentration in Air Calculations for the Construction Worker Scenario

Inhalation exposures to residual chemicals in soil can result from two separate airborne sources: VOC vapors and fugitive dust. For construction workers, fugitive dust can be generated by excavation activities and vehicular traffic. The calculation of constituent concentrations in air for both VOC vapors and fugitive dust are detailed below.

2.2.3.1 Traffic Over Unpaved Surfaces During Construction

The following empirical expression, extracted from US EPA's *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites,* (1985), can be used to estimate the fugitive dust generated during construction:

$$PERv = (k)x(5\ 9)x(s/12)x(S/30)x(W/3)^{\circ 7}x(w/4)^{\circ 5}x\ ((365\ -p)/3\ 65)$$

[Equation 2]

where:

PERv =		particle emission rate for vehicular traffic (lb/vehicle mile traveled);
k	=	particle size multiplier;
s	=	percent silt content;
S		mean vehicle speed (mph);
W	=	mean vehicle weight (ton);
w		mean number of wheels per vehicle; and
p	=	mean number of days with ≥ 0.01 inches of precipitation per year.

The particle size multiplier is assumed to be *0.45,* corresponding to particles less than 15 microns *(jtm) (US EPA Compilation of Air Pollution Emission Factors,* 1996). Percent silt content is estimated to have a value of *31.5%* (site-specific, Weston, 1997). Vehicle characteristics consist of the following: mean vehicle speed was assumed to be 15 mph, with mean vehicle weight was *assumed to be approximately 12.5 tons (US EPA Compilation of Air Pollution Emission Factors,* 1996) for eight-wheeled vehicles. For the Riverview, Michigan area, the estimated mean number of days with precipitation equal to or greater than 0.01 inches per year is 140 (US EPA *Superfund Exposure Assessment Manual,* 1988). Total resultant dust emission rate for constituents during vehicular movement activities (PERv) was estimated to be approximately *8.25* lbs/vehicle mile or 0.000069 kg/sec. This conversion of units from lbs/vehicle mile to kg/sec was performed by assuming a vehicle travels 12 miles per construction job and each construction event lasts *45* days. Also, assuming one working day is eight hours long, the units of lbs/vehicle mile were converted to lbs/sec. Applying additional conversion factors of *453.59* g/lb and 1000 g/kg, the lbs/sec units were converted to kg/sec for use in the emission rate calculation. These calculations are summarized in Table 7.

2.2.3.2 Excavation of Soil

Future excavation may be performed by bulldozers andlor a drill rig. The following estimate of particulate emissions less than 15 tm in diameter (to be converted to PM_{10} during the intake calculation, see Section 2.2.2.3 for conversion factor) from bulldozing activity can be found in US

EPA's *Compilation of Air Pollution Emission Factors (1996). This* methodology was developed from studies of emissions from bulldozing in uncontrolled open dust sources at western surface coal mines.

$$PERe = (1.0 \times s^{5})/M^{4} \qquad \textbf{[Equation 3]}$$

where:

PERe		particle emission factor for excavation of soil (Ib/hr);
s	=	percent silt content; and
M	=	percent soil moisture.

The site-specific percent silt content was *31.5%* and the site-specific soil moisture content was 18% (Weston, *1997).* The resultant fugitive dust emission rate during excavation activities (PERe) was *8.59* x10 lbs/hour or 0.000389 kg/sec. The unit conversion from lbs/hour to kg/sec was performed by applying conversion factors of 3,600 seconds/hour, *453.59* g/lb and 1,000 g/kg. Table *7* summarizes these calculations.

To calculate the emission rate of chemical constituents entrained onto the fugitive dusts, (Ei), the site-specific soil concentration was multiplied by the sum of the PERv and PERe parameters so that:

$$Ei = Cs \times (PERV + PERe) \qquad \textbf{[Equation 4]}$$

where:

Ei		constituent emission rate (mg/sec);
Cs	=	concentration in soil (mg/kg);
PERv		particle emission rate for vehicular traffic (lb/vehicle mile traveled); and
PERe	=	particle emission factor for excavation of soil (lb/br).

2.2.3.3 Volatile Emissions from Soil

The emission rate (Ei) was calculated for volatiles using the following formula:

$$Ei\ (mg/sec) = (Flux \times A)/ CFa \qquad \textbf{[Equation 5]}$$

where:

Ei	=	constituent emission rate (mg/sec);
Flux	=	flux rate of VOC (mg/day-cm^2);
A		affected area (cm^2); and
CFa	=	conversion factor (86,400 sec/day).

To calculate average mass flux of VOCs from soils, US EPA's Exposure Model for Soil Organic Fate and Transport (EMSOFT), which was obtained on US EPA's web page site (www.epa.gov), was utilized. EMSOFT is based largely on the work of Jury, *et* al. (1983, 1990), and Jury's code was modified to provide a convenient user interface with enhanced calculation capabilities. The EMSOFT interface has been designed to facilitate entering requisite input data and viewing model results. The user navigates through a set of input screens, providing the necessary data either manually or from previously developed input files, and selecting the desired calculation options. Modeled results, including average mass flux or emission rate, are viewed in a series of output screens. The EMSOFT computer model and user manual may be obtained from the US EPA Office of Research and Development. EMSOFT is designed to predict flux rates for both finite and infinite sources of organic compounds in surface soil. The EMSOFT program also permits calculation of vapor emission rates from constituent sources where an overlying layer of clean soil is present or where several soil layers (up to five) of differing levels of constituents are present at a given area.

Physical chemical properties of VOCs required for the EMSOFT model include Henry's Law Constant and diffusivities in air and water. Another chemical—specific requisite input parameter is the organic carbon partition coefficient, which provides an index of how an organic chemical will partition between the organic carbon present in soil and water within the soil matrix. Other model input parameters include the fraction of soil comprised of organic carbon *(1.5%)*, soil porosity (32.9%), soil moisture content (18%), soil bulk density (1.86 g/cm^3), pore water flux (a value of zero assumes no pore water flux and was used in the absence of site-specific data), and boundary air layer thickness *(0.5* cm, standard default value). The site-specific values indicated were extracted

from the RCRA Facility Investigation Phase I Report for the West Brine Field (Weston, 1997). The last remaining input variable is the half-life of the chemical in the environment. The half-life is the amount of time it takes for one-half of the chemical present to breakdown or decay due to natural degradation processes. For this analysis, essentially no breakdown is conservatively assumed to occur by utilizing a half-life of one million days, the maximum value permitted in the EMSOFT model for this input variable. The only VOC selected as a COPC was 2-methylnaphthalene. The resulting flux rate for 2-methylnaphthalene was *5.9x* 1020 mg/day-cm2.

The affected area (A) used in Equation 5 was estimated to be the area of SWMUs 1, 3, and 4 and Area 7. This area was calculated to be approximately 2.4 acres (9.7^{x} iO cm^2).

The resulting emission rate for 2-methylnaphthalene was $6.65x^{1017}$ mg/sec.

2.2.3.4 Near-Field Dispersion of Volatilized Constituents and Fugitive Dust

Various methodologies are utilized to determine the mass flux of entrained dusts and VOC vapors from exposed affected subsurface soil (excavated and placed on the ground surface) into air. Gaussian models are conventionally used to determine downwind ambient air concentrations from the emission rate estimated. However, in this scenario, such models have limited applicability when the receptor(s) is at or very near the source of emission. In this case, a bulldozer operator, for example, is situated directly within the area of ground emissions of vapors and dusts. Average ambient air concentrations in this circumstance are best estimated by use of a near-field box model *(US EPA Superfund Exposure Assessment Manual, 1988).*

This model assumes uniform wind speed and uniform mixing throughout the box. The release and mixing of VOCs and chemicals entrained onto respirable dusts in ambient air is estimated as follows:

$$C_a = \frac{E_i}{H_b \times W \times V}$$ **[Equation 61**

where:

		concentration of constituent in ambient air (mg/rn^3);
		emission rate of constituent (mg/sec);
Ca	=	downwind height of box (m);
El	=	width of box in crosswind dimension within the area of affected soil (m); and
Hb	=	
W	=	average wind speed through the box (rnlsec).

V

The emission rates (Ei) of VOCs and dust-entrained nonvolatiles were derived using the methodologies presented above. The value of Hb in this calculation was determined by the downwind distance and the atmospheric turbulence at ground level, which determines the trajectory of a release from the upwind edge of the source of vapor or dust emissions. For the construction worker, the Hb value was determined to be 4.81 m.. For neutral atmospheric conditions, the height at the downwind boundary may be expressed by the following function (Pasquill *1975,* Horst 1979):

$$= 6.25r_{[(Hb/r)}{}^{x} \ln(H_b/r) — (i\ .58H_b/r) + 1.58] \qquad \textbf{[Equation 7]}$$

where:

z	=	downwind distance to boundary (m); and
r	=	a terrain-dependent roughness height (m).

For the construction worker scenario, on any given workday, it was estimated that grading or excavation activities occur over the entire 'workable' site area (or a portion of an exposure unit) from whri± dusts are generated. This area was estimated to be 2500 m^2, with a box length and width (W in Equation 6) of 50 m. The downwind distance (z in Equation 7) was estimated to be 50m.

The greater the roughness height (r in Equation 7), the greater the wind turbulence and constituent dilution *(i.e.,* the height of the box increases). For the purposes of this risk assessment, it was conservatively assumed that the roughness height is 0.20 meters , which corresponds to a terrain with grass, and some small bushes and occasional trees (US EPA *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites,* 1985). An annual average wind speed

(5.86 ml/sec) was obtained from wind data obtained from the Stability Array (STAR) data set (Table 8), accessed through the Personal Computer Graphical Exposure Modeling System (PCGEMS) system, for STAR station 94847, Detroit/Metropolitan Michigan, for the period 1973-1977.

The Ca variable calculated using Equation 6 is the concentration term used in the intake Equation (Equation 1).

2.2.4 Concentration in Air Calculations for the Maintenance Worker and Trespasser Scenarios

Like the construction worker inhalation pathway, the maintenance worker and trespasser can be exposed to residual chemicals in soil via inhalation of VOC vapors or inhalation of chemicals entrained onto dust particles. The calculation of emission rates and air concentrations for VOCs (using EMSOFT to determine chemical flux and a near-field box model to estimate air concentration) for the maintenance worker and trespasser scenarios was virtually identical to that of the construction worker scenario discussed above. The only exception was that the box length and width used in the box model (Equations 6 and 7) for the trespasser and maintenance worker scenarios reflected the total area of the West Brine Field SWMUs so that the exposure area (the "box") had side dimensions of 98.6 m (total area of 9.73×10^7 cm^2). Inhalation exposures to dust-entrained chemicals for the maintenance worker and trespasser were estimated using the methodology that follows.

The following equation was utilized to derive concentrations of nonvolatiles in air the for the maintenance worker and trespasser inhalation exposure pathway. This paradigm was extracted *from US EPA's Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)* (1991) and was used by the US EPA for deriving risk-based soil clean-up goals for soil constituents under an industrial worker scenario:

$$Ca = C \times (1/PEF) \qquad \textbf{[Equation 81}$$

where:

Ca	=	concentration of inorganic particulates in air (mg/rn^3);
Cs	=	concentration in soil (mg/kg); and
PEF		particle emission factor (m^3/kg).

The particle emissions factor (PEF) converts concentrations of constituents in soil to concentrations on dust particles in the air as a result of fugitive dust emissions from bare surface soils. US EPA provides the methodology required to calculate the PEF *(Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites Peer Review Draft, 200 1):*

$$PEF\ (m^3/kg) = (Q/C)x\ \frac{3600\ s/h}{0.036\ x\ (ix\ V)x\ (u_1/U)^3\ x\ F(x)} \qquad \textbf{lEquation 9]}$$

where:

PEF	=	particle emission factor (m^3/kg);
Q/C	=	dispersion factor for wind erosion (g/m^2-s per kg/m^3);
V	=	fraction of vegetative cover (unitless);
Urn	=	mean annual windspeed (mis);
U	=	equivalent threshold value of windspeed at *7* m (mis); and
F(x)	=	function dependent on Urn/Ut (unitiess).

A value of *50%* was chosen for V for the West Brine Field. The mean annual windspeed (U_{rn}) IS 5.86 mIs as obtained from the Stability Array (STAR) data set (Table 8), accessed through the Personal Computer Graphical Exposure Modeling System (PCGEMS) system, for STAR station *94847,* Detroit/Metropolitan Michigan, for the period *1973-1977. US* EPA *(2001)* provides a U value of *11.32* and an F(x) value of *0.194.* Both of these values were used in this calculation.

The Q/C value in Equation *9* can be calculated using the following algorithm (US EPA, *2001):*

$$Q/C\ (g/m^2\text{ - s per kg/rn}^3) = A\ x\ \exp\left|\frac{(mA - B)^2}{C}\right| \qquad \textbf{[Equation 10]}$$

where:

		dispersion factor for wind erosion (g/m^2-s per kg/rn^3);
		climate-based constant;
Q/C	=	climate-based constant;
A	=	climate-based constant; and
B		affected area of site (acres).
C	=	
Asite	=	

Data from the Chicago, Illinois meteorological station (in climate region VII as delineated by the US EPA [2001]) was used in determining the unitless constants A, B, and C. These values were *16.8653*, 18.7848, and 215.0624, respectively. The affected area of the West Brine Field is approximately 2.4 acres These inputs resulted in a Q/C parameter value of 74.94 glm^2-s per kg/rn^3.

The resulting PEF value for the West Brine Field was 557x 108 m3/kg.

The concentration in air (Ca) calculated using Equation 8 was then input into the intake equation for inhalation exposures.

2.2.5 Calculation of Concentrations in Building Air Resulting From Groundwater Vapor Emissions

Vapor intrusion into indoor air from subsurface sources of VOCs *(i.e.*, subsurface soils, groundwater, or light non-aqueous phase liquid [LNAPL]) may be estimated with the American Society of Testing and Materials' Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM RBCA) model (ASTM E1739-95) or the heuristic model developed by Johnson and Ettinger (1991). Johnson and Ettinger developed both steady-state and unsteady-state versions of their vapor intrusion models. The infinite model was used for VOC releases from underlying soil as a conservative measure *(i.e.*, the source is never depleted). In order to predict vapor intrusion rates, the model makes several assumptions:

Constituent vapors enter a building primarily through cracks and holes in the foundation and walls; and that any floor/wall cracks or openings are filled with dust or dirt physically similar, with respect to density, porosity, and moisture content, to the underlying soils;

The velocity of the vapors entering the building decreases dramatically as distance from the building increases;

- In the soil layers very close to the building, convective transport (driven by pressure differentials) is most likely the dominant transport mechanism while vapor-phase diffusion is the most significant mechanism where the constituent sources are more distant;

- Unless the foundation provides a perfectly sealed vapor barrier, all of the constituent vapors from sources directly below the building will enter the building; and

- It is assumed that the soil in any given horizontal plane is homogenous relative to effective diffusion coefficients and that the convective vapor flow is uniform in the areas very near the foundation (Johnson and Ettinger, 1991).

There are several advantages to using the Johnson and Ettinger model (1991) as a basis for estimating vapor intrusion. First, this model accounts for both convective and diffusive vapor transport mechanisms by calculating a parameter called the Peclet number (Pe, discussed below). This model also takes into account differences in effective diffusion coefficients on a vertical plane resulting from heterogeneous soil layers. Furthermore, building under pressurization is incorporated into the calculation of convective vapor flow rate. Lastly, the Johnson and Ettinger model was adopted by the MDEQ for the development of its soil and groundwater volatilization to indoor air generic screening criteria (1998a).

If the vapor source is constantly being renewed, or very large and concentrated, or vapor emissions are very slow, the scenario can be thought of in terms of a steady-state (infinite source) model. Even though this may not be characteristic of the West Brine Field site, this model conservatively assumes that even as the constituents are volatilized into the air, the source is not depleted.

In order to expand on the Johnson and Ettinger vapor intrusion model, calculations were employed to account for saturation vapor phase concentrations, constituent half-lives, and partial pressure contributions when multiple volatile constituents are present *(i.e.,* mole fractions of each

constituent). Each of these adjustments is discussed in detail below. Several of the parameters described in the following sections have been conceptualized in Figure 1.

The concentration in building air (Cbldg) is the concentration term used for the C parameter in the intake formula presented as Equation 1. Cbldg is the product of the attenuation coefficient (cc), the vapor phase concentration at the source (Cso) and a conversion factor so that:

$$Cbldg = ccxCsoxCFa \qquad \textbf{[Equation 111}$$

where:

Cbldg = concentration in building air (mg/rn^3);
cc = attenuation coefficient (unitless);
Cso vapor phase concentration at the source (g/cm^3); and
CFa conversion factor (1 x iO cm^3-mg/m^3-g).

The attenuation coefficient is actually the ratio of the concentration of constituent in the indoor air of the building (basement) to the concentration in soil air pore space at the source; however, since the concentration in the building remains unknown at this point, a must be calculated using a more complex algorithm:

$$cc = \frac{Dteffx\ Ab\ x\ exp(Pe)}{QbldgxLt} \Big/ \left[\exp(Pe) + \frac{DteffxAb}{Qbldg \times Lt} + \frac{Dteffx\ Ab}{Qsoil \times Lt_1} \times (\exp(Pe)-1) \right] \qquad \textbf{[Equation 121}$$

where:

cc = attenuation coefficient (unitless);
Dteff = overall effective porous media diffusion coefficient (cm^2/s);
Ab = underground surface area of basement floor and walls (cm^2);
Qbldg = basement ventilation rate (cm^3/s);
Lt = distance between constituent source and building (cm);
Pe = peclet number (unitless); and
Qsoil = convective flow rate from the soil into the basement (cm^3/s).

The parameters Dteff, Ab, Qbldg, Pc and Qsoil require additional calculations and will be discussed below. The Lt parameter depends on the distance to the constituent source below the

structure. An Lt value of one foot (30.48 cm) was conservatively used as the depth to affected soils for the West Brine Field.

The parameter Ab is simply the area of the building that is below grade. Since a commercial structure is generally built on a slab-ongrade, only the slab would be considered below grade. In this assessment, the slab was assumed to be 15 cm thick (Zcr), a common construction code requirement (MDEQ, 1998a). The MDEQ default area of the footprint of a commercial building was chosen as representative of a building footprint for the West Brine Field. This value was 4000 fi^2 or a building with sides of 1928.7 cm (MDEQ, 1998a). Using this information, Ab was calculated using the following equation:

$$Ab = (L \times W) + \{(2 \times (Zcr \times L)) + (2 \times (Zcr \times W))\} \qquad \textbf{[Equation 13]}$$

where:

Ab	=	underground surface area of basement floor and walls (cm^2);
L	=	building length (cm);
W	=	building width (cm); and
Zcr		depth of building below grade (cm).

The thickness of the foundation, 15 cm, was used for Zcr, since commercial buildings generally are not built with basements. The resulting Ab value was $3.84 \times {}^{106}$ cm^2.

Qbldg, in Equation 12, describes the building ventilation rate, and is also a function of building size. It is calculated using the following equation:

$$Qbldg = \frac{L \times W \times Hgt \times ACH}{CFb} \qquad \textbf{[Equation 14]}$$

where:

Qbldg =		basement ventilation rate (cm^3/s);
L	=	building length (cm);
W	=	building width (cm); and

Hgt		building height (cm);
ACH	=	building *air* exchange rate (exchanges/hour); and
CFb	=	conversion factor (3600 seconds/hour).

The height of the building was estimated to be 244 cm, or one story, and an exchange rate of two indoor air exchanges/hour was utilized. Both of these values are typical assumptions for commercial structures (MDEQ, 1998a). The resulting Qbldg was *5.04* x 10 cm^3/s.

2.2.5.1 Overall Effective Porous Media Diffusion Coefficient

Dteff (Equation 12) is defined as "the 'overall' effective porous media diffusion coefficient based on vapor-phase concentrations for the region between the source and foundation" (Johnson and Ettinger, 1991). Used in the groundwater vapor intrusion model only, it combines the diffusion coefficients through the tension-saturated zone (Dseff), the vadose zone (Dveff), and the foundation cracks (Dcr which equals Dveff, to be discussed in a later section). The tension-saturated zone, applicable only in the groundwater vapor model, is the moist soil layer located directly above the water table line. This area, also called the capillary fringe, is near-saturated because the capillary action of the drier soil wicks the groundwater upward. The result is a "semi-saturated" layer of soil between the saturated layer at the groundwater table and the relatively dry layer above, known as the vadose zone. The vadose zone is the unsaturated soil layer between the top of the tension-saturated zone and ground surface. Dteff is approximated using the following algorithm:

$$Dteff\ (cm^2/s) = \frac{L_t}{\frac{n_v + L_{cr}}{D_{veff}} + \frac{n_t}{D_{seff}}}$$ **[Equation 151**

where:

Lt	=	Distance between the constituent source and the building (cm);
by	=	Thickness of the vadose zone below the foundation (cm);
Lcr	=	Building foundation thickness (cm);

ht	=	Thickness of the tension-saturated zone (cm);
Dveff	=	Effective diffusion coefficient through the vadose zone (cm^2/s); and
Dseff		Effective diffusion coefficient through the tension-saturated zone (cm^2/s).

The Lt parameter was described in Equation 12. A value of 15 cm (a common construction code requirement) was used by both MDEQ (1997) and Johnson and Ettinger (1991) for the Lcr parameter, and was adopted here. The height of the tension-saturated zone, ht, assumed the soil to be a silty clay, like that found at the site. This type of soil permits a capillary rise of over 100 cm (MDEQ, 1997). Since the depth to groundwater is only approximately *1.5* feet (46 cm; MDEQ, 1997), groundwater in the tension-saturated zone was assumed to rise to the base of the office building. Thus, a value of 30.7 cm was adopted for the ht parameter (the distance between the groundwater table and the building foundation). Because the capillary rise potentially reaches the building foundation, the thickness of the vadose zone below the building foundation, hv, was 0 cm. Figure 1 provides a conceptual model of the Lt, Lcr, and ht parameters.

Dveff and Dseff (in Equation *15)* are the effective diffusion coefficients through the vadose zone and the tension-saturated zone, respectively. Dveff is calculated using the following algorithm:

$$Dveff\ (cm^2/s) = D_{air} \times \frac{(ev)^{3.33}}{et^2} + \frac{(D_{ew})^{3.33}}{(H' \times et)^2}, \qquad \textbf{[Equation 16]}$$

where:

Dair	=	Constituent diffusivity in air (cm^2/s);
ev	=	Vadose zone vapor-filled soil porosity (unitless);
et	=	Total soil porosity (unitless);
		Constituent diffusivity in water (cm^2/s);
H'	=	Henry's Law constant (unitless); and
ew	=	Vadose zone water-filled soil porosity (unitless).

Dair and H' are two of the many physical properties of a compound, and published values can be found in various scientific literature or chemistry reference books. For this assessment, both D_aj_r

and H' were adjusted to an average site-specific soil temperature of 10 °C (based on US EPA, 1997 guidance). The ev parameter was calculated using the following formula:

$$ev = et - (o_{r,} \times pb) \qquad \textbf{[Equation 17]}$$

where:

ev	=	vadose zone vapor-filled soil porosity (unitless);
et	=	total soil porosity (unitless);
em	=	soil moisture content (cm^3/g); and
ph	=	bulk soil density (g/cm^3).

For this assessment, values of 32.9% and 0.151 cm^3/g were used for average soil moisture content and total soil porosity, respectively. A bulk density of 1.86 g/cm^3 was also used. Each of these values are site-specific and were extracted from the RCRA Facility Investigation Phase I Report for the West Brine Field (Weston, 1997). The resulting ev was 0.048.

The D parameter (Equation 16)is the diffusivity in water. Like Dair, D is one of the many physical properties of a compound, and published values can be found in various scientific literature or chemistry reference books. For this assessment, D was adjusted to an average soil temperature of 10 °C. H' is the unitless version of the Henry's Law constant. This is calculated for each constituent by dividing the Henry's Law constant in atm-m^3/mol by the Universal Gas constant (8.20 x i0 atm-m^3/mol-K) and the estimated site-specific soil temperature of 283 K (MDEQ, 1997). Lastly, ew is the water-filled soil porosity. This value is equal to the total soil porosity minus the vapor-filled soil porosity, or 0.281.

Finally, Dseff, in Equation *15,* is the effective diffusion coefficient through the tension-saturated zone. This value is defined by the equation:

$$Dseff\ (cm/s) = D_{ar} \times\!< \frac{evt^{333}}{et^{3}} + \frac{D}{H'} \frac{ewt^{33}}{et} \qquad \textbf{(Equation 18]}$$

where:

Dair	=	Constituent diffusivity in air (cm^2/s);
evt	=	Tension-saturated zone vapor-filled soil porosity (unitless); and
et	=	Total soil porosity (unitless);
	=	Constituent diffusivity in water (cm^2/s);
H'		Henry's Law constant (unitless); and
ewt	=	Tension-saturated zone water-filled soil porosity (unitless).

The soil pore space in the tension-saturated zone will be filled with much more water than in the vadose zone. Keeping the et parameter at 0.306, the evt and ewt values are estimated to be 0.06 12 and *0.245,* respectively.

2.2.5.2 Peclet Number

The Peclet number (Pe) in Equation 12 quantitatively describes the transport of constituent vapors through the soil in the cracks of the building foundation. If Pe is much greater than 1.0, convective transport is the dominant mechanism; however, if Pe is much less than 1 .0, diffusive transport dominates (Johnson and Ettinger, 1991). Pe is dependent on several variables and is calculated using the following algorithm:

$$Pe = \frac{Qsoil \times Lcr}{Dcr \times Acr}$$ **[Equation 19]**

where:

Pe	=	Peclet number (unitless); and
Qsoil	=	convective flow rate from the soil into the basement (cm^3/s);
Lcr	=	building foundation thickness (cm);
Dcr		effective diffusion coefficient through the cracks (cm^2/s); and
Acr	=	total area of cracks (cm^2).

The parameter, Lcr, was described in Equation *15.* Acr was reasonably estimated to be 0.01% of the surface area of the building that is below grade, or 384 cm^2. The flow rate into the basement, Qsoil, is a complex calculation involving parameters such as area of cracks, physical characteristics of the soil, indoor/outdoor pressure differences, and basement structure and air

exchange. In order to simplify this, Johnson and Ettinger (1991) assumed that the physical characteristics of the soil within the cracks in the building foundation are the same as those of the underlying soil. As a result of this assumption, Dcr becomes the same as Dveff in Equation 15. Qsoil is described in the following section.

2.2.5.3 Convective Flow Rate

In order to evaluate vapor flow into the basement, an idealized cylinder model was used by Johnson and Ettinger (1991). The cylinder has a length, Xcr, a radius, rcr, and is located at a depth of Zcr below the ground surface. The convective flow rate, Qsoil, from the soil into the basement is defined by the following equation:

2 x 7t X

$$Qsoil = \frac{x\ kv\ x\ \underline{Xcr}}{x\ \ln((2\ x\ Zcr)/\ rcr))}$$

[Equation 201

where:

Qsoil	=	convective flow rate from the soil into the basement (cm^3/s);
AP	=	indoor/outdoor pressure difference ($g/cm\text{-}s^2$);
ky	=	soil permeability to vapor flow (cm^2);
Xcr	=	length of the cylinder modeling the vapor flow (cm);
	=	vapor viscosity (g/cm-s);
Zcr	=	building depth below grade to bottom of foundation (cm); and
rcr	=	radius of the cracks (cm).

The AP parameter describes the pressure difference between the interior, below grade part of the building and the surrounding soil outside the building. A default value of 10 $g/cm\text{-}s^2$, as used by MDEQ (1998a) and Johnson and Ettinger (1991), was chosen for this site. Soil permeability to vapor flow (kv) is a measurement of how easily air flows through the soil and is very dependent on soil type, grain size, and grain shape. A site-specific value of 1.25 x $10^{'2}$ cm^2 was used for this assessment based on site-specific data provided in the *RCRA Facility Investigation Phase I Report* for the West Brine Field (Weston, 1997). A value of 1.8 x g/crn-s was used by Johnson and Ettinger (1991) for vapor viscosity, p.. This value was adopted for this evaluation.

Xcr is the length of the cylinder modeling the vapor flow, and it is equal to 7714.8 cm. This is the floor/wall seam perimeter distance, assuming a floor dimensions of 1928.7 x 1928.7 cm. Zcr is the depth of the cylinder below grade, which is equivalent to the depth of the foundation, or 15 cm. Lastly, rcr is the radius of the cylinder, or the foundation crack radius. This value is given by:

$$rcr\ (cm) = \frac{x\ Ab}{Xcr} \qquad \textbf{[Equation 21]}$$

where:

rcr	=	radius of the cracks (cm).
11	=	ratio of the area of the cracks to area of the basement (cm^2/cm^2);
Ab	=	underground surface area of basement floor and walls (cm^2);
Xcr	=	length of the cylinder modeling the vapor flow (cm);

The ratio of the area of the cracks to the area of the basement was estimated to be 0.01%. The resulting value of rcr was 4.9 cm.

2.2.5.4 Model Adjustments

The Johnson and Ettinger model was adjusted to account for several site-specific physical and chemical characteristics. Adjustments were made to account for saturation vapor phase concentration (Csi), mole fraction of constituent in a mixture (Mx), constituent half-life (thalf), and site-specific soil temperature (T). Each of these adjustments is described in detail in the following sections.

Saturation and Equilibrium Vapor Concentrations

The saturation vapor concentration (Csi) for any given constituent is the maximum vapor concentration sustainable in soil air at a given temperature and pressure. At the Csi, the soil air is saturated with volatile vapors, and the vapor phase concentration at that point for any given constituent can not be exceeded, even if the concentration of constituent at the source increases.

For purposes of comparison, the soil concentration that corresponds to the Csi was calculated in the exposure model.

As a result of the physical properties associated with the Csi calculation, it is impossible for the concentration of a constituent in soil air to exceed its saturation vapor concentration, no matter how large or concentrated the source may be. If the source is not concentrated enough to achieve soil air saturation at equilibrium, the constituent will volatilize to a point where the vapor phase concentration is in equilibrium with the soil concentration. At this point, the constituent concentration in the soil air is called the equilibrium vapor phase concentration (Cas).

Oftentimes, vapor emission models incorporate one of two vapor concentration calculations. The first of these methods estimates vapor concentrations relative to soil concentrations and independent of the relative abundance of the other constituents in the residual mixture. Such a calculation can predict vapor concentrations that continually increase with increasing constituent levels, regardless of saturation vapor concentrations. Vapor concentrations calculated using this procedure can be overestimated when vapor saturation is reached, and the vapor concentration becomes independent of residual soil concentrations (labeled Equation *3* in Figure 2, Johnson *et al.,* 1990).

The second approach estimates vapor concentrations that result from substantial source quantities of a single chemical in a mixture *(e.g.,* free product), but are independent of the residual concentration in soil. This type of steady-state model incorporates the property that the vapor phase concentration cannot increase once the saturation vapor concentration is reached; however, it does not account for decreases in the equilibrium vapor concentration at levels below saturation. This model predicts a vapor phase concentration that generally overestimates actual vapor concentrations, especially at low constituent levels in soil (labeled Equation 4 in Figure 2, Johnson *et ci.,* 1990).

In order to more accurately predict vapor emissions from soil, both the relative abundance of a chemical in a mixture and the saturation vapor concentration must be considered. Figure 2 uses

benzene as an example and compares the two different methods discussed above with a full model that combines both methods. Equation 1 in Figure 2 represents a method that incorporates both of the above methods and more accurately predicts vapor concentrations (Johnson *et al.*, 1990).

So, in order to determine which value, Csi or Cas, to use as the vapor phase concentration at the source (Cso in Equation 11), the values must be compared in the following manner: If Cas is less than Csi, then Cso is equal to Cas; however, if Cas is greater than or equal to Csi, then Cso is equal to Csi. To summarize, if Cas is less than Csi, then Cso is simply equal to the calculated Cas, because soil air vapor saturation has not been reached. If, however, Cas, is greater than Csi, then Cso is equal to Csi because it is physically impossible for the concentration in soil air at equilibrium to be greater than saturation vapor concentration at the temperature of interest. Calculations for both Csi and Cas are presented below.

Calculation of Saturation Vapor Concentration

Csi is calculated independent of the concentration in soil. It is more dependent on the physical properties of the individual chemicals located at the source and their abundance relative to each other provided there are multiple constituents. The calculation is as follows:

$$Csi\ (mg/cm3) = \frac{Mx \times VP \times MW \times CFc}{RgxT}$$ **[Equation** 22J

where:

Csi	=	saturation vapor concentration (mg/cm^3);
Mx	=	mole fraction of compound (unitless);
VP	=	vapor pressure (mmHg);
MW	=	molecular weight (g/mol);
CFc	=	conversion factor (1 x 10 mg/g);
Rg	=	Universal Gas Constant (6.24 x i0 mmHg-cm^3/mol-K); and
T	=	soil temperature (K).

An estimated site-specific soil temperature of 10 °C was used. Chemical-specific vapor pressures and molecular weights can be found in various chemistry texts.

The mole fraction of constituent *i* (any given constituent), Mx, describes its abundance at the source relative to the other constituents present, if any. This step is unique in that many models assume the vapor is comprised entirely of one constituent. Such an assumption can lead to an overestimation of vapor-phase concentrations (Johnson *et* al., 1990). Mx is calculated using a two-step process:

$$Mx_i = \frac{RMF_i}{RMF_{+11}} \qquad \textbf{[Equation 23]}$$

where:

Mx = mole fraction of constituent *i* (unitless); and
RMF_1 = relative mole fraction of constituent *i* (mol/g).

The RMF_I was calculated for each VOC by using molecular weight and the ratio of a single VOC's soil concentration to the sum of the concentrations of all VOCs so that:

$$RMF\ (mol/g) = \frac{\left(\frac{Cs_i}{Cs_{in}}\right)}{MW_1} \qquad \textbf{[Equation 24]}$$

where:

RIvIF = relative mole fraction of constituent i (mol/g);
Cs = Concentration in soil of constituent i (mg/L); and
MW = Molecular weight of constituent *i* (g/mol).

If the RMF for each VOC is calculated correctly, the sum of the RiMFs should be equal to 1.0. If there is only one COPC, the RMF should also be 1 .0, as was the case with the West Brine Field (2-methylnapthalene being the only VOC evaluated for the office worker scenario).

Calculation of Equilibrium Vapor Concentration

The equilibrium vapor concentration, Cas, was calculated using the following formula:

$$Cas\ (g/cm^3) = \frac{H'xCs \times CFd}{H'x(ev/7b) + Om + Kd} \left| 1 - \exp\left(-\frac{u}{ur}\right) \right| \quad \textbf{[Equation 251}$$

where:

Cas		equilibrium vapor concentration (g/cm^3);
H'		dimensionless Henry's Law constant (unitless);
Cs	=	concentration in soil (mg/kg);
CFd	=	conversion factor (0.001 kg/g);
ev		vapor-filled soil porosity (unitless);
pb		soil bulk density (g/cm^3);
Om	=	soil moisture content (cm^3/g);
Kd		soil-water partition coefficient (cm^3/g);
u	=	net degradation rate (days); and
	=	time period (days).

H', a chemical-specific physical property, is discussed in Equation 16. The net degradation rate, u, describes the degradation of a constituent over time and is calculated using a constituent's half-life so that:

$$u(days) = \frac{\ln(2)}{thaif} \quad \textbf{[Equation 26]}$$

where:

u	=	net degradation rate (days); and
thaif	=	Constituent half-life (days).

For this assessment, a conservative half-life of one million days was assumed so as to discount degradation as a factor. Lastly, r was determined to be the exposure duration parameter expressed in days: *10,950*.

2.2.6 Calculation of Concentrations in Building Air Resulting From Soil Vapor Emissions

Essentially, the soil vapor intrusion model is the same as that used for groundwater with a few minor adjustments. First, the Dteff (Equation 15) value was simply replaced with the Dveff calculation derived using Equation 16. Dteff is not required in the soil vapor intrusion model because there is no tension-saturated zone to contend with. Also, the solubility limit screen discussed above is not incorporated into the soil model because groundwater is not considered to be present in the soil paradigm.

Lastly, the Cas parameter is calculated slightly differently. For soil vapor sources, Equation 25 is revised as follows:

$$\text{Cas (g/cm}^3\text{ air)} = \frac{H'xCs \times CF}{Hx(ev/pb) + Om + Kd} - \frac{(i - \exp(- '))}{u-r -} \qquad \textbf{[Equation 27J}$$

where:

H'	=	Dimensionless Henry's Law constant (unitless);
Cs	=	Concentration in soil (mg/kg);
CF	=	Conversion factor (0.00 1 kg/g);
ev		Vapor-filled soil porosity (unitless);
ph	=	Soil bulk density (g/cm^3);
Om	=	Soil moisture content (cm^3/g);
Kd	=	Soil-water partition coefficient (cm^3/g);
u	=	Net degradation rate (days); and
	=	Time period (days).

Equation 27 incorporates the physical properties of the chemical with the physical properties of the surrounding soil to estimate the equilibrium vapor concentration of VOCs in soil air (Cas).

Most of the parameter values discussed in Equations 11 through 26 remain the same for the soil vapor model with the exception of the Lt parameter *(viz.,* the distance between the constituent

source and the building foundation). For the soil vapor model, a conservative value of one foot was used for Lt. The Kd value (soil-water partition coefficient) was not used in the groundwater vapor intrusion model. Kd can be calculated by multiplying a chemical's octanol-water partition coefficient (Koc) by a soil organic carbon fraction (foc) which was 0.014 (site average; MDEQ, 1997).

2.2.7 Concentration in Air Calculations for the Utility Trench Worker Scenario

The model used to assess exposures to trench workers from groundwater vapors emanating from pooled groundwater in the bottom of an excavation trench is based on the box model presented above (Equations 6 and 7) and an approach outlined in *Chemical Property Estimation Methods* (Lyman, *et al.,* 1982) and US EPA's *Superfund Exposure Assessment Manual* (1988). When evaluating this approach, several conservative assumptions were made that are likely to overestimate potential hazards and risks. First, the model assumes a steady-state presence of VOCs. That is, the supply of VOCs is constantly being renewed and does not degrade over time. Also, a standard assumption when using the box model is that the air is uniformly mixed throughout the box *(i.e.,* the vapor-mixing volume within the breathing zone), which could possibly underestimate potential VOC vapor inhalation hazards and risks under very unusual conditions.

The emission rate, Eiw, for groundwater exposures was calculated using the following paradigm excerpted from US EPA's *Superfund Exposure Assessment Manual* (1988):

$$Eiw\ (g/sec) = Ki \times Clx\ Ab \times Mxw \qquad \textbf{[Equation 28]}$$

where:

Ki		Overall mass transfer coefficient (cmlsec);
Cl		Liquid phase concentration (g/cm^3);
Ab	=	Exposed area (cm^2); and
Mxw	=	Mole fraction of compound in water.

This approach assumes that the water phase is well-mixed and that background atmospheric concentrations are negligible. The Ki parameter is a function of the mass transfer coefficients for the water phase and the gas phase and is discussed below. The liquid phase concentration is the concentration of chemical in the water. A conversion factor of $1x10^6$ was used to convert the exposure-point concentration from units of mg/L to units of g/cm^3 for the Cl parameter. The exposed area was assumed to be a trench with dimensions of twenty feet (6.1 meters) long by four meters (1.2 meters) wide or $^{74+4}$ cm^2. Lastly, the mole fraction of the compound takes into account the partial pressures of multiple VOCs that are present in the liquid phase (groundwater). The mole fraction of a constituent , Mxw, was calculated using Equations 23 and 24.

The overall mass transfer coefficient, Ki, was derived using the following formula from US *EPA's Superfund Exposure Assessment Manual* (1988):

$$\frac{1}{Ki\ (cmlsec)} = 1/ \qquad + \frac{RxT}{ku\ Hxkig}$$ **[Equation** 291

where:

Ki	=	Overall mass transfer coefficient (cmlsec);
ku	=	Liquid phase mass transfer coefficient (cmlsec);
R		Ideal Gas Law constant (8.2x i0 atm-m^3/mol-K);
T	=	Temperature (K);
H	=	Henry's Law constant (atm-m^3/mol); and
kig	=	Gas phase mass transfer coefficient (cmlsec).

A temperature of 283.15 K (10°C) was used for the T parameter. Henry's Law constant is one of the many chemical characteristics of a compound and can be found in various published literature. The remaining parameters, kil and kig, were derived using calculations presented below.

According to Lyman *et al.* (1982), the liquid-phase mass transfer coefficient calculation is dependent on the molecular weight of a given chemical and the wind speed at the site. For a utility trench, wind speed is assumed to be ten percent of the wind speed over a flat terrain. Some air movement and air turnover is inevitable in a shallow trench. tinder conditions of zero

air movement, the trench would constitute a "confined space", subject to entry precautions outlined under provisions of the Occupational Safety and Health Administration (OSHA). If air at the surface is moving over the trench, air within the trench will be subject to turnover and mixing due to aspiration effects and other pneumo-dynamic phenomena. Accordingly, ten percent of ambient wind velocity is a reasonable assumption for air movement within a shallow trench. An annual average wind speed of *5.86* ml/sec was obtained from wind data recorded for STAR (Stability Array) station *94847,* in Detroit/Metropolitan, Michigan for the period *19731977* (Table *8,* PCGEMS, *2001);* therefore, a trench wind velocity of *0.586* m/s was used.

If the molecular weight of a compound is greater than *65* g/mole and the wind speed in the trench is less than *1.9* mIs (this assessment used *0.59* m/s or one-tenth the ambient air wind speed), then the following formula should be used for the kil parameter:

$$kil(cm/sec) = \frac{lhr}{3600\ sec} \times 23.51 \times \frac{(v.0969\ '\backslash}{Z^{0673}} \times \sqrt{32/MW} \qquad \textbf{[Equation 30]}$$

.1

where:

Kil	=	Liquid phase mass transfer coefficient (cm/sec);
Vcurr	=	Water current speed (ml/sec);
Z	=	Depth of water in bottom of pit (cm); and
MW	=	Molecular weight (g/mol).

Since this process assessed exposures to groundwater in a trench, the speed of the current was minimized to 0.01 ml/sec. The Z parameter was set to a reasonable maximum of *12* inches or *30.48* cm. Water depths greater than this would require pumping in order for individuals to continue working in the excavation pit. The molecular weights of chemicals can be found in various published chemistry literature.

For those chemicals with molecular weights less than *65* g/mole *(e.g.,* vinyl chloride), the following equation, extracted from Lyman *et al. (1982),* was used to calculate kil:

$$ku\ (cm/sec) = \frac{1hr}{3600\ sec} \times 20 \times J44/MW \qquad \textbf{[Equation 31]}$$

The MW parameter is described above.

The gas-phase mass transfer coefficient is similarly dependent on the molecular weight of the chemical in question. For constituents with molecular weights less than 65 g/mole, the following paradigm, recommended by Lyman *et al.* (1982), was used to calculate kig:

$$kig\ (cmlsec) = \frac{l\ b\ r}{3600\ sec} \times 3000 \times ji\ 8/MW \quad \textbf{[Equation 32]}$$

For chemicals with molecular weights greater than 65 g/mole, Lyman *et al.* (1982) recommends the following equation:

$$kig\ (cm/see) = \frac{l\ h\ r}{3600\ sec} \times li\ 37.5 \times (V + V) \times 18/MW \qquad \textbf{[Equation 331}$$

The V parameter was the wind speed in the trench *(0.59* m/s). The remaining variable parameters used in this paradigm are discussed above in Equation 30.

Once an emission rate was calculated using Equations 28 through 33, a concentration of VOC vapor in air was estimated. Various methodologies are utilized to determine the mass flux of VOC vapors from groundwater into air. Gaussian models are conventionally used then to determine downwind ambient air concentrations from the emission rate estimated. However, in this scenario, such models have limited applicability when the receptor(s) is at or very near the source of emission. In this case, a utility trench worker, for example, is situated directly within the area of emissions of vapors. Average ambient air concentrations in this circumstance are best estimated by use of a near-field box model (US EPA *Superfund Exposure Assessment Manual,* 1988) as described in Equations 6 and 7.

The emission rates (Eiw) of VOCs were derived using the methodologies presented above (Equations 28 through 33). For neutral atmospheric conditions, the height of the box may be expressed by the function presented in Equation 6 (Pasquill *1975,* Horst 1979). It was assumed that a utility trench would measure approximately twenty feet long (6.1 meters) by four feet wide (1.2 meters), or 80 ft^2. The resulting height of the box (Hb, calculated using Equation 7) was 0.77 meters (this conservatively represents the vertical dimension of the vapor-mixing "space," and not the depth of the trench).

The greater the roughness height (r in Equation 7), the greater the wind turbulence and constituent dilution *(i.e.,* the height of the box increases). For the purposes of this risk assessment, it was conservatively assumed that the roughness height is 0.05 meters (US EPA *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites,* 1985). This assumption is appropriate for conditions within an excavation trench. An annual average ambient wind speed of 5.86 ml/sec was assumed from wind data obtained from the Stability Array (STAR) data set, accessed through the Personal Computer Graphical Exposure Modeling System (PCGEMS) system, for STAR station 94847, Detroit/Metropolitan Michigan, for the period 1973-1977 (Table 8). For the trench scenario, a value of 0.586 ml/sec was used for the average wind-speed parameter within the trench *(viz.,* box).

The Ca variable calculated using Equation 6 is the concentration tetisi used in the general intake equation (Equation 1).

2.3 Toxicity Assessment

The toxicity assessment involves the evaluation of available toxicity information that will be utilized in the risk assessment process. Toxicity values derived from a dose-response relationship can be used to estimate the potential for the occurrence of adverse effects in individuals exposed to various constituent levels.

Exposure to a chemical does not necessarily result in adverse health effects. The relationship between a dose and a response defines the quantitative indices of toxicity required to evaluate the potential health risks associated with a given level of exposure. If the nature of the dose-

response relationship is such that no effects can be demonstrated below a certain level of exposure, a threshold can be defined and an acceptable exposure level can be derived. Humans are routinely exposed to naturally-occurring non-nutritive chemicals (anutrients) and man-made chemicals at low levels through the typical diet, air, and water, with no apparent adverse effects. However, the potential for adverse effects may occur if the exposure level exceeds the threshold level in a variably sensitive population. This threshold applies primarily to chemicals that produce noncarcinogenic (systemic) effects, although there is a growing body of scientific evidence that suggests that exposure thresholds may exist for certain carcinogenic constituents as well.

Adverse effects can be caused by acute exposure, which is a single or short-term exposure to a toxic substance, or by chronic exposure to lower levels on a continuous or repeated basis over an extended period of time. "Acceptable" acute or chronic levels of exposure are considered to be without any anticipated adverse effects. Such exposure levels are commonly expressed as RfDs, health advisories, *etc.* An acceptable exposure level is calculated to provide an "adequate margin of safety."

Chronic RfDs, which have been derived by the US EPA for a number of chemicals, were utilized to evaluate exposures lasting 7 to 70 years (US EPA, 1989b). Activities involving exposures of shorter (subchronic or less than 7 years) duration to chemicals at the Site are anticipated to result in risk estimates that are much lower than those associated with the long-term exposures. Subchronic RfDs were used to evaluate exposures lasting less than 7 years.

Currently, the US EPA has not developed toxicity values to be utilized in deririal exposure scenarios; however, the US EPA does provide the following guidance for dennal exposure:

> No RfDs or slope factors are available for the deimal route of exposure. In some cases, however, noncarcinogenic or carcinogenic risks associated with deunal exposure can be evaluated using an oral RID or oral slope factor, respectively. (US EPA, 1989b).

In accordance with this guidance, oral RIDs and CSFs were used for dermal pathways.

In several cases, the US EPA may not have developed RfD values for oral and inhalation exposures. In these instances, a thorough search of the literature was undertaken to determine the best available scientific dose-response toxicity information from which to derive provisional RfD values. This was accomplished utilizing well-accepted methodologies adopted by the National Academy of Sciences and endorsed by the US EPA. These procedures and methodologies were applied to COPCs identified on-Site in order to estimate potential risks or hazards for each constituent.

A number of sources of toxicity information exist, and these sources vary with regard to the availability and strength of supporting evidence. The following protocol has been established for the determination of toxicity indices; it defines a hierarchy of sources to be consulted and the methodology for the determination of toxicity values. This protocol has been developed in accordance with current US EPA methodology adopted andlor developed by the National Academy of Sciences. Toxicity values for the chemicals of concern at the Site were obtained with reference to the following hierarchy of sources:

1) Toxicity values were obtained from the *Integrated Risk Information System* (IRIS, US EPA, 2000) database. This database contains the Risk Reference Doses (RfDs) and Cancer Slope Factors (CSFs), which have been verified by the US EPA's RfD and Carcinogen Risk Assessment Verification Endeavor (CRAVE) workgroups, and is, thus, the agency's preferred source for toxicity values. IRIS supersedes all other information sources.

2) For toxicity values which are unavailable on IRIS, the most current source of information is the Health Effects Assessment Summary Tables (HEAST, US EPA, 1997), published by the US EPA. HEAST contains interim, as well as verified RfDs and CSFs. Supporting toxicity information for verified values is provided in an extensive reference section fHEAST.

3) In cases where IRIS or HEAST could not provide toxicity values, US EPA Region III's Risk-Based Concentration (RBC) Tables (2001) were visited. These tables often provide toxicity values generated by reliable sources other than IRIS or HEAST. For example, in response to specific requests from risk assessors, the US EPA National Center for Environmental Assessment (NCEA) develops provisional RfDs or CSFs for chemicals not listed in IRIS or HEAST. Region III's RBC tables will list such provisional values. Also, RfDs or CSFs that have

since been withdrawn from IRIS or HEAST are still listed on the Region III REC tables, although they are flagged with a "W." These toxicity values were no longer agreed upon by US EPA scientists; however, the Region III RBC tables continue to publish such values because risk assessors still need to quantify exposures to these chemicals. Lastly, the Region III RBC tables will list toxicity indices found in "other" US EPA documents. These values are flagged with an

4) If any of the above sources did not provide the necessary toxicity information, other sources of scientific literature were reviewed for appropriate toxicity data. These data were used to develop provisional RfDs or CSFs using US EPA-approved methodologies. These provisional values are labeled Pa or Ps in Table 7. Provisional toxicity values for the inhalation exposure route labeled "Ps" were derived using values from absorbed doses from oral exposures; therefore it is appropriate to adjust for relative absorption from oral to inhalation. Since gastrointestinal absorption is relatively complete, a factor of *0.5* (50%) is applied to the inhalation intake equation (for chemicals qualified "Ps") to account for the difference in the amount of chemical absorbed through ingestion and that absorbed when inhaled.

The US EPA has derived carcinogenic slope factors for both oral and inhalation pathways, and these are utilized to estimate risks quantitatively. In the first step of the US EPA's evaluation, the available data are analyzed to determine the likelihood that the chemical is a human carcinogen. The evidence is characterized separately for human studies and animal studies as sufficient, limited, inadequate, no data, or evidence of no effect. The characterizations of these two types of data are combined, and based on the extent to which the agent has been shown to be a carcinogen in experimental animals or humans, or both, the agent is given a provisional weight-of-evidence classification. The US EPA scientists then adjust the provisional classification upward or downward, based on other supporting evidence of carcinogenicity (see *Section 7.1.3, US EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part A: Interim Final,* 1989b). For a further description of the role of supporting evidence, see the US EPA guidelines (US EPA *Guidelines for Carcinogenic Risk Assessment,* Federal Register, 1986).

The US EPA classification system for weight of evidence is shown in the table below. This system is adapted from the approach taken by the International Agency for Research on Cancer.

US EPA WEIGHT-OF-EVIDENCE CLASSIFICATION SYSTEM FOR CARCINOGENICITY	
Group	**Description**
A	Human carcinogen
Bi or B2	Probable human carcinogen Bi indicates that limited human data are available B2 indicates sufficient evidence in animals and inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of noncarcinogenicity for humans

(US EPA, 1989b)

Toxicity indices used in this assessment were tabulated for the identified COPCs and are presented in Table 9.

2.4 Risk Characterization

The objective of the risk characterization is to integrate information in the Exposure Assessment (Section 2.2) and the Toxicity Evaluation (Section 2.3) in order to evaluate the potential human health impacts associated with residual chemicals in soil and groundwater at the West Brine Field Site. Carcinogenic risk refers to the probability of cancer resulting from exposure to known or suspected carcinogenic chemicals identified in this study. Carcinogenic risk generally is expressed in scientific notation *(e.g.,* an individual lifetime `risk` of one in 100,000 is represented as 1 x i0 or 1E-05). That is, a 1 in 100,000 added cancer `risk` is the upper-bound

probability that one incidence of cancer would result over a lifetime out of a population of 100,000 persons so exposed.

Impacts of noncarcinogenic chemicals on human health are evaluated by comparing projected or estimated intakes with reference levels for the chemicals of concern. A reference level represents an estimated exposure level at which there is not expected to be an appreciable risk of deleterious effects with margins of safety incorporated. The impact of carcinogenic chemicals is assessed by comparing predicted risks with target risks for known or suspected carcinogens. RfDs and target risks (CSFs) were discussed in Section 2.3.

Hazard and risk calculations are summarized for each receptor and each exposure route in Table 10. Detailed presentations of the hazard and risk calculations for each exposure pathway are provided in Tables 11 through 23.

2.4.1 Noncarcinogenic Effects

The estimated intakes calculated for each exposure pathway considered and each COPC were compared to RIDs for non-carcinogenic effects. The following formula was used to estimate the potential for non-carcinogenic health effects for each COPC.

$$HQ \quad ADI/RfD \qquad \textbf{[Equation 34]}$$

where:

HQ	=	hazard quotient - potential for noncancer health effects (unitless);
ADI	=	average daily intake of COPC (mg/kg-day); and
RID	=	reference dose (mg/kg-day).

RIDs have been developed by the US EPA for chronic *(e.g.*, lifetime) andlor subchronic exposure to constituents based on the most sensitive non-carcinogenic effects. The chronic RID for a constituent is an estimate of a lifetime daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects. The potential for noncancer health effects was evaluated by comparing the site-specific

exposure level with the RID derived by the US EPA for a similar exposure period. This ratio of exposure to toxicity is called the hazard quotient (HQ). If the site-specific exposure level exceeds the threshold *(i.e.*, the HQ exceeds a value greater than 1.0), there may be concern for potential noncancer effects.

To assess the overall potential for noncancer effects posed by multiple constituents, a hazard index (HI) is derived by summing the individual HQs. This approach assumes additivity of critical effects of multiple constituents. This is appropriate only for compounds that induce the same effect by the same mechanism of action. This conservative approach significantly overestimates the actual potential for adverse health impacts.

There were no HIs exceeding the 1.0 benchmark. A summary of the hazard calculations is presented in Table 10.

2.4.2 Carcinogenic Effects

In cancer risk assessment, the US EPA has required the use of the upper limit which produces an estimate of risk that has a *95* percent probability of exceeding the actual risk, which may, in fact, be zero. The following formula was utilized to estimate the upper bound excess cancer risk for each carcinogen (note that not all COPCs are carcinogens):

$$TR = LDI^{x} CSF \qquad \textbf{[Equation 35]}$$

where:

TR = target risk - excess probability of an individual developing cancer (unitless);
CLDI lifetime average daily intake of carcinogenic COPC (mg/kg-day); and
CSF cancer slope factor (mg/kg-day)'.

For exposures to multiple carcinogens, the upper limits of cancer risks are summed to derive a total cancer risk. The US EPA recognizes that it is not technically appropriate to sum upper confidence limits of the risk to produce a realistic total probability, but requires this approach be used.

Carcinogenic risk refers to the probability of developing cancer as a result of exposure to known or suspected carcinogens. There were no human health cancer risk estimates for the West Brine Field that exceeded the 1 x 1 0 benchmark for the construction worker, trespasser, office worker, and utility trench worker scenarios. The total cancer risk for the maintenance worker scenario was $3x10^5$. This risk level is solely attributable to a single hit of n-nitrosodiethylamine in surface soil at sample location **SB**-2 (collected in 1996). This result (0.78 mg/kg qualified with a "J") is the only detection of n-nitrosodiethyelamine in surface soil at the West Brine Field site and so this maximum concentration was assumed to be universally present, despite results indicating no detections in other samples. Sample location SB-2 is situated within SWMU-7 that is slated for remediation in the near future. Remediation of sample location **SB**-2 would result in risk levels less than $1x10^5$. A summary of the risk calculations for each receptor is presented in Table 10.

3.0 Ecological Risk Assessment

Similar to the human health risk assessment, an ecological risk assessment (ERA) is based on two major elements: characterization of exposure and characterization of effects. As noted in the US EPA's *Framework for Ecological Risk Assessment (1992),* the US EPA acknowledged that, although the traditional risk assessment paradigm *(i.e.,* hazard identification, exposure assessment, dose-response toxicity assessment, and risk characterization) is generally applicable in an ERA, ecological assessments differ from human health risk assessments in three points of emphasis:

Ecological risk assessment endpoints can be characterized at a community or ecosystem level rather than at an organism level; therefore, characterization of effects may be more complex than for that of individuals;

Receptors can include species from a wide taxonomic range *(e.g.,* plants, mammals, fish) and, consequently, no single set of measurement endpoints can be generally applied in all situations; and

. Possible effects of nonchemical stressors may be included as contributing factors to total risk.

In order to accommodate these differences, the US EPA established the following unique paradigm for conducting an ERA.

Problem Formulation — This step in the ERA process involves presentation of a preliminary characterization of exposure and effects and the examination of data needs, issues, and objectives in order to define the scope, goals, and feasibility of the assessment. This step is comparable to *hazard identification* and *planning* issues that are addressed at the beginning of most human health risk assessments. Information compiled during problem formulation can be used to select assessment endpoints, measures of effect, and ecological receptors of concern.

Analysis — This step in the ERA process includes characterization of exposure and ecological effects. The analysis phase of the ERA explicitly addresses the two main requirements of assessing risk: the inherent capacity of a stressor to cause adverse effects and the potential for the

co-occurrence of a stressor and an ecological component. This step is comparable to the *data evaluation* and *exposure assessment* steps in the traditional human health risk assessment paradigm. The analysis phase consists of the following elements: data evaluation, screening of constituents of potential concern (COPCs), and exposure assessment.

Risk Characterization — This step in the ERA process involves the evaluation of the likelihood of adverse ecological effects associated with exposure to the identified stressors, including a discussion of variability, uncertainties, and the strengths and weaknesses of the assessment. This step is comparable to *risk characterization* in the traditional human health risk assessment paradigm.

These steps are presented in detail in the following sections.

3.1 Problem Formulation

Problem formulation is a critical step in the ecological assessment and consists of a mix of information organization, planning, and technical analysis activities. As part of the problem formulation phase, the ecological conceptual site model (CSM) is developed to describe the potential stressors associated with site-related activities and how the stressors may potentially impact ecological receptors. Successful completion of problem formulation is governed by the quality of the following products:

Identification of primary sources of constituents associated with the site;

- Description of the primary pathways of these constituents through the environment;
- Selection of the primary ecological receptors exposed to these media;
- The completeness and accuracy of exposure pathways for each receptor; and
- Selection of assessment and measurement endpoints.

Based on the outcome of the ecological CSM, decisions related to the primary focus of an ecological investigation of risk are made. For the West Brine Field site, the focus was placed on the effects of chemical stressors on ecological receptors. The following sections define, in detail, the rationale behind why each chemical stressor and ecological receptor selected is judged significant for the West Brine Field site.

3.1.1 Ecological Site Characterization

The purpose of the site characterization is to identify and characterize important habitats and flora and fauna that potentially may be impacted by constituents at the site. Currently, the West Brine Field site is an undeveloped, 92-acre parcel of slightly vegetated to highly vegetated land surrounded by residential and light industrial areas. Bounding the site is a 7-foot high chain-link fence, which is intended to preclude entrance by unauthorized personnel and, most likely, restricts the movement of some ecological receptors into the site.

Vegetation at the site consists of a mosaic of the following community types:

- Lawn area
- Early successional field
- Scrub/shrub
- Woodland
- Aquatic/riparian

Lawn Area

The lawn area of the site is mowed regularly and is limited primarily to the peripheral regions of the site. These regions are dominated by a variety of grasses and weed species, and include some low growing shrubs and trees.

Early Successional Field

These areas are located in southern portion of the site and are dominated by herbaceous vegetation. Shrubs, including goldenrod *(Solidago spp.),* aster *(Aster spp.),* and common reed *(Phragrnites australis)* are prevalent in these areas. Early successional tree species common in

these areas include the box elder *(Acer negundo),* quaking aspen *(Populus trernuloides),* and red-*panicle dogwood (Cornus racemosa).*

Scrub/Shrub

Except for the perimeter, this vegetative community type is interspersed regularly throughout the West Brine Field site. Herbaceous shrubs and saplings identified in the early successional field areas are common in the scrub/shrub habitat.

Woodland

The northeastern portion of the site contains a wooded area consisting of overstory trees, with limited growth of saplings and other understory shrubs. Box elder is the dominant tree species in this area.

Aquatic/Riparian

This area consists of a portion of Huntington Drain and associated riparian habitat. Little or no vegetation grows within or along the banks of Huntington Drain, the only portion of the site that offers surface water (albeit, intermittently). Plant species similar to those identified in the early successional field, scrub/shrub, and woodland communities grow above the stream bank.

Wildlife observations taken during an on-site investigation in October 1996 revealed the presence of herbivorous mammals (rabbits, probably eastern cottontail *[Sylvilagus floridanus])* and omnivorous birds *(e.g.,* sparrows and juncos). No reptiles or amphibians were observed at the site during the investigation. According to a Michigan Natural Features Inventory database search for the area, no threatened or endangered species or ecologically sensitive communities were identified at the West Brine Field site.

3.1.2 Assessment Endpoints

Critical to a sound assessment of ecological risk is the appropriate selection of assessment endpoints, which are defined as "explicit expressions of [an] actual environmental value that is to

be protected, operationally defined by an ecological entity and its attributes" (US EPA, *Guidelines for Ecological Risk Assessment, 1998).* Selection of assessment endpoints for the West Brine Field ERA was based on the constituents present and their concentrations, the mode of toxicity of constituents to various receptors, the presence of sensitive or highly susceptible ecological receptors, and exposure pathway completeness (US EPA, *Ecological Risk Assessment Guidance for Superfund, 1997).*

Assessment endpoints may be selected at several levels of organization including individual, *population, and community levels (US EPA, Ecological Significance and Selection of Candidate Assessment Endpoints, 1996).* Because results of the Michigan Natural Features Inventory indicated no threatened or endangered species or ecologically sensitive communities at the West Brine Field site, individual level *(e.g.,* threatened or endangered species) endpoints are not relevant for this ERA. Furthermore, community-level assessment endpoints such as the "protection of the benthic invertebrate community" are often broad-based and do not define the ecological value of the endpoint in sufficient detail (US EPA, *Ecological Risk Assessment Guidance for Superfund, 1997).* Specific assessment endpoints associated with effects that can be applied to population-level measurement endpoints *(e.g.,* mortality, growth) and provide answers to specific risk questions are most pertinent for this ERA.

The portion of Huntington Drain at the West Brine Field site does not provide quality habitat for aquatic flora and fauna; thus, it does not present a suitable foraging area for terrestrial or semi-aquatic receptors. Results from Habitat Suitability Index (HSI) models used to determine the suitability of habitat types for a number of ecological receptors indicated that potential habitat does exist at the West Brine Field site for some terrestrial mammals and birds (Weston, *1999).* As a result, mammalian and avian receptors that reside and forage primarily in upland habitat were considered to be the most appropriate for quantitative risk analysis. Furthermore, the browsing and probing foraging nature of many species within these trophic groups may result in potentially high levels of soil ingestion. These groups are also likely to be at higher risk from potential bioaccumulative effects stemming from ingestion of terrestrial organisms and soil-dwelling vegetation. Consequently, the primary assessment endpoints for this investigation are:

- the protection of mammalian herbivore populations from adverse effects associated with constituents in site-related media; and

- the protection of avian omnivore populations from adverse effects associated with constituents in site-related media.

HSI modeling results indicated that the availability of breeding sites for mammalian omnivores such as the raccoon *(Procyon lotor)* was extremely limited, thus it is highly unlikely that the West Brine Field Site is capable of supporting populations of these animals (Weston, 1999). Consequently, species belonging to the mammalian omnivore foraging guild are not relevant to the site and as such were not selected for quantitative exposure assessment.

3.1.3 Ecological Receptors of Concern

Identification of ecological receptors of concern was the first step in defining species-specific assessment endpoints. These species types were selected because they possess attributes that are potentially at risk and reflect meaningful assessment criteria. In other words, they possess measurable attributes that can be evaluated to assess particular aspects of both population-level characteristics and community function. These species are also widely distributed and span a broad range of taxonomic groups and community function *(i.e.,* standing in the food chain, foraging habits, *etc.).*

The surrogate ecological receptors selected for quantitative analysis included the white-tailed *deer (Odocoileus virginianus),* the meadow vole *(Microtus pennsylvanicus),* and the American robin *(Turdus migratorius).* The following sections provide a brief overview of the habits and life history of the selected indicator species as well as the rationale for their inclusion in the ERA for the West Brine Field site.

White-Tailed Deer *(0docoi1eus virginianus)* — The white-tailed deer is the most abundant big-game mammal in the United States and can be found in a diversity of habitats such as meadows, thickets, riparian areas, and urban locales. Because of its cosmopolitan distribution in Michigan and throughout the United States and its capacity to dwell or forage in a variety of upland and

lowland habitats, the white-tailed deer is susceptible to a variety of potential exposure sources. As such, the white-tailed deer was selected as a receptor for this investigation and was considered representative of other large terrestrial herbivores potentially present at the site. Exposure routes for the whitetailed deer included ingestion of surface water and vegetation, as well as incidental ingestion of soil and sediment.

Meadow Vole *(Microtus pennsylvanicus)* — Meadow voles are herbivorous rodents that live in a wide variety of habitats and therefore could be found potentially in many areas of the site. Individuals reach maturity within several weeks after birth. The mean litter size is approximately six pups; however, litter size varies tremendously with age and latitude. Females generally produce several litters per year. Mortality rates are generally very high and individuals typically do not live for more than 1 year. Meadow voles tend to consume mostly herbaceous vegetation and often fall prey to carnivorous animals; thus, they provide a suitable trophic link between soil, sediment, and surface water exposures and upper trophic level organisms. Furthermore, their small size translates into higher susceptibility to residual chemical concentrations. Potential routes of exposure include incidental soil and sediment ingestion, surface water ingestion, and ingestion of soil-dwelling plants.

American Robin *(Turdus migratorius)* — The American robin is a medium-sized migratory member of the thrush family (Muscicapidae). This species is typically found in a range of habitats including open woodlands, moist forests, hedges, gardens, and urban parks. Nests are constructed of mud and fine grasses and may be found on the ground or in treetops. Three to 6 pastel blue eggs are laid during the breeding season, which generally spans from April to July. Robins usually winter in the southeast United States, but some populations may remain in the northern latitudes during the winter season. As such, year-round exposure to chemical constituents at the West Brine Field site is assumed for this species. The diet of the American robin consists of soil-dwelling invertebrates *(e.g.,* earthworms), as well as fruits, seeds, and grasses. Relevant exposure pathways for the American robin include incidental ingestion of soil and sediment, ingestion of surface water, ingestion of terrestrial invertebrates, and ingestion of vegetation.

The white-tailed deer, meadow vole, and American robin are expected to forage in upland areas because the ecological value of Huntington Drain is extremely limited. Water quality and flow are greatly reduced during dry periods, and little or no riparian vegetation is present (Weston, 1999). As a result, ingestion of vegetation by the white-tailed deer and meadow vole and consumption of invertebrates and vegetation by the American robin are expected to occur within the lawn, field, scrub/shrub, and wooded areas of the site. Conservative exposure assumptions for each of these receptors should produce exposure estimates representative and sufficiently protective of other species comprising their respective trophic guilds.

3.1.4 Measures of Effect

Measures of effect are measurable responses to a stressor that are related to the valued characteristics chosen as assessment endpoints (US EPA, *Guidelines for Ecological Risk Assessment,* 1998). Assessment endpoints generally refer to broader characteristics of populations and ecosystems; however, it is usually impractical to measure changes in these characteristics as part of an assessment. Consequently, the appropriate measures of effect are those measurement endpoints that can be measured and extrapolated to predict effects on *assessment endpoints (US EPA, Guidelines for Ecological Risk Assessment,* 1998).

The measures of effect selected for this assessment are No-Observable-Adverse-Effect-Levels (NOAELs). NOAELs are constituent levels at which an entire test population exhibited no observable adverse effects. NOAEL values are generally extremely conservative, and in many cases, grossly underestimate the actual threshold dose below which no adverse effect is observed. The white-tailed deer, meadow vole, and American robin are abundant locally and nationally; thus, less conservative measures of effect are probably more appropriate because protection of the population rather than individual organisms is the primary focus of the assessment endpoint. The US EPA recognizes that the primary concern in an ecological risk assessment is the health of the population, not of the weaker, more sensitive individuals within a *population (US EPA, Supplemental Risk Assessment Guidance for the Superfund Program, Part 2:*

Guidance for Ecological Assessment, 1 989c). To maintain conservatism, however, NOAEL values were used as measurement endpoints for this assessment.

NOAELs selected for both the white-tailed deer and the meadow vole are based upon systemic effects induced in a range of mammals, primarily mice and rats (Tables *25* and *26);* consequently, these literature-derived measures of toxic effect must be appropriately modified to account for differences in body mass. For mammals, an equivalent dose level based on body weight allometry follows the relationship:

$$\text{NOAEL (mg/kg - day)} = \text{NOAEL1} \left| \frac{\text{bwt "}}{\quad} \right. \qquad \text{(Sample } \textit{et al., 1996)}$$

where:

NOAELW		NOAEL for wildlife receptor species (mg/kg-day);
NOAEL	=	NOAEL for test species (mg/kg-day);
bw	=	body weight of test species (kg); and
bw	=	body weight of wildlife receptor species (kg).

Toxicity values for the American robin are shown in Table *27.* In a study by Mineau *et al. (1996),* body weight-based scaling factors for several avian species exposed to a range of compounds were not statistically different from 1.0. Therefore, measures of effect between taxonomically distinct birds do not require allometric modification. In other words:

$$\text{NOAELW} = \text{NOAEL} \qquad \text{(Sample } \textit{et al., 1996)}$$

For each COPC, care was taken to select a measurement endpoint *(e.g.,* NOAEL) that reflected the same exposure route (oral exposure) as the assessment endpoint it represents, as mandated under US *EPA guidance (US EPA, Ecological Risk Assessment Guidance for Superfund, 1997).*

3.1.5 Ecological Conceptual Site Model

Potential environmental stressors at the West Brine Field site include inorganic and organic constituents that may be associated with historic site operations and practices. Such constituents

may remain at their point of origin or, more likely, may be dispersed and deposited into various media in the surrounding area. Source areas identified at the West Brine Field site include *5* Solid Waste Management Units (SWMUs) formerly used as landfills or disposal areas. The areas of concern at the West Brine Field site include upland (soil) habitat and riparian habitat, thus environmental media potentially assessed in this investigation relevant to ecological receptors are soil, sediment, and surface water.

To afford the reader a better understanding of potential exposure pathways, exposure routes, and potential ecological receptors, a general schematic of exposure scenarios is presented in Figure 3. As shown in this figure, there are several possible routes by which constituents and ecological receptors can be linked. Constituents may migrate from point sources into surrounding surface water, sediment, or soil. Once in soil, constituents may migrate to surface water through surface soil erosion or through the shallow-water bearing zone of the brown clay stratigraphic layer present at the site. Because the topography of the site is flat, erosional processes are predicted to be negligible. Moreover, because the hydraulic gradient and conductivity are low, transport of constituents from groundwater to the Huntington Drain and associated riparian habitat is considered inconsequential (Weston, 1999). Although the Phase I RFI states that any contribution of site-related constituents from storm water runoff is minimal, the Huntington Drain, being at a lower elevation than the majority of the site, may serve as the primary receiving area for transported surface soil during intense storm events. To conservatively account for the potential risks from exposures to all ecologically relevant media, direct measurements for sediment and surface water, as well as for soil, have been collected. These data reflect actual site conditions after erosion and sediment-surface water partitioning processes have taken place, and were utilized appropriately in this ERA.

The US EPA defines an ecological component as any portion of an ecological system *(Framework for Ecological Risk Assessment,* 1992). In general, both aquatic and terrestrial resources represent the ecological components potentially affected by environmental stressors. Aquatic faunas include aquatic (small fish and invertebrates) and semi-aquatic (amphibians, reptiles, birds, and mammals) animals found in and around rivers, streams, lakes, ponds, and

wetlands within the assessment area. Similarly, terrestrial faunas (reptiles, birds, and mammals) are those animals present in forested and non-forested upland habitats. As mentioned previously, there is no historic evidence that the portion of Huntington Drain at the West Brine Field site provides a potential habitat or nursery area for ecologically important species. As such, the potential for ecological risk to the aquatic community was not considered in this study; however, the ecological risks posed to terrestrial species from ingestion of surface water and sediment were evaluated.

Based on current conditions at the site, ecological may contact surficial soils in upland portions of the site and sediment and surface water within or along Huntington Drain. Receptors may be exposed directly to potentially affected media through dermal contact, inhalation, or incidental ingestion, or indirectly through potentially affected food items. Ecological exposure through dermal and inhalation pathways is generally considered insignificant and not a typical component of an ecological risk assessment (Sample *et al.,* 1997). Consequently, this ERA focused on the ingestion of surface water and incidental ingestion of soil and sediment as direct exposure pathways and ingestion of food items as the primary indirect exposure pathway.

3.2 Analysis Phase

3.2.1 Data Evaluation

Soil, sediment, and surface water analytical data used in this assessment were collected by Roy F. Weston, Inc. during the summer of 1999. Soil samples were collected at non-regular increments downward beginning at a dcptii of 1--foot•--belowground surface (bgs). Soils most applicable for an analysis of ecological risk are those in the uppermost horizons. Although the SWMUs at the site have been covered with *0.5-2* feet of topsoil, which does not pose a risk to wildlife, it is possible that potential future activities at the site *(e.g.,* construction, *etc.)* could mix surface soils with subsurface soils. Consequently, analytical data from the 1-3 foot bgs range were used as the basis for statistical and ecological exposure analysis. Analytical data related to sediments were collected from depths of 0-0.5 feet bgs.

The laboratory data were compiled into media-specific data sets representing soil, sediment, and surface water. Each data set was analyzed statistically using SiteStat®, a commercially available software package, to calculate the minimum, maximum, arithmetic mean, logarithmic mean, standard deviation, and the 95% upper confidence limit of the mean concentration (95% UCL) for each constituent based on distributional analyses of the data. Summaries of the statistical analyses for each exposure medium are presented in Tables 28 through 30.

In many instances, data for a specific constituent contained a number of non-detections ("U" entries). In such cases, a constituent was conservatively assumed to be present in the sample at a concentration equivalent to one-half of the sample quantitation limit (SQL), unless the SQL exceeded the maximum detected concentration.

3.2.2 Screening of Analytical Data

Residual levels of constituents found in each applicable environmental medium were evaluated based on the potential to cause adverse toxicological effects. A comparison of maximum concentrations to criteria derived for toxicity screening purposes was conducted to determine whether a quantitative assessment of ecological risk was necessary. If a constituent was not detected in a given medium, then it was considered to be of *"de minimis"* risk and was eliminated from further analysis. Likewise, if the constituent of interest was present at a concentration below a conservative screening criterion, it was not carried forward in the risk assessment; if the maximum concentration of a constituent was greater than the applicable benchmark, the constituent was considered a COPC and retained for quantitative exposure assessment. Any constituent for which a screening criterion was not available was retained as a COPC.

To develop a list of COPCs for quantitative risk analysis, maximum soil, sediment, and surface water concentrations were screened against appropriate US EPA Region *5* Ecological Data Quality Levels (EDQLs) (US EPA Region *5, RCRA Quality Assurance Project Plan* Instructions, 1998). These values are regarded as highly conservative criteria derived for protection of a broad range of species across an array of trophic guilds. Soil EDQLs were used for comparison with shallow-depth soil concentrations, however these benchmarks were not

available for all COPCs. In the absence of soil EDQLs, values developed by Oak Ridge National Laboratory (ORNL) were used for comparative purposes. These effects-based benchmarks were compiled by ORNL for the protection of earthworms and soil microorganisms (Efroymson *et al.*, 1997) and are endorsed by US EPA Region 4 for screening potentially affected soils (US EPA, *Region 4 Memorandum,* 1998). The results of the soil, sediment, and surface water screening processes are presented in Tables 31 through 33.

3.2.3 Exposure Point Concentration

The exposure point concentration is the concentration of a given constituent where an ecological receptor comes into potential contact with the chemical. In accordance with US EPA guidance (US EPA, *Risk Update,* 1994), the *95%* UCL of the arithmetic mean for each COPC was utilized as the exposure-point concentration. Both the normal and logarithmic *95%* UCLs were calculated for each COPC. A goodness-of-fit test was performed on the data and the most appropriate distribution type was selected. If the data distribution could be characterized as either normal or lognormal, the appropriate *95%* UCL value was selected for use in calculating receptor exposure. In accordance with US EPA guidance, if the distribution type was unknown, the log ***95%*** UCL was selected.

In the statistical analysis of COPCs, the *95%* UCL may exceed the maximum concentration detected for certain constituents due to sample size or to elevated detection limits resulting from dilutions for several samples. Therefore, in circumstances where the maximum concentration is lower than the *95%* UCL, the maximum concentration was used as the exposure-point concentration *(US EPA, Risk Assessment Guidance for Superfund, Part A,* 1989b; *Supplemental Guidance to RAGS: Calculating the Concentration Term,* 1992).

3.2.4 Exposure Assessment

Characteristics of terrestrial and semi-aquatic ecological receptors such as habitat needs, food preference, reproductive cycles, seasonal activities such as migration, and selective use of resources influence their exposure to constituents. These factors were considered in the exposure assessment to further refine species-specific intake rates. The following general equation

incorporated these factors and was utilized in the ERA to estimate a mass-specific, time-weighted average intake for each medium or food source:

$$\text{Intake (mg/kg - day)} = \frac{C \times IR \times EF \times SFF}{BW}$$

where:

C		chemical exposure point concentration *(e.g.*, mg/kg or mg/L);
JR	=	foodlwater intake rate (kg/day or L/day);
EF	=	exposure frequency (expressed as an areal proportion);
SFF		site foraging factor (unitless); and
BW	=	body weight of exposed individual (kg).

The following sub-sections describe the species-specific exposure parameters incorporated into the white-tailed deer, meadow vole, and American robin exposure models.

3.2.4.1 Exposure Frequency

The exposure frequency (EF) describes the number of times per year an exposure event is likely to occur and is often expressed in days per year. In this assessment, however, exposure frequency is expressed as a proportion of time spent in a particular habitat or exposure area based on the intrinsic characteristics of the site and the tendency of receptors to be found in habitats provided at the site. As a conservative measure, In other words, a receptor is conservatively assumed to be present in a soil-associated habitat, sediment-associated habitat, or a combination of these habitats every day of its lifetime because of the suitability of these habitats for providing forage, shelter, and other life requisite parameters. The percentage of time spent in each exposure medium is a function of the total area of each habitat at the site.

The EF value for the white-tailed deer, meadow vole, and American robin was obtained by measuring the areal coverage of the habitats of concern and determining the percentage that each contributes to the total area (Figure 4). Based on the "generalist" life requirements and behaviors of these receptors, each may be found in a variety of habitats, from upland areas to aquatic systems. An aerial assessment of the site using Computer Assisted Design (CAD) techniques determined that upland habitat represents approximately 99% of the West Brine Field site.

Upland areas are conservatively assumed to contain soil-associated habitats that are wholly available for habitability by ecological receptors. Sediment-associated habitat offered by Huntington Drain comprises approximately 1% of the site. If it is assumed that the white-tailed deer, meadow vole, and American robin utilize these habitats with a frequency directly related to their areal coverage, then the frequency of exposure to soil is 0.99 and the frequency of exposure to sediment is 0.01.

3.2.4.2 Site Foraging Factor

The site foraging factor (SFF) accounts for the proportion of time that an organism spends at the site during the time period of possible exposure. This factor discounts the exposure time by a ratio of the size of site to the home range of each receptor. For the white-tailed deer, a midpoint home range of 715 acres is reported in Sample and Suter (1994). This value is consistent with the findings of other profiles for this species (Merritt [1987] reported a home range of 321 to 1,628 acres). The home range for the white-tailed deer is greater than the total area of the site (92 acres); thus, the white-tailed deer is expected to forage at the West Brine Field site only 13% of the time (=92/7 1 *5).* It should be noted that exit and entry by deer is expected to occur to some extent at the site despite the chain link fence surrounding the property (field observations indicate that sections of the fence do allow passage of large-bodied mammals). For the meadow vole and the American robin, home ranges are significantly less than the total area of the site. Consequently, the SFF for these receptors was set equal to 1.0 (100%).

3.2.4.3 Body Weight

For the white-tailed deer, a body weight of 56.5 kg was extracted from Sample and Suter (1994). Mean body weights for the meadow vole (0.036 kg) and the American robin (0.08 kg) were obtained from a series of studies described in US EPA's *Wildlife Exposure Factors Handbook* (US EPA, 1993).

3.2.4.4 Food Chain Exposure

Transfer of constituents from the site-related media to the biotic components of the West Brine Field site is anticipated to occur primarily through the ingestion pathway because the contribution to the overall exposure for ecological receptors from inhalation and dermal pathways is often negligible (Mayernik and Fehrenkamp, 1992). Ingestion routes that were assessed quantitatively include direct ingestion of a given COPC in soil, sediment, and surface water and indirect ingestion of a COPC as it moves through the terrestrial food chain. Soil and sediment ingestion are assumed to be incidental; that is, small amounts of these media may be ingested during foraging bouts or during washing or preening activities.

Food Ingestion

A vital step in estimating exposure rates for terrestrial wildlife is the calculation of food ingestion rates. For the white-tailed deer, Sample and Suter (1994) report a food ingestion rate of 1.7 kg/day. For the meadow vole, US EPA's *Wildlife Exposure Factors Handbook (US* EPA, 1993) provides an allometric equation, from Nagy (1987), to estimate food intake based on body mass, as follows:

$$Fl\ (kg/day) = 0.0687\ (BW^{0.822})$$

where:

Fl	=	food intake rate (kg/day); and
BW	=	body weight (kg).

White-tailed deer, meadow voles, and American robins are anticipated to forage in varying degrees on vegetation at the site. Bioaccumulation of COPCs from plant ingestion was evaluated based on chemical-specific plant tissue concentrations. A steady-state plant concentration resulting from soil-to-plant transfer of COPCs was calculated according to the following algorithm:

$$C_{piant} \qquad UF$$

where:

C_{plant} = chemical-specific plant tissue concentration (mg/kg-dry weight);
Cs = concentration in soil (mg/kg); and
UIF_S. = soil-plant uptake factor (unitless).

Soil-plant uptake factors for inorganic chemicals were extracted from Baes ci' at. (1984) and Bechtel Jacobs (1998). These values correspond to uptake of inorganic elements by aboveground portions of plants *(i.e.*, those tissues anticipated to be consumed by receptors in this assessment). For organic compounds, uptake by plants is inversely proportional to the square root of a constituent's octanol-water partition coefficient (K) and follows the relationship:

$$\log UIF, = 1.588 - 0.578(\log K) \quad \text{(Travis and Arms, 1988)}$$

For the omnivorous American robin, a food ingestion rate of 0.011 kg/day was calculated based on avian body weight allometry:

$$FT = 0.05\,82\,(BW^{651}) \quad \text{(Nagy, 1987)}$$

To account for the bio transfer of organic COPCs in soil to terrestrial invertebrate prey, uptake factors directly correlated with a constituent's K_0 were utilized. Uptake of organic constituents by invertebrates from soil follows the relationship described in Connell (1990):

$$= 0.44\,K_0^{\circ\circ 5}$$

where:

= soil-to-invertebrate uptake factor (unitless).

For inorganic elements, soil-to-invertebrate uptake factors were obtained from Roberts and Dorough *(1985),* Beyer and Stafford (1993), and Sample *etal.* (1998).

Water Ingestion

Water ingestion rates for the white-tailed deer, meadow vole, and Am
calculated from methodologies described in US EPA's *Wildlife Exposure Factors Handbook (U* EPA, 1993). For mammalian species for which empirical drinking water data are unavailable, this document provides an allometric equation to estimate water intake as a function of body mass (Calder and Braun, 1983), as follows:

$$WI\ (kg/day)\ 0.099\ (BW^{\circ 90})$$

where:

WI	=	water intake rate (kg/day); and
BW	=	body weight (kg).

For the American robin, water ingestion was calculated as follows:

$$WI\ (kg/day) = 0.059\ (BW^{\circ 67}) \qquad \text{(Calder and Braun, 1983)}$$

Soil/Sediment Ingestion

Species-specific soil ingestion rates for both the white-tailed deer and the meadow vole were available from Beyer *et al.* (1994). A soil ingestion rate for the American robin could not be located from the literature. During the pre-breeding and breeding seasons, robins forage in a manner very similar to that of the American woodcock: both species probe the soil in search of earthworms and other terrestrial invertebrate prey. As such, the estimated proportion of soil in the diet of the American woodcock, described in Beyer *et al.* (1994), was used as a surrogate measure of soil ingestion for the American robin. For the purposes of this ERA and to maintain conservatism, sediment was assumed to be ingested at the same rate as that for soil for all three receptors.

3.2.4.5 Bioaccumulation

Bioconcentration, bioaccumulation, and biomagnification were considered in calculating wildlife exposure rates. Typically, these factors are considered when evaluating risks posed to aquatic organisms because of their close association with both sediment and surface water. Because this ERA focuses on possible impacts to terrestrial organisms, potential accumulation of constituents in herbivorous and omnivorous biota was assessed according to terrestrial-based uptake factors, described in Section 3.2.4.4 and below. Bioconcentration, bioaccumulation, and biomagnification are defined as follows:

- *Bioaccumulation* is uptake and retention of a substance by an organism from its surrounding medium and food (US EPA, *Final Water Quality Guidance for the Great Lakes System,* 1995), resulting in an increase in the concentration of a constituent over time compared to the constituent's concentration in the environment. Compounds accumulate in biota when they are taken up and stored faster than they are broken down (metabolized) or excreted.

- *Bioconcentration* is the specific bioaccumulation process by which the concentration of a chemical in an organism becomes higher than its concentration in the air or water around the organism. In fish, bioconcentration occurs primarily during the intake of water through the gills. Bioconcentration is restricted to the accumulation of chemicals from environmental media by nondietary routes.

- *Biomagnification* occurs when a constituent becomes more and more concentrated as it moves up through a food chain. That is, the concentration increases as the constituent passes through the dietary linkages from single-celled plants to increasingly larger animal species. Each step results in increased bioaccumulation *(i.e.,* biomagnification). Consequently, animals at the top of the food chain may accumulate a much greater concentration of constituent than was present in organisms lower in the food chain.

Bioconcentration and bioaccumulation result from a dynamic equilibrium between exposure from the ambient environment and uptake, excretion, storage, and degradation within an organism. The degree of bioaccumulation depends on:

- physical properties of a constituent (such as solubility in either water or fat);
- the concentration of a constituent in the surrounding media;
- the amount of constituent coming into an organism from the food, air, water, or other incidental sources;
- the physical characteristics of the ecosystem (organic carbon content, pH, *etc.);*
- the ability of the organism to degrade and excrete a particular chemical; and
- the time it takes for the organism to acquire the chemical, metabolize it, and then excrete, store, andlor degrade it

To account for the possibility of bioaccumulation, bioconcentration factors (BCFs) and bioaccumulation factors (BAFs) are often compiled from primary literature sources or derived from field or laboratory studies. The soil-plant and soil-invertebrate uptake factors described in Section 3.2.4.4 are measures of bioconcentration in upland plants and invertebrates (earthworms) and are, thus, analogous to terrestrial BCFs. These factors represent the ratio of the concentration of chemical in the plant (or worn-i) to the concentration of chemical in the surface soil. Uptake (bioconcentration) factors for chemicals retained for ecological exposure analysis are provided in Table 34.

As shown in Table 34, uptake factors for most chemicals are less than 1.0, suggesting minimal or no biomagnification. Some metals *(e.g.,* cadmium, mercury, and zinc) are expected to bioaccumulate to a small degree from soil to earthworms; however, SVOCs and VOCs are not. Conversely, soil-plant biomagnification is anticipated to be unimportant for metals, but may occur to a limited extent for some SVOCs and VOCs (Table 34).

3.3 Risk Characterization

Risk characterization utilizes the results of the analysis phase to estimate risk to the ecological receptors identified in the problem formulation phase. Evaluation of the likelihood of adverse ecological effects associated with exposure to the identified stressors, including a discussion of the strengths and weaknesses of the assessment, are included in this section. The format for quantitative risk estimation for this assessment involves the construction of a ratio of the chemical-specific exposure-point concentration and a literature-derived toxicity endpoint (NOAEL) to create an ecological hazard quotient (EHQ).

3.3.1 Risk Description

The EHQ method can be utilized to estimate impacts at both the individual and population level. Quotients of varying magnitude are generally interpreted as follows:

Quotient < 1	No significant impact is indicated.
Quotient> 1	Potential ecological threat at the individual level; a threshold of no observed adverse effect has been exceeded. These values do not indicate that an adverse ecological threat has occurred at either the individual or population level; these values indicate only that it is possible and should be evaluated in more detail.
Quotient> 10	Potential ecological threat at the population level. T

Hazard quotients based on all applicable routes of exposure for the white-tailed deer, meadow vole, and American robin are presented in Tables 35 through 47. To determine the total hazard posed to these receptors from each pathway, individual hazard quotients were summed to arrive at a hazard index (HI). Pathway-specific HIs were then added to obtain a total measure of risk to each species from all exposure routes (Table 48). Constituents contributing the majority of ecological risk to the receptors of concern are also indicated in Table 48.

3.31.1 Risks to White-Tailed Deer

Based on ecological hazard indices calculated for the soil, sediment, and surface water ingestion exposure pathways, no unacceptable risk is predicted to white-tailed deer (Tables *35, 36,* and *37).* Based on a conservative modeling approach, marginal risk is predicted from the ingestion of soil-dwelling vegetation (Table 38). Food (vegetation) ingestion risk to the white-tailed deer is driven largely by phenol, which was detected at relatively high surface soil concentrations (to 15,500 mg/kg) in SWMU 4. Other than those taken from SWMU 4, only 2 surface soil samples indicated positive detections of phenol: one at SWMU 1 (1,200 mg/kg), and one at SWMU 3 *(57* mg/kg). Impacts to deer via this exposure pathway suggest the potential for individual-level effects but not population-level effects.

3.3.1.2 Risks to Meadow Vole

Hazard quotients for the meadow vole from the incidental ingestion of sediment and surface water ingestion indicate negligible risks from these exposure pathways (Tables 40 and 41). For the incidental soil ingestion pathway, the hazard index exceeded the acceptable ecological benchmark of unity (HI = 4.73) (Table 39). Ninety-seven (97) percent of the predicted risk from soil ingestion is attributable to aluminum (HQ *4.57);* however, it is not believed that aluminum levels in site soils constitute a threat to individual meadow voles, based on the following rationale. Aluminum is ubiquitous in natural systems and is the third most abundant element in the earth's crust, exceeded only by oxygen and silicon. The mean aluminum concentration in surficial soils of undisturbed regions of the conterminous United States averages 72,000 mg/kg (Shacklette and Boerngen, 1984), almost 4 times higher than the maximum concentration detected at the West Brine Field site (19,900 mg/kg). Although aluminum is often present in high concentrations in the environment, it is unlikely that residual levels of aluminum have the potential to cause significant adverse effects. To derive an effects-based toxicity threshold for aluminum, the toxicological study used for comparative purposes in this ERA administered doses of aluminum chloride (Aid_3), a soluble bioavailable aluminum salt, in water to mice (Ondreicka *et al.,* 1966). Aluminum in soils, however, tends to be either adsorbed to organic ligands or bound up in clays and minerals as oxides, hydroxides, and phosphates (Dragun, 1988).

As such, aluminum is not generally bioavailable and is highly unlikely to pose a risk to wildlife. Based on these considerations, the risk to the meadow vole (and American robin — see Section 3.3.1.3) from aluminum in surface soils is expected to be insignificant.

The level of risk calculated for meadow voles from consumption of upland vegetation suggests potential population-level effects (Table 42). The majority of this risk *(75%)* is attributable to surface soil concentrations of phenol in SWMU 4. Other COPCs contributing to the total vegetation ingestion risk include aluminum (13%) and methylene chloride (3%).

3.3.1.3 Risks to American Robin

Five exposure pathways were evaluated for the American robin: two pathways present risks within acceptable levels (incidental ingestion of sediment, ingestion of surface water), one pathway indicates potential risk to individual robins (incidental ingestion of soil), and two pathways indicate potential-level hazards (ingestion of soil-dwelling vegetation, ingestion of soil-dwelling invertebrates). Although the overall risk level for soil ingestion indicates potential individual-level hazards, no single COPC has a hazard quotient greater than 1.0 (Table 43). As with the white-tailed deer and meadow vole, risk to the robin from the consumption of vegetation is chiefly attributable (87%) to the presence of phenol in SWMU 4 surface soils. Other COPCs contributing to the vegetation ingestion risk to the American robin include methylene chloride, n-nitrosodiphenylamine, n-nitrosodiethylamine, antimony, and naphthalene(see table below).

COPC	**Hazard Quotient**
Phenol	116
Methylene chloride	5.24
N-Nitrosodiphenylamine	4.22
N-Nitrosodiethylamine	4.03
Antimony	1.47
Naphthalene	1.25

In addition to phenol, the maximum concentrations of methylene chloride, n-nitrosodiphenylamine, and naphthalene also are located in SWMU 4. Risk posed to the robin from ingestion of vegetation is primarily attributable to antimony and is based on a single sitewide detection of this element in SWMU 1 surface soil. Risk to the robin from this pathway from n-nitrosodiethylamine is attributable to a single detection of this constituent in SWMU 7.

COPC-specific and cumulative risks to the American robin from ingestion of soil invertebrates are shown in Table 47. Hazard quotients for 7 COPCs exceeded unity; these chemicals are indicated in the table below.

COPC	**Hazard Quotient**
Thallium	21.4
Phenol	10.2
Antimony	6.86
Zinc	3.44
N-Nitrosodiphenylamine	2.53
Naphthalene	1.74
Chromium	1.61

Noteworthy is that the maximum surface soil concentration of phenol, n-nitrosodiphenylamine, and naphthalene, which in each case is responsible for the elevated prey ingestion risk for these COPCs, is in SWMU 4. Similarly, invertebrate ingestion risks associated with thallium and antimony are associated with a single detection of each element in SWvIU *3* and SWMU 1 surface soils, respectively. It should be noted that the detectable thallium in SWMW 3 was at a concentration *below* that of background levels. All other surface soil samples analyzed for antimony and thallium are below their respective laboratory analytical detection limits. The maximum detected surface soil concentration of chromium at the West Brine Field site (32 mg/kg) is slightly more than half the *average* concentration in typical surficial soils of the United States (54 mg/kg) (Shacklette and Boerngen, 1984). The maximum concentration of zinc at the site (315 mg/kg) is higher than the U.S. surface soil average (60 mg/kg); however, the

logarithmic mean site concentration (81.6 mg/kg) is only slightly higher than the reported mean value for undisturbed sites.

Exposure to soil constituents by the American robin is, in all likelihood, much lower than predicted in this ERA. The ground in Michigan is typically frozen for several months of the year; therefore, foraging for soil dwelling insects by robins is anticipated to be minimal during these months. Moreover, American robins are highly migratory and only rarely do individuals overwinter in northern latitudes of the United States.

3.3.2 Uncertainty Analysis

To address uncertainty associated with ecological toxicity data, the ERA utilized the generally accepted approach of applying uncertainty factors for deriving toxicological benchmarks. Toxicological benchmarks specific to the white-tailed deer, meadow vole, or American robin could not be located from the literature. Thus, for each receptor of concern, it was necessary to obtain NOAELs from studies conducted on test or surrogate species. When NOAEL data were unavailable, an uncertainty factor was used to derive an NOAEL from Lowest-Observable-Adverse-Effect-Level (LOAEL) data or acute toxicity (LD_{50}) data, in accordance with US EPA guidance and other recommended sources (Calabrese and Baldwin, 1993; Ford *et al.*, 1993; US *EPA, Final Water Quality Guidance for the Great Lakes System, Final Rule, 1995).*

Some level of uncertainty should also be addressed appropriately in the ecological exposure assessment. For example, to derive an average daily intake for ingestion of vegetation and/or soil invertebrates to selected ecological receptors, the implementation of chemical-specific uptake factors in the appropriate exposure models was required. In these models, surface soil concentrations were multiplied by an empirically derived or calculated uptake factor in order to obtain *in vivo* concentrations of chemicals in plants or invertebrates (see Section 3.2.4.4). Whether empirically generated or calculated (from chemical-specific octanol-water partitioning coefficients), uptake factors represent a significant source of "model uncertainty" (US EPA, *Guidelines for Exposure Assessment,* 1992) because they are derived according to best-fit regression models that do not take into account various site-specific variables that may

profoundly impact a chemical's bioavailability *(e.g.,* pH of the matrix, chemical state, *etc.).* This uncertainty can be manifest as an inherent bias in either a more conservative or less conservative direction. It should be noted that for some constituents such as thallium and antimony, which are two drivers in the invertebrate ingestion risk to the robin, no data are available on chemical uptake from soil by soil invertebrates'. As such, results from food-chain exposure models must be interpreted with caution.

Uncertainty in the ERA is also manifested in the extrapolation of dose responses from surrogate species to those of the target species. The mammalian scaling algorithm discussed in Section 3.1.4 and recommended by Sample *et al.* (1996) is intended to account for taxonomic dissimilarities based on body size. While toxicity has generally been shown to bear an allometric relationship to body weight raised to the *0.75* power in mammals, interspecies differences in the uptake, distribution, and metabolism for some chemicals may "behave" according to different mathematical functions (Mineau *et al.,* 1996).

Available toxicity data often are derived from laboratory testing, which introduces uncertainty associated with extrapolation from a laboratory setting to a field setting. In addition, information for many exposure parameters such as avoidance behavior, species-specific absorption of food and constituents through the gut, bioavailability of a constituent according to its form, and potential biotransformation of a constituent is generally not attainable. Therefore, in this ERA, avoidance and biotransformation is assumed to be negligible whereas constituent absorption through the gut and bioavailability are assumed to be 100%. These assumptions are conservative and should result in an overestimation of risk related to these parameters. Summing across multiple COPCs is also highly conservative because individual chemicals often have specific mechanisms of toxic effect or may target distinct target organs.

A value of 1.0 was assumed for thallium and antimony in assessing chemical uptake by soil invertebrates.

3.4 Scientific/Management Decision Point

The results of the ERA indicate that no unacceptable risks are posed to populations of white-tailed deer from exposure to residual concentrations of inorganic and organic constituents in surface soil, sediment, or surface water at the West Brine Field site. In addition, no unacceptable risks to meadow voles or American robins are predicted from sediment and surface water exposure. Hazard indices suggest the potential for adverse effects to populations of meadow voles and American robins from the ingestion of upland vegetation, owing primarily to surficial soil concentrations of phenol in SWMU *4.* Potential population-level hazards are indicated for the American robin from the ingestion of soil invertebrates. These risks are primarily attributable to thallium, phenol, and antimony. As discussed in Section *3.3.2,* a significant source of uncertainty in the West Brine Field ERA is inherent in the modeling of food chain exposures. Based on the uptake factors utilized in the exposure assessment, potential food chain risks to the selected ecological receptors are considered unacceptable at either the individual or population level, with phenol driving the majority of the risks. US EPA's Office of Solid Waste, however, categorically ranks the persistence and aquatic and terrestrial bioaccumulation potential of phenol as "low", according to a ranking system of "low", "moderate", or "high" (US EPA, *Data Requirements and Confidence Indicators for Ecological Benchmarks Supporting Exemption Criteria for the Hazardous Waste Identification Rule, 1999).* The same documents ranks the terrestrial bioaccumulation potential of thallium and antimony, risk drivers in the soil invertebrate ingestion pathway, as "moderate". Furthermore, thallium detected in surface soils at the site was at a concentration below that of background. Thus the risk levels developed for West Brine Field food chain exposures from these constituents are, in all likelihood, higher than the levels of risk actually incurred. Moreover, the risk estimates assume that the receptors present are maximally exposed, and will not avoid "hot spots" by moving to areas of lower concentration. Phenol, for example, has an acrid, sickenly sweet odor that is perceptible in the air at extremely low concentrations (ATSDR, *1988).* Consequently, it is expected that animals at the West Brine Field site will actively avoid areas with surface soils containing high concentrations of phenol *(e.g., SWMU 4).*

Realistic hazards associated with aluminum in soils to ecological receptors are considered negligible based on the low bioavailability of this metal as well as the comparability of West Brine Field concentrations to typical concentrations from undisturbed sites across the United States. Thus, the overall risk from aluminum are considered insignificant. Like aluminum, elemental concentrations of zinc and chromium in surface soils suggest potential individual-level risk to the robin (soil invertebrate ingestion pathway, Table 47). When put into perspective, however, these risks are generated from concentrations considered to be near or below typical concentrations found across the United States (see table below). As such, it is highly unlikely that chromium or zinc pose a real ecological threat to ecological receptors at the West Brine Field site.

	Soil West Brine Field		Natural Surficial Soils Conterminous United States	
Element	Mean* (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	Range (mg/kg)
Al	11,800	19,900	72,000	700-<100,000
Cr	18.8	32.0	*54*	1-2,000
Zn	*81.6*	*315*	60	*<5-2,900*

* Because zinc concentration in surface soil followed a lognormal distribution, the logarithmic mean concentration is provided.

The receptors selected for ecological risk evaluation are those expected to be maximally exposed to media at the West Brine Field site; therefore, populations of other species that may venture, forage, or dwell within the perimeter of the site should incur lower levels of risk than those indicated in the ERA. It is important to note that, in most cases, the maximum detected concentration of a COPC was used to calculate quantitative risk estimates for ecological receptors selected for evaluation. Consequently, the risk estimates presented in the ERA should be considered "worst-case"; therefore, the exposures experienced and risks incurred by site-related wildlife at the West Brine Field site are likely to be much lower.

4.0 Conclusions

The results of the human health risk assessment for the West Brine Field indicate that no unacceptable risks are posed to hypothetical future construction workers, maintenance workers, trespasser, utility trench workers, or office workers. The maintenance worker scenario resulted in a risk level of $3x10^{5}$, which is attributable to the presence of a single detection of n-nitrosodiethylamine in soil in SWMU-7.

The results of the ERA indicate that no unacceptable risks are posed to populations of white-tailed deer, meadow vole, or American robin from exposure to residual concentrations of inorganic and organic constituents in surface water or sediment at the West Brine Field site. Potential individual-level hazards from ingesting upland vegetation are indicated for the white-tailed deer. Incidental ingestion of soil may induce adverse effects to individual meadow voles and American robins. Risk levels associated with the vegetation ingestion pathway suggest the potential for population-level effects to meadow voles and American robins. Vegetation ingestion risk to both the meadow vole and American robin was largely attributable to the presence of phenol in SWMU 4 surface soils. Robin populations may also be at risk from consuming invertebrates that dwell in surface soils. COPCs driving the risk for this pathway are thallium and phenol.

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Table 1
Statistical Summary and Screening of Constituents Detected in Soil (1-14 feet bgs)
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number Of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
Dioxins											
2,3,7,8-TCDD (TEQ)	6	3	50	5.25E-06	1.46E-05	9.76E-06	3.47E-05	1.29E-05	2.52E-05	1.17E-04	Normal/Lognormal
Inorganics											
ALUMINUM, TOTAL	43	42	97.67	1.30E+00	9.77E+03	4.55E+03	1.99E+04	4.54E+03	1.09E+04	7.87E+05	Normal
ANTIMONY, TOTAL	42	2	4.76	1.30E+00	3.37E+00	3.28E+00	1.90E+00	6.27E-01	3.54E+00	3.68E+00	Unknown
ARSENIC, TOTAL	45	45	100	1.70E+00	8.65E+00	7.92E+00	2.17E+01	3.50E+00	9.53E+00	1.00E+01	Unknown
BARIUM, TOTAL	45	45	100	1.44E+01	8.30E+01	7.48E+01	1.55E+02	3.57E+01	9.20E+01	9.71E+01	Normal/Lognormal
BERYLLIUM, TOTAL	45	9	20	4.00E-02	3.35E-01	3.05E-01	8.40E-01	1.46E-01	3.72E-01	3.91E-01	Unknown
CADMIUM, TOTAL	45	5	11.11	3.00E-01	3.26E-01	3.06E-01	1.00E+00	1.52E-01	3.65E-01	3.55E-01	Unknown
CHROMIUM, TOTAL	45	45	100	2.40E+00	1.73E+01	1.62E+01	3.20E+01	5.53E+00	1.87E+01	1.99E+01	Normal
COBALT, TOTAL	45	45	100	5.50E-01	9.31E+00	8.20E+00	2.21E+01	3.93E+00	1.03E+01	1.20E+01	Unknown
COPPER, TOTAL	45	45	100	9.20E+00	2.67E+01	2.23E+01	1.47E+02	2.47E+01	3.28E+01	2.92E+01	Unknown
IRON, TOTAL	39	39	100	1.53E+04	2.46E+04	2.31E+04	6.32E+04	1.02E+04	2.74E+04	2.71E+04	Unknown
LEAD, TOTAL	45	45	100	7.30E+00	2.43E+01	1.40E+01	2.18E+02	4.27E+01	3.50E+01	2.54E+01	Unknown
MANGANESE, TOTAL	39	39	100	2.85E+02	6.29E+02	5.11E+02	2.93E+03	5.54E+02	7.80E+02	7.18E+02	Unknown
MERCURY, TOTAL	45	7	15.56	1.40E-01	1.37E-01	7.24E-02	1.60E+00	2.80E-01	2.08E-01	1.43E-01	Unknown
NICKEL, TOTAL	45	45	100	5.00E+00	3.30E+01	2.75E+01	2.40E+02	3.40E+01	4.15E+01	3.64E+01	Unknown
SELENIUM, TOTAL	45	5	11.11	3.90E-01	3.30E-01	2.95E-01	9.80E-01	1.79E-01	3.74E-01	3.78E-01	Unknown
THALLIUM, TOTAL	45	6	13.33	1.80E-01	5.63E-01	5.04E-01	1.40E+00	2.29E-01	6.21E-01	6.92E-01	Unknown
TIN, TOTAL	6	4	66.67	8.10E-01	2.21E+00	1.19E+00	8.30E+00	3.04E+00	4.72E+00	2.61E+01	Lognormal
VANADIUM, TOTAL	45	45	100	2.70E+00	2.37E+01	2.12E+01	4.08E+01	9.20E+00	2.60E+01	2.92E+01	Normal
ZINC, TOTAL	45	45	100	2.10E+01	7.66E+01	6.91E+01	3.15E+02	4.50E+01	8.79E+01	8.52E+01	Unknown
Semivolatiles											
2,4-DICHLOROPHENOL	54	1	1.85	9.30E-02	2.85E+01	4.41E-01	9.30E-02	1.15E+02	5.48E+01	1.25E+01	Unknown
2-METHYLPHENOL	54	1	1.85	3.90E-01	2.85E+01	4.41E-01	3.90E-01	1.15E+02	5.48E+01	1.20E+01	Unknown
3&4-METHYLPHENOL	8	1	12.5	1.40E+00	5.44E+01	2.98E+00	1.40E+00	8.97E+01	1.14E+02	3.49E+07	Lognormal
BENZO(A)ANTHRACENE	55	2	3.64	3.40E-01	2.80E+01	4.46E-01	9.60E-01	1.14E+02	5.39E+01	1.14E+01	Unknown
BENZO(A)PYRENE	55	5	9.09	4.60E-02	2.80E+01	4.39E-01	8.40E-01	1.14E+02	5.39E+01	1.17E+01	Unknown
BENZO(B)FLUORANTHENE	55	6	10.91	6.20E-02	2.80E+01	4.39E-01	9.90E-01	1.14E+02	5.39E+01	1.21E+01	Unknown
BENZO(G,H,I)PERYLENE	55	3	5.45	3.50E-01	2.80E+01	4.35E-01	5.60E-01	1.14E+02	5.38E+01	1.10E+01	Unknown
BENZO(K)FLUORANTHENE	55	3	5.45	3.40E-01	2.79E+01	4.33E-01	5.60E-01	1.14E+02	5.38E+01	1.09E+01	Unknown

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Analyte	Exposure Point Concentration mg/kg	Maximum Detected mg/kg	Region IX PRG for Industrial Soil mg/kg	MI Part 201 Direct Contact Industrial and Commercial II Screening Levels mg/kg	Is Maximum Detected > Screening Criteria?
Dioxins					
2,3,7,8-TCDD (TEQ)	2.52E-05	3.47E-05	2.70E-05		YES-COPC*
Inorganics					
ALUMINUM, TOTAL	1.09E+04	1.99E+04	1.00E+05		no
ANTIMONY, TOTAL	1.90E+00	1.90E+00	8.20E+02		no
ARSENIC, TOTAL	9.53E+00	2.17E+01	2.70E+00		YES-COPC*
BARIUM, TOTAL	9.20E+01	1.55E+02	1.00E+05		no
BERYLLIUM, TOTAL	3.72E-01	8.40E-01	2.20E+03		no
CADMIUM, TOTAL	3.65E-01	1.00E+00	8.10E+02		no
CHROMIUM, TOTAL	1.87E+01	3.20E+01	6.40E+01		no
COBALT, TOTAL	1.03E+01	2.21E+01	1.00E+05		no
COPPER, TOTAL	3.28E+01	1.47E+02	7.60E+04		no
IRON, TOTAL	2.74E+04	6.32E+04	1.00E+05		no
LEAD, TOTAL	3.50E+01	2.18E+02	1.00E+03		no
MANGANESE, TOTAL	7.80E+02	2.93E+03	3.20E+04		no
MERCURY, TOTAL	2.08E-01	1.60E+00	6.10E+02		no
NICKEL, TOTAL	4.15E+01	2.40E+02	4.10E+04		no
SELENIUM, TOTAL	3.74E-01	9.80E-01	1.00E+04		no
THALLIUM, TOTAL	6.21E-01	1.40E+00	1.60E+02		no
TIN, TOTAL	8.30E+00	8.30E+00	1.00E+05		no
VANADIUM, TOTAL	2.60E+01	4.08E+01	1.40E+04		no
ZINC, TOTAL	8.79E+01	3.15E+02	1.00E+05		no
Semivolatiles					
2,4-DICHLOROPHENOL	9.30E-02	9.30E-02	2.60E+03		no
2-METHYLPHENOL	3.90E-01	3.90E-01	4.40E+04		no
3&4-METHYLPHENOL	1.40E+00	1.40E+00	4.40E+03		no
BENZO(A)ANTHRACENE	9.60E-01	9.60E-01	2.90E+00		no
BENZO(A)PYRENE	8.40E-01	8.40E-01	2.90E-01		YES-COPC*
BENZO(B)FLUORANTHENE	9.90E-01	9.90E-01	2.90E+00		no
BENZO(G,H,I)PERYLENE	5.60E-01	5.60E-01	NA	9.10E+03	no
BENZO(K)FLUORANTHENE	5.60E-01	5.60E-01	2.90E+01		no

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Analyte	Total Number Of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
BIS(2-ETHYLHEXYL)PHTHALATE	55	2	3.64	1.90E-01	2.80E+01	4.51E-01	3.40E+00	1.14E+02	5.39E+01	1.22E+01	Unknown
BUTYLBENZYLPHTHALATE	55	1	1.82	2.10E-01	2.80E+01	4.42E-01	2.10E-01	1.14E+02	5.39E+01	1.14E+01	Unknown
CHRYSENE	55	3	5.45	7.40E-02	2.80E+01	4.41E-01	1.20E+00	1.14E+02	5.39E+01	1.17E+01	Unknown
DIBENZO(A,H)ANTHRACENE	55	1	1.82	1.70E-01	2.80E+01	4.40E-01	1.70E-01	1.14E+02	5.39E+01	1.14E+01	Unknown
DIPHENYLAMINE	8	1	12.5	1.10E-01	5.42E+01	2.19E+00	1.10E-01	8.98E+01	1.14E+02	2.11E+08	Lognormal
INDENO(1,2,3-CD)PYRENE	55	3	5.45	4.70E-01	2.80E+01	4.42E-01	7.60E-01	1.14E+02	5.39E+01	1.12E+01	Unknown
N-NITROSODIETHYLAMINE	8	1	12.5	7.80E-01	5.43E+01	2.77E+00	7.80E-01	8.97E+01	1.14E+02	4.26E+07	Lognormal
N-NITROSODIPHENYLAMINE	54	3	5.56	4.70E-02	7.01E+01	4.78E-01	1.90E+03	2.99E+02	1.39E+02	2.56E+01	Unknown
PHENANTHRENE	55	4	7.27	1.40E-01	2.80E+01	4.44E-01	1.00E+00	1.14E+02	5.39E+01	1.15E+01	Unknown
PHENOL	54	9	16.67	9.20E-01	5.89E+02	7.30E-01	1.55E+04	2.51E+03	1.16E+03	8.15E+02	Unknown
Volatiles											
1,2-DICHLOROETHENE (TOTAL)	18	2	11.11	1.10E-02	1.88E+00	4.66E-02	1.30E+00	3.99E+00	3.52E+00	3.86E+03	Unknown
2-BUTANONE	17	6	35.29	3.70E-02	7.04E+00	3.10E-01	1.00E+01	1.33E+01	1.27E+01	2.61E+04	Unknown
2-METHYLNAPHTHALENE	54	1	1.85	6.40E-01	2.85E+01	4.45E-01	6.40E-01	1.15E+02	5.48E+01	1.22E+01	Unknown
4-METHYL-2-PENTANONE	18	1	5.56	3.70E-02	5.77E+00	1.00E-01	3.70E-02	1.31E+01	1.12E+01	5.38E+03	Unknown
ACETONE	18	1	5.56	9.00E-01	6.23E+00	2.96E-01	9.00E-01	1.30E+01	1.16E+01	5.48E+03	Lognormal
ANTHRACENE	55	1	1.82	3.00E-01	2.80E+01	4.45E-01	3.00E-01	1.14E+02	5.39E+01	1.14E+01	Unknown
CARBON DISULFIDE	18	2	11.11	5.30E-02	3.64E+00	4.41E-02	3.40E+01	8.57E+00	7.16E+00	1.88E+04	Unknown
ETHYLBENZENE	18	2	11.11	1.00E-02	1.80E+00	3.28E-02	8.85E-01	4.02E+00	3.45E+00	1.90E+03	Unknown
FLUORANTHENE	55	5	9.09	4.90E-02	2.80E+01	4.44E-01	1.50E+00	1.14E+02	5.39E+01	1.24E+01	Unknown
FLUORENE	55	1	1.82	1.00E-01	2.80E+01	4.36E-01	1.00E-01	1.14E+02	5.39E+01	1.15E+01	Unknown
METHYLENE CHLORIDE	18	2	11.11	5.10E-01	2.09E+00	3.48E-02	5.90E+00	4.12E+00	3.78E+00	7.23E+03	Unknown
NAPHTHALENE	54	3	5.56	3.70E+01	3.85E+01	4.96E-01	7.30E+02	1.45E+02	7.17E+01	2.36E+01	Unknown
PYRENE	55	6	10.91	4.70E-02	2.80E+01	4.41E-01	2.00E+00	1.14E+02	5.39E+01	1.25E+01	Unknown
TETRACHLOROETHENE	17	2	11.76	1.60E-02	1.92E+00	4.08E-02	3.60E-02	4.11E+00	3.66E+00	4.00E+03	Unknown
TOLUENE	18	2	11.11	2.20E-02	1.82E+00	4.38E-02	2.20E-01	4.01E+00	3.47E+00	2.01E+03	Unknown
TRICHLOROETHENE	17	2	11.76	7.00E-03	1.91E+00	3.64E-02	1.20E-02	4.11E+00	3.66E+00	4.45E+03	Unknown
XYLENES (TOTAL)	18	2	11.11	8.00E-03	2.90E+00	5.05E-02	4.80E-02	6.61E+00	5.61E+00	2.92E+03	Unknown

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BIS(2-ETHYLHEXYL)PHTHALATE	3.40E+00	3.40E+00	1.80E+02		no
BUTYLBENZYLPHTHALATE	2.10E-01	2.10E-01	1.00E+05		no
CHRYSENE	1.20E+00	1.20E+00	2.90E+02		no
DIBENZO(A,H)ANTHRACENE	1.70E-01	1.70E-01	2.90E-01		no
DIPHENYLAMINE	1.10E-01	1.10E-01	2.20E+04		no
INDENO(1,2,3-CD)PYRENE	7.60E-01	7.60E-01	2.90E+00		no
N-NITROSODIETHYLAMINE	7.80E-01	7.80E-01	1.60E-02		YES-COPC*
N-NITROSODIPHENYLAMINE	1.39E+02	1.90E+03	5.00E+02		YES-COPC*
PHENANTHRENE	1.00E+00	1.00E+00	NA	8.60E+03	no
PHENOL	1.16E+03	1.55E+04	1.00E+05		no
Volatiles					
1,2-DICHLOROETHENE (TOTAL)	1.30E+00	1.30E+00	1.50E+02		no
2-BUTANONE	1.00E+01	1.00E+01	2.80E+04		no
2-METHYLNAPHTHALENE	6.40E-01	6.40E-01	NA	4.00E+04	no
4-METHYL-2-PENTANONE	3.70E-02	3.70E-02	2.90E+03		no
ACETONE	9.00E-01	9.00E-01	6.20E+03		no
ANTHRACENE	3.00E-01	3.00E-01	1.00E+05		no
CARBON DISULFIDE	7.16E+00	3.40E+01	7.20E+02		no
ETHYLBENZENE	8.85E-01	8.85E-01	2.30E+02		no
FLUORANTHENE	1.50E+00	1.50E+00	3.00E+04		no
FLUORENE	1.00E-01	1.00E-01	3.30E+04		no
METHYLENE CHLORIDE	3.78E+00	5.90E+00	2.10E+01		no
NAPHTHALENE	7.17E+01	7.30E+02	1.90E+02		YES-COPC
PYRENE	2.00E+00	2.00E+00	5.40E+04		no
TETRACHLOROETHENE	3.60E-02	3.60E-02	1.90E+01		no
TOLUENE	2.20E-01	2.20E-01	5.20E+02		no
TRICHLOROETHENE	1.20E-02	1.20E-02	6.10E+00		no
XYLENES (TOTAL)	4.80E-02	4.80E-02	2.10E+02		no

NA - Not Available
*Not a COPC for volatilization pathways based on Michigan Part 201 NLV classification.

Table 2
Statistic nmary and Screening of Constituents Detected in Surface Soil (1-3 f. s)
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
Dioxins											
2,3,7,8-TCDD (TEQ)	3	2	66.67	5.25E-06	1.53E-05	1.28E-05	1.69E-05	9.44E-06	3.13E-05	5.92E-03	Normal/Lognormal
Inorganics											
ALUMINUM	14	14	100	3.10E+00	1.18E+04	6.71E+03	1.99E+04	5.13E+03	1.42E+04	1.95E+06	Normal
ANTIMONY	15	1	6.67	1.30E+00	3.26E+00	3.06E+00	1.30E+00	9.01E-01	3.67E+00	4.23E+00	Unknown
ARSENIC	16	16	100	1.70E+00	8.65E+00	7.48E+00	1.56E+01	3.85E+00	1.03E+01	1.33E+01	Normal
BARIUM	16	16	100	1.44E+01	8.17E+01	7.05E+01	1.49E+02	3.83E+01	9.85E+01	1.23E+02	Normal/Lognormal
BERYLLIUM	16	5	31.25	4.00E-02	3.22E-01	2.74E-01	6.30E-01	1.55E-01	3.90E-01	5.17E-01	Unknown
CADMIUM	16	2	12.5	5.70E-01	3.47E-01	3.10E-01	1.00E+00	1.97E-01	4.33E-01	4.53E-01	Unknown
CHROMIUM	16	16	100	2.40E+00	1.88E+01	1.64E+01	3.20E+01	7.74E+00	2.22E+01	2.91E+01	Normal
COBALT	16	16	100	5.50E-01	9.12E+00	7.20E+00	1.57E+01	4.12E+00	1.09E+01	2.08E+01	Normal
COPPER	16	16	100	9.20E+00	3.44E+01	2.51E+01	1.47E+02	3.81E+01	5.11E+01	4.92E+01	Unknown
IRON	13	13	100	1.55E+04	2.77E+04	2.62E+04	5.66E+04	1.05E+04	3.29E+04	3.35E+04	Normal/Lognormal
LEAD	16	16	100	7.30E+00	3.07E+01	1.78E+01	1.57E+02	4.60E+01	5.09E+01	4.77E+01	Unknown
MANGANESE	13	13	100	3.28E+02	5.34E+02	4.82E+02	1.28E+03	2.97E+02	6.80E+02	6.82E+02	Unknown
MERCURY	16	5	31.25	1.40E-01	1.53E-01	9.42E-02	9.75E-01	2.33E-01	2.55E-01	2.24E-01	Unknown
NICKEL	16	16	100	5.00E+00	4.18E+01	2.99E+01	2.40E+02	5.38E+01	6.54E+01	6.26E+01	Unknown
SELENIUM	16	2	12.5	3.90E-01	3.22E-01	2.80E-01	9.80E-01	1.93E-01	4.07E-01	4.53E-01	Unknown
THALLIUM	16	1	6.25	2.40E-01	5.09E-01	4.33E-01	2.40E-01	1.94E-01	5.94E-01	8.83E-01	Unknown
TIN	3	3	100	8.10E-01	1.40E+00	1.32E+00	1.90E+00	5.51E-01	2.33E+00	8.64E+00	Normal/Lognormal
VANADIUM	16	16	100	2.70E+00	2.47E+01	1.96E+01	4.08E+01	1.23E+01	3.01E+01	4.96E+01	Normal
ZINC	16	16	100	2.10E+01	9.55E+01	8.16E+01	3.15E+02	6.54E+01	1.24E+02	1.31E+02	Lognormal
Semivolatiles											
3&4-METHYLPHENOL	5	1	20	1.40E+00	8.68E+01	1.37E+01	1.40E+00	1.03E+02	1.85E+02	8.71E+12	Normal/Lognormal
ANTHRACENE	20	1	5	3.00E-01	6.84E+01	1.01E+00	3.00E-01	1.82E+02	1.39E+02	4.46E+03	Unknown
BENZO(A)ANTHRACENE	20	1	5	9.60E-01	6.85E+01	1.07E+00	9.60E-01	1.82E+02	1.39E+02	4.38E+03	Unknown
BENZO(A)PYRENE	20	2	10	4.50E-01	6.85E+01	1.09E+00	6.70E-01	1.82E+02	1.39E+02	4.13E+03	Unknown
BENZO(B)FLUORANTHENE	20	2	10	5.40E-01	6.85E+01	1.12E+00	9.90E-01	1.82E+02	1.39E+02	4.14E+03	Unknown
BENZO(G,H,I)PERYLENE	20	1	5	5.60E-01	6.84E+01	1.04E+00	5.60E-01	1.82E+02	1.39E+02	4.35E+03	Unknown
BENZO(K)FLUORANTHENE	20	1	5	5.60E-01	6.84E+01	1.04E+00	5.60E-01	1.82E+02	1.39E+02	4.35E+03	Unknown
BIS(2-ETHYLHEXYL)PHTHALATE	20	1	5	1.90E-01	6.84E+01	9.86E-01	1.90E-01	1.82E+02	1.39E+02	4.65E+03	Unknown
BUTYLBENZYLPHTHALATE	20	1	5	2.10E-01	6.84E+01	9.91E-01	2.10E-01	1.82E+02	1.39E+02	4.60E+03	Unknown
CHRYSENE	20	1	5	1.20E+00	6.85E+01	1.08E+00	1.20E+00	1.82E+02	1.39E+02	4.43E+03	Unknown
DIBENZO(A,H)ANTHRACENE	20	1	5	1.70E-01	6.84E+01	9.80E-01	1.70E-01	1.82E+02	1.39E+02	4.71E+03	Unknown
FLUORANTHENE	20	2	10	5.40E-01	6.85E+01	1.14E+00	1.50E+00	1.81E+02	1.39E+02	4.24E+03	Unknown
FLUORENE	20	1	5	1.00E-01	6.84E+01	9.55E-01	1.00E-01	1.82E+02	1.39E+02	5.09E+03	Unknown
INDENO(1,2,3-CD)PYRENE	20	1	5	7.60E-01	6.85E+01	1.06E+00	7.60E-01	1.82E+02	1.39E+02	4.35E+03	Unknown
NAPHTHALENE	19	2	10.53	1.40E-02	9.85E+01	1.18E+00	7.30E+02	2.34E+02	1.92E+02	2.48E+04	Unknown

Table 2
Statistical Summary and Screening of Constituents Detected in Surface Soil (1-3 feet bgs)
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Exposure Point Concentration mg/kg	Maximum Detected mg/kg	Region IX Preliminary Remediation Goal for Industrial Soil mg/kg	MI Part 201 Direct Contact Industrial and Commercial II Screening Levels mg/kg	Is Maximum Detected > Screening Criteria?
Dioxins					
2,3,7,8-TCDD (TEQ VALUE)	1.69E-05	1.69E-05	2.70E-05		no
Inorganics					
ALUMINUM	1.42E+04	1.99E+04	1.00E+05		no
ANTIMONY	1.30E+00	1.30E+00	8.20E+02		no
ARSENIC	1.03E+01	1.56E+01	2.70E+00		YES-COPC*
BARIUM	1.23E+02	1.49E+02	1.00E+05		no
BERYLLIUM	5.17E-01	6.30E-01	2.20E+03		no
CADMIUM	4.53E-01	1.00E+00	8.10E+02		no
CHROMIUM	2.22E+01	3.20E+01	6.40E+01		no
COBALT	1.09E+01	1.57E+01	1.00E+05		no
COPPER	4.92E+01	1.47E+02	7.60E+04		no
IRON	3.35E+04	5.66E+04	1.00E+05		no
LEAD	4.77E+01	1.57E+02	1.00E+03		no
MANGANESE	6.82E+02	1.28E+03	3.20E+04		no
MERCURY	2.24E-01	9.75E-01	6.10E+02		no
NICKEL	6.26E+01	2.40E+02	4.10E+04		no
SELENIUM	4.53E-01	9.80E-01	1.00E+04		no
THALLIUM	2.40E-01	2.40E-01	1.60E+02		no
TIN	1.90E+00	1.90E+00	1.00E+05		no
VANADIUM	3.01E+01	4.08E+01	1.40E+04		no
ZINC	1.31E+02	3.15E+02	1.00E+05		no
Semivolatiles					
3&4-METHYLPHENOL	1.40E+00	1.40E+00	4.40E+03		no
ANTHRACENE	3.00E-01	3.00E-01	1.00E+05		no
BENZO(A)ANTHRACENE	9.60E-01	9.60E-01	2.90E+00		no
BENZO(A)PYRENE	6.70E-01	6.70E-01	2.90E-01		YES-COPC*
BENZO(B)FLUORANTHENE	9.90E-01	9.90E-01	2.90E+00		no
BENZO(G,H,I)PERYLENE	5.60E-01	5.60E-01	NA	9.10E+03	no
BENZO(K)FLUORANTHENE	5.60E-01	5.60E-01	2.90E+01		no
BIS(2-ETHYLHEXYL)PHTHALATE	1.90E-01	1.90E-01	1.80E+02		no
BUTYLBENZYLPHTHALATE	2.10E-01	2.10E-01	1.00E+05		no
CHRYSENE	1.20E+00	1.20E+00	2.90E+02		no
DIBENZO(A,H)ANTHRACENE	1.70E-01	1.70E-01	2.90E-01		no
FLUORANTHENE	1.50E+00	1.50E+00	3.00E+04		no
FLUORENE	1.00E-01	1.00E-01	3.30E+04		no
INDENO(1,2,3-CD)PYRENE	7.60E-01	7.60E-01	2.90E+00		no
NAPHTHALENE	7.30E+02	7.30E+02	1.90E+02		YES-COPC

Table 2
Statistic mmary and Screening of Constituents Detected in Surface Soil (1-3 gs)
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
N-NITROSODIETHYLAMINE	5	1	20	7.80E-01	8.67E+01	1.22E+01	7.80E-01	1.03E+02	1.85E+02	6.13E+13	Normal/Lognormal
N-NITROSODIPHENYLAMINE	19	2	10.53	4.70E-02	1.90E+02	1.17E+00	1.90E+03	4.89E+02	3.85E+02	1.07E+05	Unknown
PHENANTHRENE	20	1	5	9.80E-01	6.85E+01	1.07E+00	9.80E-01	1.82E+02	1.39E+02	4.38E+03	Unknown
PHENOL	19	4	21.05	5.70E+01	1.40E+03	1.65E+00	1.55E+04	4.09E+03	3.02E+03	6.50E+06	Unknown
PYRENE	20	2	10	4.70E-01	6.85E+01	1.15E+00	2.00E+00	1.81E+02	1.39E+02	4.37E+03	Unknown
Volatiles											
1,2-DICHLOROETHENE (TOTAL)	6	1	16.67	1.30E+00	4.47E+00	4.68E-01	1.30E+00	6.05E+00	9.45E+00	8.59E+10	Normal/Lognormal
2-BUTANONE	5	3	60	1.00E+00	1.78E+01	8.94E+00	1.00E+01	1.94E+01	3.64E+01	6.34E+03	Normal/Lognormal
4-METHYL-2-PENTANONE	6	1	16.67	3.70E-02	1.26E+01	5.18E-01	3.70E-02	2.01E+01	2.92E+01	2.10E+13	Normal/Lognormal
ACETONE	6	1	16.67	9.00E-01	1.39E+01	5.30E+00	9.00E-01	1.92E+01	2.97E+01	1.50E+03	Normal/Lognormal
CARBON DISULFIDE	6	2	33.33	5.30E-02	9.76E+00	4.94E-01	3.40E+01	1.33E+01	2.07E+01	1.07E+15	Normal/Lognormal
ETHYLBENZENE	6	2	33.33	1.00E-02	4.24E+00	2.04E-01	8.85E-01	6.22E+00	9.35E+00	2.30E+12	Lognormal
METHYLENE CHLORIDE	6	1	16.67	5.90E+00	5.07E+00	2.29E-01	5.90E+00	6.01E+00	1.00E+01	6.12E+15	Normal/Lognormal
TETRACHLOROETHENE	5	2	40	1.60E-02	5.11E+00	6.13E-01	3.60E-02	6.53E+00	1.13E+01	8.18E+11	Normal/Lognormal
TOLUENE	6	2	33.33	2.20E-02	4.29E+00	4.85E-01	2.20E-01	6.18E+00	9.37E+00	6.21E+07	Lognormal
TRICHLOROETHENE	5	2	40	7.00E-03	5.10E+00	4.17E-01	1.20E-02	6.54E+00	1.13E+01	6.94E+15	Normal/Lognormal
XYLENES (TOTAL)	6	2	33.33	8.00E-03	6.34E+00	2.66E-01	4.80E-02	1.02E+01	1.47E+01	1.63E+13	Normal/Lognormal

Table 2
Statistical Summary and Screening of Constituents Detected in Surface Soil (1-3 feet bgs)
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Exposure Point Concentration mg/kg	Maximum Detected mg/kg	Region IX Preliminary Remediation Goal for Industrial Soil mg/kg	MI Part 201 Direct Contact Industrial and Commercial II Screening Levels mg/kg	Is Maximum Detected > Screening Criteria?
N-NITROSODIETHYLAMINE	7.80E-01	7.80E-01	1.60E-02		YES-COPC*
N-NITROSODIPHENYLAMINE	1.90E+03	1.90E+03	5.00E+02		YES-COPC*
PHENANTHRENE	9.80E-01	9.80E-01	NA	8.60E+03	no
PHENOL	1.55E+04	1.55E+04	1.00E+05		no
PYRENE	2.00E+00	2.00E+00	5.40E+04		no
Volatiles					
1,2-DICHLOROETHENE (TOTAL)	1.30E+00	1.30E+00	1.50E+02		no
2-BUTANONE	1.00E+01	1.00E+01	2.80E+04		no
4-METHYL-2-PENTANONE	3.70E-02	3.70E-02	2.90E+03		no
ACETONE	9.00E-01	9.00E-01	6.20E+02		no
CARBON DISULFIDE	3.40E+01	3.40E+01	7.20E+02		no
ETHYLBENZENE	8.85E-01	8.85E-01	2.30E+02		no
METHYLENE CHLORIDE	5.90E+00	5.90E+00	2.10E+01		no
TETRACHLOROETHENE	3.60E-02	3.60E-02	1.90E+01		no
TOLUENE	2.20E-01	2.20E-01	5.20E+02		no
TRICHLOROETHENE	1.20E-02	1.20E-02	6.10E+00		no
XYLENES (TOTAL)	4.80E-02	4.80E-02	2.10E+02		no

NA - Not Available
*Not a COPC for volatilization pathways based on Michigan Part 201 NLV classification.

Table 3
Statistical Summary and Screening of Constituents Detected in Groundwater
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number Of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Log Mean mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Log 95% UCL mg/kg	Distribution 99% Confidence
Inorganics											
ANTIMONY, TOTAL	5	2	40	1.75E-02	1.25E-02	1.13E-02	2.08E-02	6.21E-03	1.84E-02	2.53E-02	Normal/Lognormal
ARSENIC, TOTAL	5	5	100	1.24E-02	2.39E-02	2.17E-02	3.84E-02	1.10E-02	3.44E-02	5.17E-02	Normal/Lognormal
BARIUM, TOTAL	5	5	100	1.15E-01	3.32E-01	2.86E-01	5.20E-01	1.79E-01	5.02E-01	1.08E+00	Normal/Lognormal
BERYLLIUM, TOTAL	5	5	100	5.10E-04	2.15E-03	1.83E-03	3.25E-03	1.04E-03	3.14E-03	9.86E-03	Normal/Lognormal
CADMIUM, TOTAL	5	5	100	2.50E-03	4.34E-03	3.58E-03	1.08E-02	3.61E-03	7.79E-03	1.23E-02	Unknown
CHROMIUM, TOTAL	5	5	100	2.38E-02	6.76E-02	6.07E-02	9.59E-02	2.96E-02	9.58E-02	1.76E-01	Normal/Lognormal
COBALT, TOTAL	5	5	100	3.05E-02	7.76E-02	6.47E-02	1.56E-01	5.19E-02	1.27E-01	2.74E-01	Normal/Lognormal
COPPER, TOTAL	5	5	100	2.58E-02	7.60E-02	6.77E-02	1.07E-01	3.40E-02	1.08E-01	2.11E-01	Normal/Lognormal
LEAD, TOTAL	5	5	100	2.02E-02	5.89E-02	5.00E-02	1.03E-01	3.36E-02	9.09E-02	2.10E-01	Normal/Lognormal
MERCURY, TOTAL	5	4	80	1.85E-04	2.01E-04	1.73E-04	2.70E-04	9.03E-05	2.87E-04	8.28E-04	Normal/Lognormal
NICKEL, TOTAL	5	5	100	4.81E-02	1.07E-01	1.01E-01	1.41E-01	3.74E-02	1.43E-01	2.03E-01	Normal/Lognormal
THALLIUM, TOTAL	5	2	40	1.75E-03	2.55E-03	2.18E-03	2.20E-03	1.42E-03	3.90E-03	8.92E-03	Normal/Lognormal
TIN, TOTAL	5	2	40	1.08E-02	7.57E-03	6.59E-03	1.40E-02	4.55E-03	1.19E-02	1.96E-02	Normal/Lognormal
VANADIUM, TOTAL	5	5	100	2.54E-02	7.65E-02	6.86E-02	1.03E-01	3.20E-02	1.07E-01	2.07E-01	Normal/Lognormal
ZINC, TOTAL	5	5	100	8.28E-02	2.16E-01	1.93E-01	3.27E-01	1.01E-01	3.12E-01	5.47E-01	Normal/Lognormal
Semivolatiles											
BIS(2-ETHYLHEXYL)PHTHALATE	5	4	80	1.00E-02	9.00E-03	8.71E-03	1.00E-02	2.24E-03	1.11E-02	1.33E-02	Unknown
Volatiles											
ACETONE	5	1	20	1.40E-02	6.80E-03	6.14E-03	1.40E-02	4.02E-03	1.06E-02	1.31E-02	Unknown
CHLOROFORM	5	1	20	5.00E-03	3.00E-03	2.87E-03	5.00E-03	1.12E-03	4.07E-03	4.39E-03	Unknown

Table 3
Statistical Summary and Screening of Constituents Detected in Groundwater
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Exposure Point Concentration mg/L	Maximum Detected mg/L	Region IX Preliminary Remediation Goal for Tap Water mg/L	MI Part 201 mg/L	Is Maximum Detected > Screening Criteria?
Inorganics					
ANTIMONY, TOTAL	1.84E-02	2.08E-02	1.50E-02		YES-COPC*
ARSENIC, TOTAL	3.44E-02	3.84E-02	4.50E-05		YES-COPC*
BARIUM, TOTAL	5.02E-01	5.20E-01	2.60E+00		no
BERYLLIUM, TOTAL	3.14E-03	3.25E-03	7.30E-02		no
CADMIUM, TOTAL	7.79E-03	1.08E-02	1.80E-04		YES-COPC*
CHROMIUM, TOTAL	9.58E-02	9.59E-02	1.10E-02		YES-COPC*
COBALT, TOTAL	1.27E-01	1.56E-01	2.20E+00		no
COPPER, TOTAL	1.07E-01	1.07E-01	1.40E+00		no
LEAD, TOTAL	9.09E-02	1.03E-01	NA	NA	NA - COPC
MERCURY, TOTAL	2.70E-04	2.70E-04	1.10E-02		no
NICKEL, TOTAL	1.41E-01	1.41E-01	7.30E-01		no
THALLIUM, TOTAL	2.20E-03	2.20E-03	2.90E-03		no
TIN, TOTAL	1.19E-02	1.40E-02	2.20E+01		no
VANADIUM, TOTAL	1.03E-01	1.03E-01	2.60E-01		no
ZINC, TOTAL	3.12E-01	3.27E-01	1.10E+01		no
Semivolatiles					
BIS(2-ETHYLHEXYL)PHTHALATE	1.00E-02	1.00E-02	4.80E-03		YES-COPC*
Volatiles					
ACETONE	1.06E-02	1.40E-02	6.10E-01		no
CHLOROFORM	4.07E-03	5.00E-03	1.60E-04		YES-COPC

NA - Not Available
*Constituent not a COPC for volatilization pathways based on MI Part 201 NLV classification.

Table 4

Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Soil

ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/kg	Screening Level mg/kg	Screening Level Source	Is the SQL > Screening Criteria?
Constituents with Detection Limits Greater Than Screening Levels				
2,3,7,8-TCDD	1.30E-04	2.70E-05	Region IX	Yes
DISULFOTON	5.20E+01	3.50E+01	Region IX	Yes
METHYL PARATHION	5.20E+01	2.80E+02	MDEQ	Yes
AROCLOR-1016	3.15E+02	2.90E+01	Region IX	Yes
AROCLOR-1221	3.15E+02	1.00E+00	Region IX	Yes
AROCLOR-1232	3.15E+02	1.00E+00	Region IX	Yes
AROCLOR-1242	3.15E+02	1.00E+00	Region IX	Yes
AROCLOR-1248	3.15E+02	1.00E+00	Region IX	Yes
AROCLOR-1254	6.30E+02	1.00E+00	Region IX	Yes
AROCLOR-1260	6.30E+02	1.00E+00	Region IX	Yes
4,4'-DDD	6.30E+01	1.70E+01	Region IX	Yes
4,4'-DDE	6.30E+01	1.20E+01	Region IX	Yes
4,4'-DDT	6.30E+01	1.20E+01	Region IX	Yes
ALDRIN	3.15E+01	1.50E-01	Region IX	Yes
ALPHA-BHC	3.15E+01	5.90E-01	Region IX	Yes
ALPHA-CHLORDANE	3.15E+02	1.10E+01	Region IX	Yes
BETA-BHC	3.15E+01	2.10E+00	Region IX	Yes
DIELDRIN	6.30E+01	1.50E-01	Region IX	Yes
GAMMA-BHC (LINDANE)	3.15E+01	2.90E+00	Region IX	Yes
GAMMA-CHLORDANE	3.15E+02	1.10E+01	Region IX	Yes
HEPTACHLOR	3.15E+01	5.50E-01	Region IX	Yes
HEPTACHLOR EPOXIDE	3.15E+01	2.70E-01	Region IX	Yes
KEPONE	6.30E+01	1.40E-01	Region IX	Yes
TOXAPHENE	6.30E+02	2.20E+00	Region IX	Yes
1,2,4,5-TETRACHLOROBENZENE	4.75E+02	2.60E+02	Region IX	Yes
1,2-DICHLOROBENZENE	1.50E+03	3.70E+02	Region IX	Yes
1,3-DICHLOROBENZENE	1.50E+03	5.20E+01	Region IX	Yes
1,3-DINITROBENZENE	9.55E+02	8.80E+01	Region IX	Yes
1,4-DICHLOROBENZENE	1.50E+03	8.10E+00	Region IX	Yes
1,4-DIOXANE	9.55E+02	2.20E+02	Region IX	Yes
2,4,6-TRICHLOROPHENOL	1.50E+03	2.20E+02	Region IX	Yes
2,4-DINITROPHENOL	3.70E+03	1.80E+03	Region IX	Yes
2,6-DINITROTOLUENE	1.50E+03	8.80E+02	Region IX	Yes
2-CHLOROPHENOL	1.50E+03	2.40E+02	Region IX	Yes
2-NITROANILINE	3.70E+03	5.00E+01	Region IX	Yes
3,3'-DICHLOROBENZIDINE	1.50E+03	5.50E+00	Region IX	Yes
3,3'-DIMETHYLBENZIDINE	2.35E+03	1.80E+02	Region IX	Yes
A,A-DIMETHYLPHENETHYLAMINE	2.35E+03	8.80E+02	Region IX	Yes
ACETOPHENONE	4.75E+02	1.60E+00	Region IX	Yes
ANILINE	2.35E+03	4.30E+02	Region IX	Yes
ARAMITE	9.55E+02	9.90E+01	Region IX	Yes
BIS(2-CHLOROETHYL)ETHER	1.50E+03	6.20E-01	Region IX	Yes
CARBAZOLE	1.50E+03	1.20E+02	Region IX	Yes
CHLOROBENZILATE	4.75E+02	9.10E+00	Region IX	Yes
DIALLATE	4.75E+02	4.00E+01	Region IX	Yes
DI-N-BUTYLPHTHALATE	1.50E+03	7.60E+02	MDEQ	Yes
DINOSEB	9.55E+02	8.80E+02	Region IX	Yes
HEXACHLOROBENZENE	1.50E+03	1.50E+00	Region IX	Yes
HEXACHLOROBUTADIENE	1.50E+03	3.20E+01	Region IX	Yes
HEXACHLOROETHANE	1.50E+03	1.80E+02	Region IX	Yes
HEXACHLOROPHENE	3.85E+03	2.60E+02	Region IX	Yes
N-NITROSODI-N-BUTYLAMINE	4.75E+02	6.10E-02	Region IX	Yes
N-NITROSODI-N-PROPYLAMINE	1.50E+03	3.50E-01	Region IX	Yes

Table 4
Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Soil
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/kg	Screening Level mg/kg	Screening Level Source	Is the SQL > Screening Criteria?
N-NITROSODIMETHYLAMINE	4.75E+02	4.80E-02	Region IX	Yes
N-NITROSOMETHYLETHYLAMINE	4.75E+02	1.10E-01	Region IX	Yes
N-NITROSOPYRROLIDINE	2.35E+03	1.20E+00	Region IX	Yes
NITROBENZENE	1.50E+03	1.10E+02	Region IX	Yes
PENTACHLORONITROBENZENE	4.75E+02	9.50E+00	Region IX	Yes
PENTACHLOROPHENOL	3.70E+03	1.10E+01	Region IX	Yes
PYRIDINE	9.55E+02	8.80E+02	Region IX	Yes
1,1,1,2-TETRACHLOROETHANE	5.00E+01	7.00E+00	Region IX	Yes
1,1,2,2-TETRACHLOROETHANE	2.50E+01	9.00E-01	Region IX	Yes
1,1,2-TRICHLOROETHANE	2.50E+01	1.90E+00	Region IX	Yes
1,1-DICHLOROETHENE	2.50E+01	1.20E-01	Region IX	Yes
1,2,3-TRICHLOROPROPANE	5.00E+01	3.10E-03	Region IX	Yes
1,2-DIBROMO-3-CHLOROPROPANE	1.00E+02	4.00E+00	Region IX	Yes
1,2-DIBROMOETHANE	1.00E+02	4.80E-02	Region IX	Yes
1,2-DICHLOROETHANE	2.50E+01	7.60E-01	Region IX	Yes
1,2-DICHLOROPROPANE	2.50E+01	7.70E-01	Region IX	Yes
2-CHLORO-1,3-BUTADIENE	5.00E+02	1.20E+01	Region IX	Yes
ACROLEIN	2.50E+03	3.40E-01	Region IX	Yes
ACRYLONITRILE	5.00E+02	5.10E-01	Region IX	Yes
BENZENE	2.50E+01	1.50E+00	Region IX	Yes
BROMODICHLOROMETHANE	2.50E+01	2.40E+00	Region IX	Yes
BROMOMETHANE	5.00E+01	1.30E+01	Region IX	Yes
CARBON TETRACHLORIDE	2.50E+01	5.30E-01	Region IX	Yes
CHLOROETHANE	5.00E+01	6.50E+00	Region IX	Yes
CHLOROFORM	2.50E+01	5.20E-01	Region IX	Yes
CHLOROMETHANE	5.00E+01	2.70E+00	Region IX	Yes
DIBROMOCHLOROMETHANE	2.50E+01	2.70E+00	Region IX	Yes
METHACRYLONITRILE	1.00E+02	8.80E+00	Region IX	Yes
TRANS-1,4-DICHLORO-2-BUTENE	1.00E+02	1.80E-02	Region IX	Yes
VINYL CHLORIDE	5.00E+01	4.90E-02	Region IX	Yes
Constituents Without Screening Levels				
FAMPHUR	5.20E+01			
O,O,O-TRIETHYL PHOSPHOROTHIOAT	5.20E+01			
SULFOTEPP	5.20E+01			
ZINOPHOS	5.20E+01			
DELTA-BHC	3.15E+01			
ISODRIN	3.15E+01			
1,4-NAPHTHOQUINONE	2.35E+03			
1-NAPHTHYLAMINE	9.55E+02			
2,2'-OXYBIS(1-CHLOROPROPANE)	1.50E+03			
2,6-DICHLOROPHENOL	4.75E+02			
2-ACETYLAMINOFLUORENE	9.55E+02			
2-AMINONAPHTHALENE (BETA NAPHT	1.19E+03			
2-PICOLINE	4.75E+02			
3-METHYLCHOLANTHRENE	4.75E+02			
3-NITROANILINE	3.70E+03			
4,6-DINITRO-2-METHYLPHENOL	3.70E+03			
4-AMINOBIPHENYL	9.55E+02			
4-BROMOPHENYL-PHENYLETHER	1.50E+03			
4-CHLOROPHENYL-PHENYLETHER	1.50E+03			
4-NITROANILINE	3.70E+03			
4-NITROQUINOLINE-1-OXIDE	2.35E+03			
5-NITRO-O-TOLUIDINE	9.55E+02			

Table 4

Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Soil

ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/kg	Screening Level mg/kg	Screening Level Source	Is the SQL > Screening Criteria?
7,12-DIMETHYLBENZ(A)ANTHRACENE	9.55E+02			
BIS(2-CHLOROETHOXY)METHANE	1.50E+03			
ETHYLMETHANESULFONATE	4.75E+02			
HEXACHLOROPROPENE	2.35E+03			
ISOSAFROLE	4.75E+02			
METHAPYRILENE	1.19E+03			
METHYLMETHANESULFONATE	4.75E+02			
N-NITROSOMORPHOLINE	9.55E+02			
N-NITROSOPIPERIDINE	4.75E+02			
P-DIMETHYLAMINOAZOBENZENE	9.55E+02			
PHENACETIN	4.75E+02			
PRONAMIDE	4.75E+02			
SAFROLE	4.75E+02			
CIS-1,3-DICHLOROPROPENE	2.50E+01			
IODOMETHANE	5.00E+01			
METHYLMETHACRYLATE	1.00E+02			
PENTACHLOROETHANE	1.00E+02			
PROPIONITRILE	2.50E+02			
TRANS-1,3-DICHLOROPROPENE	2.50E+01			
Constituents with Detection Limits Less Than Screening Levels				
2,4,5-T	6.90E-01	8.80E+03	Region IX	no
2,4,5-TP (SILVEX)	6.90E-01	7.00E+03	Region IX	no
2,4-D	6.90E+00	1.20E+04	Region IX	no
ANTIMONY, TOTAL	9.30E+00	8.20E+02	Region IX	no
CYANIDE, TOTAL	6.60E-01	1.80E+04	Region IX	no
SILVER, TOTAL	1.50E+00	1.00E+04	Region IX	no
DIMETHOATE	5.20E+01	1.80E+02	Region IX	no
ETHYL PARATHION	5.20E+01	5.30E+03	Region IX	no
PHORATE	5.20E+01	1.80E+02	Region IX	no
ENDOSULFAN I	3.15E+01	5.30E+03	Region IX	no
ENDOSULFAN II	6.30E+01	5.30E+03	Region IX	no
ENDOSULFAN SULFATE	6.30E+01	5.30E+03	Region IX	no
ENDRIN	6.30E+01	2.60E+02	Region IX	no
ENDRIN ALDEHYDE	6.30E+01	2.60E+02	Region IX	no
METHOXYCHLOR	3.15E+02	4.40E+03	Region IX	no
1,2,4-TRICHLOROBENZENE	1.50E+03	3.00E+03	Region IX	no
1,3,5-TRINITROBENZENE	4.75E+03	2.60E+04	Region IX	no
2,3,4,6-TETRACHLOROPHENOL	4.75E+02	2.60E+04	Region IX	no
2,4,5-TRICHLOROPHENOL	3.70E+03	8.80E+04	Region IX	no
2,4-DIMETHYLPHENOL	1.50E+03	1.80E+04	Region IX	no
2,4-DINITROTOLUENE	1.50E+03	1.80E+03	Region IX	no
2-CHLORONAPHTHALENE	1.50E+03	2.70E+04	Region IX	no
2-NITROPHENOL	1.50E+03	3.10E+03	MDEQ	no
4-CHLORO-3-METHYLPHENOL	1.50E+03	2.20E+04	MDEQ	no
4-CHLOROANILINE	1.50E+03	3.50E+03	Region IX	no
4-METHYLPHENOL	1.50E+03	4.40E+03	Region IX	no
4-NITROPHENOL	3.70E+03	7.00E+03	Region IX	no
ACENAPHTHENE	1.50E+03	3.80E+04	Region IX	no
ACENAPHTHYLENE	1.50E+03	8.00E+03	MDEQ	no
BENZYL ALCOHOL	4.75E+02	1.00E+05	Region IX	no
DI-N-OCTYLPHTHALATE	1.50E+03	1.00E+04	Region IX	no
DIBENZOFURAN	1.50E+03	5.10E+03	Region IX	no
DIETHYLPHTHALATE	1.50E+03	1.00E+05	Region IX	no

Table 4

Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Soil

ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/kg	Screening Level mg/kg	Screening Level Source	Is the SQL > Screening Criteria?
DIMETHYLPHTHALATE	1.50E+03	1.00E+05	Region IX	no
HEXACHLOROCYCLOPENTADIENE	1.50E+03	5.90E+03	Region IX	no
ISOPHORONE	1.50E+03	2.60E+03	Region IX	no
O-TOLUIDINE	4.75E+02	6.70E+02	MDEQ	no
P-PHENYLENEDIAMINE	9.55E+02	1.00E+05	Region IX	no
PENTACHLOROBENZENE	4.75E+02	7.00E+02	Region IX	no
2,4,5-TP (SILVEX)	1.00E-01	7.00E+03	Region IX	no
2,4-D	1.00E+00	1.20E+04	Region IX	no
CHLORDANE	1.00E-03	1.10E+01	Region IX	no
1,1-DICHLOROETHENE	1.00E-01	1.20E-01	Region IX	no
1,2-DICHLOROETHANE	1.00E-01	7.60E-01	Region IX	no
2-BUTANONE	1.00E+00	2.80E+04	Region IX	no
BENZENE	1.00E-01	1.50E+00	Region IX	no
CARBON TETRACHLORIDE	1.00E-01	5.30E-01	Region IX	no
CHLOROBENZENE	1.00E-01	5.40E+02	Region IX	no
CHLOROFORM	1.00E-01	5.20E-01	Region IX	no
TETRACHLOROETHENE	1.00E-01	1.90E+01	Region IX	no
TRICHLOROETHENE	1.00E-01	6.10E+00	Region IX	no
1,1,1-TRICHLOROETHANE	2.50E+01	1.40E+03	Region IX	no
1,1-DICHLOROETHANE	2.50E+01	2.10E+03	Region IX	no
2-HEXANONE	9.70E+01	2.50E+03	MDEQ	no
ACETONITRILE	5.00E+02	1.70E+03	Region IX	no
ALLYL CHLORIDE	1.00E+02	4.30E+04	Region IX	no
BROMOFORM	2.50E+01	3.10E+02	Region IX	no
CHLOROBENZENE	2.50E+01	5.40E+02	Region IX	no
DIBROMOMETHANE	5.00E+01	2.00E+03	MDEQ	no
DICHLORODIFLUOROMETHANE	1.00E+02	3.10E+02	Region IX	no
ETHYLMETHACRYLATE	1.00E+02	1.40E+02	Region IX	no
ISOBUTANOL	1.00E+04	4.00E+04	Region IX	no
STYRENE	2.50E+01	1.70E+03	Region IX	no
TRICHLOROFLUOROMETHANE	5.00E+01	2.00E+03	Region IX	no
VINYL ACETATE	5.00E+01	1.40E+03	Region IX	no

Region IX - US EPA Region IX PRGs - Industrial Soil

MDEQ - MDEQ Cleanup Criteria - Direct Contact Industrial and Commercial II

Table 5

Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Groundwater
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/L	Screening Level mg/L	Screening Level Source	Is the SQL > Screening Criteria?
Constituents with Detection Limits Greater Than Screening Levels				
2,3,7,8-TCDD	5.00E-07	1.00E-08	MDEQ	Yes
AROCLOR-1221	5.00E-04	3.40E-05	Region IX	Yes
AROCLOR-1232	5.00E-04	3.40E-05	Region IX	Yes
AROCLOR-1242	5.00E-04	3.40E-05	Region IX	Yes
AROCLOR-1248	5.00E-04	3.40E-05	Region IX	Yes
AROCLOR-1254	1.00E-03	3.40E-05	Region IX	Yes
AROCLOR-1260	1.00E-03	3.40E-05	Region IX	Yes
ALPHA-BHC	5.00E-05	1.10E-05	Region IX	Yes
ALPHA-CHLORDANE	5.00E-04	1.90E-04	Region IX	Yes
BETA-BHC	5.00E-05	3.70E-05	Region IX	Yes
KEPONE	1.00E-04	3.70E-06	Region IX	Yes
1,3-DINITROBENZENE	2.00E-02	3.60E-03	Region IX	Yes
1,4-DIOXANE	2.00E-02	6.10E-03	Region IX	Yes
2-NITROANILINE	5.00E-02	2.10E-03	Region IX	Yes
3,3'-DIMETHYLBENZIDINE	5.00E-02	7.30E-06	Region IX	Yes
ARAMITE	2.00E-02	2.70E-03	Region IX	Yes
BENZO(A)ANTHRACENE	1.00E-02	9.40E-03	MDEQ	Yes
BENZO(A)PYRENE	1.00E-02	5.00E-03	MDEQ	Yes
BENZO(B)FLUORANTHENE	1.00E-02	2.00E-03	MDEQ	Yes
BENZO(G,H,I)PERYLENE	1.00E-02	5.00E-03	MDEQ	Yes
BENZO(K)FLUORANTHENE	1.00E-02	5.00E-03	MDEQ	Yes
CHRYSENE	1.00E-02	5.00E-03	MDEQ	Yes
DIALLATE	1.00E-02	1.10E-03	Region IX	Yes
DIBENZO(A,H)ANTHRACENE	1.00E-02	5.00E-03	MDEQ	Yes
HEXACHLOROBENZENE	1.00E-02	4.60E-03	MDEQ	Yes
HEXACHLOROPHENE	1.00E-01	1.10E-02	Region IX	Yes
INDENO(1,2,3-CD)PYRENE	1.00E-02	5.00E-03	MDEQ	Yes
N-NITROSODI-N-BUTYLAMINE	1.00E-02	2.00E-06	Region IX	Yes
N-NITROSODIETHYLAMINE	1.00E-02	4.50E-07	Region IX	Yes
N-NITROSODIMETHYLAMINE	1.00E-02	1.30E-06	Region IX	Yes
N-NITROSOMETHYLETHYLAMINE	1.00E-02	3.10E-06	Region IX	Yes
N-NITROSOPYRROLIDINE	5.00E-02	3.20E-05	Region IX	Yes
1,2-DIBROMO-3-CHLOROPROPANE	2.00E-02	4.80E-05	Region IX	Yes
1,2-DIBROMOETHANE	2.00E-02	7.60E-07	Region IX	Yes
2-CHLORO-1,3-BUTADIENE	1.00E-01	1.40E-02	Region IX	Yes
METHACRYLONITRILE	2.00E-02	1.00E-03	Region IX	Yes
TRANS-1,4-DICHLORO-2-BUTENE	2.00E-02	1.20E-06	Region IX	Yes
Constituents Without Screening Levels				
DELTA-BHC	5.00E-05			
ISODRIN	5.00E-05			
1,4-NAPHTHOQUINONE	5.00E-02			
1-NAPHTHYLAMINE	2.00E-02			
2,2-OXYBIS(1-CHLOROPROPANE)	1.00E-02			
2,6-DICHLOROPHENOL	1.00E-02			

Table 5

Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Groundwater
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/L	Screening Level mg/L	Screening Level Source	Is the SQL > Screening Criteria?
2-ACETYLAMINOFLUORENE	2.00E-02			
2-AMINONAPHTHALENE (BETA NAPH	2.50E-02			
2-PICOLINE	1.00E-02			
3-METHYLCHOLANTHRENE	1.00E-02			
3-NITROANILINE	5.00E-02			
4,6-DINITRO-2-METHYLPHENOL	5.00E-02			
4-AMINOBIPHENYL	2.00E-02			
4-BROMOPHENYL-PHENYLETHER	1.00E-02			
4-CHLOROPHENYL-PHENYLETHER	1.00E-02			
4-NITROANILINE	5.00E-02			
4-NITROQUINOLINE-1-OXIDE	5.00E-02			
5-NITRO-O-TOLUIDINE	2.00E-02			
7,12-DIMETHYLBENZ(A)ANTHRACEN	2.00E-02			
A,A-DIMETHYLPHENETHYLAMINE	5.00E-02			
BIS(2-CHLOROETHOXY)METHANE	1.00E-02			
ETHYLMETHANESULFONATE	1.00E-02			
HEXACHLOROPROPENE	5.00E-02			
ISOSAFROLE	1.00E-02			
METHAPYRILENE	2.50E-02			
METHYLMETHANESULFONATE	1.00E-02			
N-NITROSOMORPHOLINE	2.00E-02			
N-NITROSOPIPERIDINE	1.00E-02			
O-TOLUIDINE	1.00E-02			
P-DIMETHYLAMINOAZOBENZENE	2.00E-02			
PHENACETIN	1.00E-02			
SAFROLE	1.00E-02			
IODOMETHANE	1.00E-02			
PENTACHLOROETHANE	2.00E-02			
PROPIONITRILE	5.00E-02			
Constituents with Detection Limits Less Than Screening Levels				
2,4,5-T	1.10E-03	3.60E-01	Region IX	No
2,4,5-TP (SILVEX)	1.10E-03	4.30E+01	MDEQ	No
2,4-D	1.10E-02	1.20E+02	MDEQ	No
CYANIDE, TOTAL	1.00E-02	7.30E-01	Region IX	No
SELENIUM, TOTAL	1.40E-02	9.70E+02	MDEQ	No
SILVER, TOTAL	1.80E-03	1.50E+03	MDEQ	No
AROCLOR-1016	5.00E-04	9.60E-04	Region IX	No
4,4'-DDD	1.00E-04	4.40E-02	MDEQ	No
4,4'-DDE	1.00E-04	2.70E-02	MDEQ	No
4,4'-DDT	1.00E-04	1.30E-02	MDEQ	No
ALDRIN	5.00E-05	3.40E-04	MDEQ	No
DIELDRIN	1.00E-04	2.40E-03	MDEQ	No
ENDOSULFAN I	5.00E-05	5.10E-01	MDEQ	No
ENDOSULFAN II	1.00E-04	5.10E-01	MDEQ	No
ENDOSULFAN SULFATE	1.00E-04	5.10E-01	MDEQ	No

Table 5

Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Groundwater
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/L	Screening Level mg/L	Screening Level Source	Is the SQL > Screening Criteria?
ENDRIN	1.00E-04	1.60E-01	MDEQ	No
ENDRIN ALDEHYDE	1.00E-04	1.60E-01	MDEQ	No
GAMMA-BHC (LINDANE)	5.00E-05	5.20E-05	Region IX	No
GAMMA-CHLORDANE	5.00E-04	1.90E-01	MDEQ	No
HEPTACHLOR	5.00E-05	2.90E-03	MDEQ	No
HEPTACHLOR EPOXIDE	5.00E-05	2.90E-03	MDEQ	No
METHOXYCHLOR	5.00E-04	4.50E-02	MDEQ	No
TOXAPHENE	1.00E-03	4.40E-02	MDEQ	No
1,2,4,5-TETRACHLOROBENZENE	1.00E-02	1.30E+00	MDEQ	No
1,2,4-TRICHLOROBENZENE	1.00E-02	1.90E+01	MDEQ	No
1,2-DICHLOROBENZENE	1.00E-02	1.60E+02	MDEQ	No
1,3,5-TRINITROBENZENE	1.00E-01	1.10E+00	Region IX	No
1,3-DICHLOROBENZENE	1.00E-02	2.00E+00	MDEQ	No
1,4-DICHLOROBENZENE	1.00E-02	6.40E+00	MDEQ	No
2,3,4,6-TETRACHLOROPHENOL	1.00E-02	1.10E+00	Region IX	No
2,4,5-TRICHLOROPHENOL	5.00E-02	1.70E+02	MDEQ	No
2,4,6-TRICHLOROPHENOL	1.00E-02	1.00E+01	MDEQ	No
2,4-DICHLOROPHENOL	1.00E-02	4.80E+01	MDEQ	No
2,4-DIMETHYLPHENOL	1.00E-02	5.20E+02	MDEQ	No
2,4-DINITROPHENOL	5.00E-02	7.30E-02	Region IX	No
2,4-DINITROTOLUENE	1.00E-02	8.60E+00	MDEQ	No
2,6-DINITROTOLUENE	1.00E-02	3.60E-02	Region IX	No
2-CHLORONAPHTHALENE	1.00E-02	6.70E+00	MDEQ	No
2-CHLOROPHENOL	1.00E-02	9.40E+01	MDEQ	No
2-METHYLNAPHTHALENE	1.00E-02	2.50E+01	MDEQ	No
2-METHYLPHENOL	1.00E-02	8.10E+02	MDEQ	No
2-NITROPHENOL	1.00E-02	7.90E+01	MDEQ	No
3&4-METHYLPHENOL	1.00E-02	8.10E+02	MDEQ	No
3,3'-DICHLOROBENZIDINE	2.00E-02	1.80E-01	MDEQ	No
4-CHLORO-3-METHYLPHENOL	1.00E-02	7.90E+01	MDEQ	No
4-CHLOROANILINE	1.00E-02	1.50E-01	Region IX	No
4-NITROPHENOL	5.00E-02	2.90E-01	Region IX	No
ACENAPHTHENE	1.00E-02	4.20E+00	MDEQ	No
ACENAPHTHYLENE	1.00E-02	3.90E+00	MDEQ	No
ACETOPHENONE	1.00E-02	6.10E+03	MDEQ	No
ANILINE	5.00E-02	1.40E+02	MDEQ	No
ANTHRACENE	1.00E-02	4.30E-02	MDEQ	No
BENZYL ALCOHOL	1.00E-02	4.40E+04	MDEQ	No
BIS(2-CHLOROETHYL)ETHER	1.00E-02	5.70E+00	MDEQ	No
BUTYLBENZYLPHTHALATE	1.00E-02	2.70E+00	MDEQ	No
CHLOROBENZILATE	1.00E-02	7.30E+00	Region IX	No
DI-N-BUTYLPHTHALATE	1.00E-02	1.10E+01	MDEQ	No
DI-N-OCTYLPHTHALATE	1.00E-02	4.00E-01	MDEQ	No
DIBENZOFURAN	1.00E-02	2.40E-02	Region IX	No
DIETHYLPHTHALATE	1.00E-02	1.10E+03	MDEQ	No
DIMETHYLPHTHALATE	1.00E-02	3.60E+02	Region IX	No

Table 5
Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Groundwater
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/L	Screening Level mg/L	Screening Level Source	Is the SQL > Screening Criteria?
DINOSEB	2.00E-02	3.60E-02	Region IX	No
DIPHENYLAMINE	1.00E-02	9.10E-01	Region IX	No
FLUORANTHENE	1.00E-02	2.10E-01	MDEQ	No
FLUORENE	1.00E-02	2.00E+00	MDEQ	No
HEXACHLOROBUTADIENE	1.00E-02	4.00E-01	MDEQ	No
HEXACHLOROCYCLOPENTADIENE	1.00E-02	1.80E+00	MDEQ	No
HEXACHLOROETHANE	1.00E-02	1.90E+00	MDEQ	No
ISOPHORONE	1.00E-02	9.90E+02	MDEQ	No
N-NITROSODI-N-PROPYLAMINE	1.00E-02	3.60E-01	MDEQ	No
N-NITROSODIPHENYLAMINE	1.00E-02	3.50E+01	MDEQ	No
NAPHTHALENE	1.00E-02	3.10E+01	MDEQ	No
NITROBENZENE	1.00E-02	1.10E+01	MDEQ	No
P-PHENYLENEDIAMINE	2.00E-02	6.90E+00	Region IX	No
PENTACHLOROBENZENE	1.00E-02	2.40E-01	MDEQ	No
PENTACHLORONITROBENZENE	1.00E-02	3.20E-02	MDEQ	No
PENTACHLOROPHENOL	5.00E-02	2.00E-01	MDEQ	No
PHENANTHRENE	1.00E-02	1.00E+00	MDEQ	No
PHENOL	1.00E-02	2.90E+04	MDEQ	No
PRONAMIDE	1.00E-02	2.70E+00	Region IX	No
PYRENE	1.00E-02	1.40E-01	MDEQ	No
PYRIDINE	2.00E-02	9.40E+01	MDEQ	No
1,1,1,2-TETRACHLOROETHANE	1.00E-02	3.00E+01	MDEQ	No
1,1,1-TRICHLOROETHANE	5.00E-03	1.30E+03	MDEQ	No
1,1,2,2-TETRACHLOROETHANE	5.00E-03	4.70E+00	MDEQ	No
1,1,2-TRICHLOROETHANE	5.00E-03	2.10E+01	MDEQ	No
1,1-DICHLOROETHANE	5.00E-03	2.40E+03	MDEQ	No
1,1-DICHLOROETHENE	5.00E-03	1.10E+01	MDEQ	No
1,2,3-TRICHLOROPROPANE	1.00E-02	8.40E+01	MDEQ	No
1,2-DICHLOROETHANE	5.00E-03	1.90E+01	MDEQ	No
1,2-DICHLOROETHENE (TOTAL)	5.00E-03	2.00E+02	MDEQ	No
1,2-DICHLOROPROPANE	5.00E-03	1.60E+01	MDEQ	No
2-BUTANONE	1.00E-02	2.40E+05	MDEQ	No
2-HEXANONE	1.00E-02	5.20E+03	MDEQ	No
4-METHYL-2-PENTANONE	1.00E-02	1.30E+04	MDEQ	No
ACETONITRILE	1.00E-01	5.60E+03	MDEQ	No
ACROLEIN	5.00E-01	3.40E+03	MDEQ	No
ACRYLONITRILE	1.00E-01	1.40E+01	MDEQ	No
ALLYL CHLORIDE	2.00E-02	1.80E+00	Region IX	No
BENZENE	5.00E-03	1.10E+01	MDEQ	No
BROMODICHLOROMETHANE	5.00E-03	1.40E+01	MDEQ	No
BROMOFORM	5.00E-03	1.40E+02	MDEQ	No
BROMOMETHANE	1.00E-02	7.00E+01	MDEQ	No
CARBON DISULFIDE	5.00E-03	1.20E+03	MDEQ	No
CARBON TETRACHLORIDE	5.00E-03	4.60E+00	MDEQ	No
CHLOROBENZENE	5.00E-03	8.60E+01	MDEQ	No
CHLOROETHANE	1.00E-02	4.40E+02	MDEQ	No

Table 5

Comparison of Detection Limits to Screening Criteria for Nondetect Constituents in Groundwater
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detection Limit mg/L	Screening Level mg/L	Screening Level Source	Is the SQL > Screening Criteria?
CHLOROMETHANE	1.00E-02	4.90E+02	MDEQ	No
CIS-1,3-DICHLOROPROPENE	5.00E-03	1.30E+01	MDEQ	No
DIBROMOCHLOROMETHANE	5.00E-03	1.80E+01	MDEQ	No
DIBROMOMETHANE	1.00E-02	5.30E+02	MDEQ	No
DICHLORODIFLUOROMETHANE	2.00E-02	3.00E+02	MDEQ	No
ETHYLBENZENE	5.00E-03	1.70E+02	MDEQ	No
ETHYLMETHACRYLATE	2.00E-02	5.50E-01	Region IX	No
ISOBUTANOL	2.00E+00	2.50E+04	MDEQ	No
METHYLENE CHLORIDE	5.00E-03	2.20E+02	MDEQ	No
METHYLMETHACRYLATE	2.00E-02	1.40E+00	Region IX	No
STYRENE	5.00E-03	9.70E+00	MDEQ	No
TETRACHLOROETHENE	5.00E-03	1.20E+01	MDEQ	No
TOLUENE	5.00E-03	5.30E+02	MDEQ	No
TRANS-1,3-DICHLOROPROPENE	5.00E-03	1.30E+01	MDEQ	No
TRICHLOROETHENE	5.00E-03	3.70E+01	MDEQ	No
TRICHLOROFLUOROMETHANE	1.00E-02	1.10E+03	MDEQ	No
VINYL ACETATE	1.00E-02	8.00E+03	MDEQ	No
VINYL CHLORIDE	1.00E-02	5.70E-01	MDEQ	No
XYLENES (TOTAL)	5.00E-03	1.90E+02	MDEQ	No

MDEQ - MDEQ Cleanup Criteria - Industrial-Commercial Groundwater Contact Criteria
Region IX - US EPA Region IX Tap Water PRGs

Table 6
Summary of Exposure Parameters
ATOFINA Chemicals, West Brine Field, Riverview, MI

Receptor:		Construction Worker		Maintenance Worker		Office Worker		Adolescent Trespasser		Utility Trench Worker	
Parameter	**Units**		**Source**		**Source**		**Source**		**Source**		**Source**
Exposure frequency (soil)	days/year	45	1	250	4	245	3	24	1	NA	NA
Exposure frequency (groundwater)	days/year	5	1	NA	NA	245	3	NA	NA	10	1
Exposure duration	years	1	1	25	4	21	2	6	1	1	1
Exposure time	hours/day	4	1	NA	NA	NA	NA	NA	NA	4	1
Body weight	kg	70	4	70	4	70	4	56	7	70	4
Averaging time - noncarcinogenic	days	365	4	9125	4	7665	4	2190	1	365	4
Averaging time - carcinogenic	days	25550	4	25550	4	25550	4	25550	4	25550	4
Exposed skin surface area	cm^2/day	2570	2	2570	2	NA	NA	4381	7	2570	2
Adherence Factor	mg/cm^2	0.143	1	0.036	1	NA	NA	0.025	7	NA	NA
Soil ingestion rate	mg/day	480	7	50	2	NA	NA	50	2	NA	NA
Dermal absorption (non-volatiles)	percent	1%	2	1%	2	NA	NA	1%	2	NA	NA
Dermal absorption (volatiles)	percent	10%	2	10%	2	NA	NA	10%	2	NA	NA
Inhalation Rate	m^3/shift	20	4	20	4	10	3	10	2	20	4

1 Reasonable Maximum

2 MDEQ, Part 201 Cleanup Criteria Technical Support Document, October 2, 1998

3 MDEQ, Draft Part 201 Generic Residential and Commercial/Industrial Groundwater and Soil Volatilization to Indoor Air Inhalation Criteria: Technical Support Document, March 1998.

4 US EPA HHEM Supplemental Guidance, 1991.

5 Cowherd, 1985

6 ICRP, 1968

7 US EPA Exposure Factors Handbook, 1997

Table 7
Particulate Emission Rate for Vehicular Movement and Excavation
ATOFINA Chemicals, West Brine Field, Riverview, MI

Vehicular Movement

E (lbs/vehicle mile) = k * (5.9) * (s/12)(S/30) * (W/3)^0.7((w/4)^0.5) * ((365-p)/365)

E =	8.25	particulate emission rate (lbs/vehicle mile - 24 miles travelled total over 45 - 8 hr days)	
k =	0.45	particle size multiplier	U.S. EPA SEAM, 1988
s =	31.5	percent silt content	Site Specific
S =	15	mean vehicle speed (mi/hr)	U.S. EPA SEAM, 1988
W =	12.5	mean vehicle weight (ton)	U.S. EPA SEAM, 1988
w =	8	mean number of wheels per vehicle	U.S. EPA SEAM, 1988
p =	140	mean number of days with ³0.01 inches of precipitation per year	U.S. EPA SEAM, 1988

Emission Rate =	lbs/sec	(E lbs/mi) * (24 mi/job) * (job/45 days) * (1 day/8 hrs) * (1 hr/3600 sec)
	1.53E-04	lbs/sec
	6.93E-02	g/sec
	0.000069	**kg/sec**

Excavation

$E = (1.0 * s^{1.5})/M^{1.4}$ = 3.09E+00 lbs/hour

E =	3.09E+00	particulate emission factor (lbs/hr)	
s =	31.5	percent silt content	Site Specific
M =	18	percent soil moisture content	Site Specific

Emission Rate =	8.59E-04	lbs/sec
	0.389	g/sec
	0.000389	**kg/sec**

Table 8
Summary of Windrose Data
ATOFINA Chemicals, West Brine Field, Riverview, MI

GRAPHICAL EXPOSURE MODELING SYSTEM
STAR STATION 94847 DETROIT/METROPOLITAN MICHIGAN 1973-1977

AUXILIARY VARIABLES
Afternoon mixing height (meters): 1403
Nocturnal mixing height (meters): 499
Ambient air temperature (Kelvin): 299
Precipitation frequency (fraction): 281.4
Precipitation intensity (mm/hour): 71.58
Grand average windspeed (m/s): 5.86

Table 9
COPC Toxicity Information
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Oral Chronic RfD mg/kg/d	Source	Inhalation Chronic RfD mg/kg/d	Source	Oral Subchronic RfD mg/kg/d	Source	Inhalation Subchronic RfD mg/kg/d	Source	Oral CSF 1/mg/kg/d	Source	Inhalation CSF 1/mg/kg/d	Source
Dioxins												
2,3,7,8-TCDD TEQ	NA	NA	NA	NA	NA	NA	NA	NA	1.50E+05	H	1.50E+05	H
Inorganics												
ANTIMONY, TOTAL	4.00E-04	I	2.60E-04	Pa	4.00E-04	H	2.60E-03	Pa	NA	NA	NA	NA
ARSENIC, TOTAL	3.00E-04	I	1.00E-04	Pa	3.00E-04	H	1.00E-04	Pa	1.50E+00	I	1.51E+01	I
CADMIUM, TOTAL	5.00E-04	I	5.70E-05	E	2.30E-03	Pa	5.80E-04	Pa	NA	NA	6.30E+00	I
CHROMIUM, TOTAL	3.00E-03	I	3.00E-05	I	2.00E-02	H	1.00E-04	Pa	NA	NA	4.10E+01	H
LEAD, TOTAL	2.80E-03	Pa	4.29E-04	NAAQS	2.80E-03	Pa	4.29E-04	NAAQS	NA	NA	NA	NA
Semivolatiles												
BENZO(A)PYRENE	1.20E-03	Pa	1.20E-03	Ps	1.20E-02	Pa	1.20E-02	Ps	7.30E+00	I	3.10E+00	IE
BIS(2-ETHYLHEXYL)PHTHALATE	2.00E-02	I	2.00E-02	Ps	2.00E-02	W	2.00E+00	Ps	1.40E-02	I	1.40E-02	IE
N-NITROSODIETHYLAMINE	6.00E-02	Pa	5.40E-02	Ps	6.00E-01	Pa	5.40E-01	Ps	1.50E+02	I	1.50E+02	I
N-NITROSODIPHENYLAMINE	5.00E-02	Pa	5.00E-02	Ps	1.50E+00	Pa	1.50E+00	Ps	4.90E-03	I	4.90E-03	Ps
Volatiles												
NAPHTHALENE	2.00E-02	I	9.00E-04	I	4.00E-02	Pa	5.30E-02	Ps	NA	NA	NA	NA
CHLOROFORM	1.00E-02	I	8.60E-05	E	1.00E-02	H	7.30E-02	Pa	6.10E-03	I	8.10E-02	I

Footnotes:

NA - Not Available

E - US EPA NCEA provisional value

I - IRIS, 2000

IE - values are published in IRIS as RfC values and are converted to RfD values

H - HEAST, 1997

NAAQS - National Ambient Air Quality Standard expressed in mg/kg/day

W - Withdrawn from IRIS or HEAST

Pa - provisional, administered dose

Ps - provisional, absorbed dose

Table 10
Summary of Hazard and Risk Calculations
ATOFINA Chemicals, West Brine Field, Riverview, MI

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Table Referenced
Dermal Exposure to Soil	Construction Workers	3E-04	1E-08	11
Ingestion of Soil	Construction Workers	3E-02	2E-06	12
Inhalation of Fugitive Dust and VOC Vapors	Construction Workers	2E-03	4E-08	13
Dermal Exposure to Groundwater	Construction Workers	4E-04	9E-10	14
	Total:	**3E-02**	**2E-06**	
Dermal Exposure to Soil	Maintenance Worker	2E-06	2E-10	15
Ingestion of Soil	Maintenance Worker	5E-02	3E-05	16
Inhalation of Fugitive Dust and VOC Vapors	Maintenance Worker	1E-01	3E-08	17
	Total:	**2E-01**	**3E-05**	
Dermal Exposure to Soil	Trespasser	1E-07	4E-12	18
Ingestion of Soil	Trespasser	6E-03	7E-07	19
Inhalation of Fugitive Dust and VOC Vapors	Trespasser	7E-03	5E-10	20
	Total:	**1E-02**	**7E-07**	
Inhalation of Vapors from Soil Infiltrating Into Building	Office Worker	1E-01	NA	21
Inhalation of Vapors from Groundwater Infiltrating Into Building	Office Worker	1E-05	3E-11	22
	Total:	**1E-01**	**3E-11**	
Dermal Exposure to Groundwater in a Construction Pit	Utility Trench Workers	7E-04	2E-09	23
Inhalation of VOC Vapors from Groundwater in a Construction Pit	Utility Trench Workers	2E-10	2E-14	24
	Total:	**7E-04**	**2E-09**	

NA - Not Applicable

Table 11

Dermal Exposure to Soil (1-14 feet bgs) by a Construction Worker

ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	see below	
SA - Surface area available for exposure =	cm^2/shift	2570	MDEQ, 1998
AH - Adherence factor =	mg/cm^2	0.143	reasonable maximum
ABS_n - Absorption - non-volatiles =		0.01	MDEQ, 1998
ABS_v - Absorption - volatiles =		0.1	MDEQ, 1998
EF - Exposure frequency =	shifts/year	45	reasonable maximum
ED - Exposure duration =	years	1	reasonable maximum
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	US EPA, 1991
AT_n - Averaging time - noncarcinogenic =	days	365	reasonable maximum
AT_c - Averaging time - carcinogenic =	days	25550	US EPA, 1991

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD TEQ	3.47E-05	2.24E-13	NA	NA	3.21E-15	1.50E+05	4.81E-10
Inorganics							
ARSENIC, TOTAL	9.53E+00	6.17E-08	3.00E-04	2.06E-04	8.81E-10	1.50E+00	1.32E-09
Semivolatiles							
BENZO(A)PYRENE	8.40E-01	5.44E-09	1.20E-02	4.53E-07	7.77E-11	7.30E+00	5.67E-10
N-NITROSODIETHYLAMINE	7.80E-01	5.05E-09	6.00E-01	8.41E-09	7.21E-11	1.50E+02	1.08E-08
N-NITROSODIPHENYLAMINE	1.39E+02	9.00E-07	1.50E+00	6.00E-07	1.29E-08	4.90E-03	6.30E-11
Volatiles							
NAPHTHALENE	7.17E+01	4.64E-06	4.00E-02	1.16E-04	6.63E-08	NA	NA

NA - Not Available

Total Hazard Index = 3.23E-04

Total Cancer Risk = 1.33E-08

Table 12
Ingestion of Soil (1-14 feet bgs) by a Construction Worker
ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Cs * IngR * EF * ED * CF}{BW * AT}$$

Cs - Concentration in soil =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/shift	480	US EPA, 1997
EF - Exposure frequency =	shifts/year	45	reasonable maximum
ED - Exposure duration =	years	1	MDEQ, 1998
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	US EPA, 1991
AT_n - Averaging time - noncarcinogenic =	days	365	reasonable maximum
AT_c - Averaging time - carcinogenic =	days	25550	US EPA, 1991

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD TEQ	3.47E-05	2.93E-11	NA	NA	4.19E-13	1.50E+05	6.28E-08
Inorganics							
ARSENIC, TOTAL	9.53E+00	8.06E-06	3.00E-04	2.69E-02	1.15E-07	1.50E+00	1.73E-07
Semivolatiles							
BENZO(A)PYRENE	8.40E-01	7.10E-07	1.20E-02	5.92E-05	1.01E-08	7.30E+00	7.41E-08
N-NITROSODIETHYLAMINE	7.80E-01	6.59E-07	6.00E-01	1.10E-06	9.42E-09	1.50E+02	1.41E-06
N-NITROSODIPHENYLAMINE	1.39E+02	1.18E-04	1.50E+00	7.83E-05	1.68E-06	4.90E-03	8.23E-09
Volatiles							
NAPHTHALENE	7.17E+01	6.06E-05	4.00E-02	1.52E-03	8.66E-07	NA	NA
NA - Not Available			Total Hazard Index =	2.85E-02		Total Cancer Risk =	1.73E-06

Exposure to Construction Workers from Inhalation of VOC Vapors and Fugitive Dust
ATOFINA Chemicals, West Brine Field, Riverview, MI

Intake (mg/kg-day) = ıke (mg/kg-day) = $\frac{Ca*InhR*EF*ED}{BW*AT}$

Ca - Concentration in air (mg/m^3) =	see below	calculated
InhR - Inhalation rate (m^3/shift) =	20	USEPA 1991
EF - Exposure frequency (shifts/year) =	45	reasonable maximum
ED - Exposure duration (years) =	1	reasonable maximum
BW - Body weight (kg) =	70	USEPA 1991
AT_n - Averaging time - noncarcinogenic (days) =	365	reasonable maximum
AT_c - Averaging time - carcinogenic (days) =	25550	USEPA 1991

Ei - Emission Rate for dust-entrained chemicals (mg/sec) = Cs*(PERv+PERe)

Cs - Concentration in soil (mg/kg) =	see below	Site specific
PERv - Particle Emission Rate (Vehicular movement, kg/sec) =	6.93E-05	Site specific
PERe - Particle Emission Rate (Excavation, kg/sec) =	3.89E-04	Site specific

Ca = Concentration in Air (mg/m^3) = Ei/(Hb*W*V)

Ei - Emission Rate of Component (mg/sec) =	see below
Hb - Downwind Ht (m) =	4.81
W - Width (m) =	50
V - Wind speed (m/sec) =	5.86
Length (downwind distance) (m) =	50
r - Roughness Ht. (m) =	0.20
z - downwind distance (m) =	50

z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Ei - Emission Rate for VOCs (mg/sec) =	(Flux*A)/CFb
Flux - Flux rate ($mg/day-cm^2$) =	chem. specific
A - Affected area (cm^2) =	9.73E+07
CFb - Conversion factor (s/day) =	86400

Constituent	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins									
2,3,7,8-TCDD TEQ	3.47E-05	1.59E-08	1.13E-11	3.98E-13	NA	NA	5.69E-15	1.50E+05	8.53E-10
Inorganics									
ARSENIC, TOTAL	9.53E+00	4.37E-03	3.11E-06	1.09E-07	1.00E-04	1.09E-03	1.56E-09	1.51E+01	2.36E-08
Semivolatiles									
BENZO(A)PYRENE	8.40E-01	3.85E-04	2.74E-07	9.64E-09	1.20E-02	8.03E-07	1.38E-10	3.10E+00	4.27E-10
N-NITROSODIETHYLAMINE	7.80E-01	3.58E-04	2.54E-07	8.95E-09	5.40E-01	1.66E-08	1.28E-10	1.50E+02	1.92E-08
N-NITROSODIPHENYLAMINE	1.39E+02	6.38E-02	4.53E-05	1.60E-06	1.50E+00	1.06E-06	2.28E-08	NA	NA
Volatiles									
NAPHTHALENE	7.17E+01	9.99E-01	7.09E-04	2.50E-05	5.30E-02	4.72E-04	1.79E-07	NA	NA

NA - Not Available

Total Hazard Index = 1.57E-03 Total Cancer Risk = 4.41E-08

Table 14
Dermal Exposure to Groundwater by a Construction Worker
ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ET*EF*ED*CF}{BW*AT}$$

C_w - Concentration in groundwater =	mg/L	chem. spec.	
SA - Surface area available for exposure =	cm^2	2570	MDEQ, 1998
Kp - Dermal permeability constant =	cm/hr	chem. spec.	
ET - Exposure time =	hrs/day	4	reasonable assumption
EF - Exposure frequency =	days/year	5	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1997, EFH
AT_n - Averaging time - noncarcinogenic =	days	365	reasonable assumption
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Groundwater mg/L	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics							
ANTIMONY, TOTAL	1.84E-02	3.70E-08	4.00E-04	9.24E-05	5.28E-10	NA	NA
ARSENIC, TOTAL	3.44E-02	3.32E-08	3.00E-04	1.11E-04	4.74E-10	1.50E+00	7.11E-10
CADMIUM, TOTAL	7.79E-03	1.57E-08	2.30E-03	6.81E-06	2.24E-10	NA	NA
CHROMIUM, TOTAL	9.58E-02	4.05E-07	2.00E-02	2.02E-05	5.78E-09	NA	NA
LEAD, TOTAL	9.09E-02	1.47E-08	2.80E-03	5.25E-06	2.10E-10	NA	NA
Semivolatiles							
BIS(2-ETHYLHEXYL)PHTH	1.00E-02	6.64E-07	2.00E-02	3.32E-05	9.48E-09	1.40E-02	1.33E-10
Volatiles							
CHLOROFORM	4.07E-03	1.06E-06	1.00E-02	1.06E-04	1.52E-08	6.10E-03	9.27E-11

NA - Not Available

Total Hazard Index = 3.75E-04

Total Cancer Risk = 9.37E-10

Table 15

Dermal Exposure to Soil (1-3 feet bgs) by a Maintenance Worker
ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	see below	
SA - Surface area available for exposure =	cm^2/shift	2570	MDEQ, 1998
AH - Adherence factor =	mg/cm^2	0.036	reasonable maximum
ABS_n - non-volatiles =		0.01	MDEQ, 1998
ABS_v - Absorption - volatiles =		0.1	MDEQ, 1998
EF - Exposure frequency =	shifts/year	250	US EPA, 1991
ED - Exposure duration =	years	25	US EPA, 1991
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	US EPA, 1991
AT_n - Averaging time - noncarcinogenic =	days	9125	US EPA, 1991
AT_c - Averaging time - carcinogenic =	days	25550	US EPA, 1991

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics							
ARSENIC, TOTAL	1.03E+01	3.64E-11	3.00E-04	1.21E-07	1.30E-11	1.50E+00	1.95E-11
Semivolatiles							
BENZO(A)PYRENE	6.70E-01	2.36E-12	1.20E-03	1.97E-09	8.43E-13	7.30E+00	6.15E-12
N-NITROSODIETHYLAMINE	7.80E-01	2.75E-12	6.00E-02	4.58E-11	9.81E-13	1.50E+02	1.47E-10
N-NITROSODIPHENYLAMINE	1.90E+03	6.69E-09	5.00E-02	1.34E-07	2.39E-09	4.90E-03	1.17E-11
Volatiles							
NAPHTHALENE	7.30E+02	2.57E-08	2.00E-02	1.29E-06	9.18E-09	NA	NA

NA - Not Available

Total Hazard Index = 1.54E-06

Total Cancer Risk = 1.85E-10

Table 16
Ingestion of Soil (1-3 feet bgs) by a Maintenance Worker
ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Cs*IngR*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/shift	50	US EPA, 1991
EF - Exposure frequency =	shifts/year	250	US EPA, 1991
ED - Exposure duration =	years	25	US EPA, 1991
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	US EPA, 1991
AT_n - Averaging time - noncarcinogenic =	days	9125	US EPA, 1991
AT_c - Averaging time - carcinogenic =	days	25550	US EPA, 1991

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics							
ARSENIC, TOTAL	1.03E+01	5.06E-06	3.00E-04	1.69E-02	1.81E-06	1.50E+00	2.71E-06
Semivolatiles							
BENZO(A)PYRENE	6.70E-01	3.28E-07	1.20E-03	2.73E-04	1.17E-07	7.30E+00	8.55E-07
N-NITROSODIETHYLAMINE	7.80E-01	3.82E-07	6.00E-02	6.36E-06	1.36E-07	1.50E+02	2.04E-05
N-NITROSODIPHENYLAMINE	1.90E+03	9.30E-04	5.00E-02	1.86E-02	3.32E-04	4.90E-03	1.63E-06
Volatiles							
NAPHTHALENE	7.30E+02	3.57E-04	2.00E-02	1.79E-02	1.28E-04	NA	NA

NA - Not Available

Total Hazard Index = 5.36E-02

Total Cancer Risk = 2.56E-05

Inhalation of VOC Vapors and Fugitive Dust by a Maintenance Worker
ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Ca * InhR * EF * ED}{BW * AT}$$

Ca - Concentration in air (mg/m^3) =	see below	calculated
InhR - Inhalation rate (m^3/shift) =	20	US EPA, 1991
EF - Exposure frequency (shifts/year) =	250	US EPA, 1991
ED - Exposure duration (years) =	25	US EPA, 1991
BW - Body weight (kg) =	70	US EPA, 1991
AT_n - Averaging time - noncarcinogenic (days) =	9125	US EPA, 1991
AT_c - Averaging time - carcinogenic (days) =	25550	US EPA, 1991

Ca = Concentration of VOC in Air (mg/m^3) = Ei/(Hb*W*V)
Ei - Emission Rate of Component (mg/sec) = see below
Hb - Downwind Ht (m) = 7.54
W - Width (m) = 98.6
V - Wind speed (m/sec) = 5.86
Length (downwind distance) (m) = 98.6
r - Roughness Ht. (m) = 0.20
z - downwind distance (m) = 98.6
z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Ei - Emission Rate for VOCs (mg/sec) = (Flux*A)/Cfb
Flux - Flux rate (mg/day-cm^2) = chem. specific
A - Affected area (cm^2) = 9.73E+07
CFb - Conversion factor (s/day) = 86400

Ca for chemical entrained on dust (mg/m^3) =	Cs * 1/PEF	
Cs - Concentration in soil (mg/kg) =	site specific	see below
PEF - Particulate Emission Factor (m^3/kg) =	5.57E+08	calculated

PEF (m^3/kg) = $(Q/C)*3600/(0.036*(1-V)*(U_m/U_t)^3*F(x)$

Q/C - Dispersion factor (g/m^2 per kg/m^3) =	74.94	US EPA, 2001
V - Vegetative cover (%) =	0.5	site specific
U_m - Mean annual windspeed (m/sec) =	5.86	site specific
U_t - Equivalent threshold value of windspeed at 7m (m/s) =	11.32	US EPA, 2001
F(x) - Um/Ut-dependent function (unitless) =	1.94E-01	US EPA, 2001

Q/C (g/m^2 per kg/m^3) = $A*(\exp((\ln A_{site}-B)^2/C)$
A - dispersion constant (unitless) = 16.8653
B - dispersion constant (unitless) = 18.7848
C - dispersion constant (unitless) = 215.0624
Asite - affected area of site (acres) = 2.4

Constituent	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics									
ARSENIC, TOTAL	1.03E+01	NA	1.86E-08	3.63E-09	1.00E-04	3.63E-05	1.30E-09	1.51E+01	1.96E-08
Semivolatiles									
BENZO(A)PYRENE	6.70E-01	NA	1.20E-09	2.35E-10	1.20E-03	1.96E-07	8.41E-11	3.10E+00	2.61E-10
N-NITROSODIETHYLAMINE	7.80E-01	NA	1.40E-09	2.74E-10	5.40E-02	5.08E-09	9.79E-11	1.50E+02	1.47E-08
N-NITROSODIPHENYLAMINE	1.90E+03	NA	3.41E-06	6.68E-07	5.00E-02	1.34E-05	2.38E-07	NA	NA
Volatiles									
NAPHTHALENE	7.30E+02	2.23E+00	5.11E-04	1.00E-04	9.00E-04	1.11E-01	3.57E-05	NA	NA

NA - Not Applicable

Total Hazard Index = 1.11E-01 Total Cancer Risk = 3.45E-08

Table 18
Dermal Exposure to Soil (1-3 feet bgs) by an Adolescent Trespasser (12-18 years old)
ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	see below	
SA - Surface area available for exposure =	cm^2/day	4381	US EPA, 1997
AH - Adherence factor =	mg/cm^2	0.025	US EPA, 1997
ABS_n - non-volatiles =		0.01	MDEQ, 1998
ABS_v - Absorption - volatiles =		0.1	MDEQ, 1998
EF - Exposure frequency =	days/year	24	reasonable maximum
ED - Exposure duration =	years	6	reasonable maximum
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	56	US EPA, 1997
AT_n - Averaging time - noncarcinogenic =	days	2190	reasonable maximum
AT_c - Averaging time - carcinogenic =	days	25550	US EPA, 1991

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics							
ARSENIC, TOTAL	1.03E+01	3.03E-12	3.00E-04	1.01E-08	2.60E-13	1.50E+00	3.90E-13
Semivolatiles							
BENZO(A)PYRENE	6.70E-01	1.97E-13	1.20E-03	1.64E-10	1.69E-14	7.30E+00	1.23E-13
N-NITROSODIETHYLAMINE	7.80E-01	2.29E-13	6.00E-02	3.82E-12	1.96E-14	1.50E+02	2.94E-12
N-NITROSODIPHENYLAMINE	1.90E+03	5.58E-10	5.00E-02	1.12E-08	4.78E-11	4.90E-03	2.34E-13
Volatiles							
NAPHTHALENE	7.30E+02	2.14E-09	2.00E-02	1.07E-07	1.84E-10	NA	NA

NA - Not Available

Total Hazard Index = 1.29E-07

Total Cancer Risk = 3.69E-12

Table 19

Ingestion of Soil (1-3 feet bgs) by an Adolescent Trespasser (12-18 years old)

ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Cs * IngR * EF * ED * CF}{BW * AT}$$

Cs - Concentration in soil =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	50	MDEQ, 1998
EF - Exposure frequency =	days/year	24	reasonable maximum
ED - Exposure duration =	years	6	reasonable maximum
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	56	US EPA, 1997
AT_n - Averaging time - noncarcinogenic =	days	2190	reasonable maximum
AT_c - Averaging time - carcinogenic =	days	25550	US EPA, 1991

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics							
ARSENIC, TOTAL	1.03E+01	6.07E-07	3.00E-04	2.02E-03	5.20E-08	1.50E+00	7.80E-08
Semivolatiles							
BENZO(A)PYRENE	6.70E-01	3.93E-08	1.20E-03	3.28E-05	3.37E-09	7.30E+00	2.46E-08
N-NITROSODIETHYLAMINE	7.80E-01	4.58E-08	6.00E-02	7.63E-07	3.93E-09	1.50E+02	5.89E-07
N-NITROSODIPHENYLAMINE	1.90E+03	1.12E-04	5.00E-02	2.23E-03	9.56E-06	4.90E-03	4.68E-08
Volatiles							
NAPHTHALENE	7.30E+02	4.29E-05	2.00E-02	2.14E-03	3.67E-06	NA	NA

NA - Not Available

Total Hazard Index = 6.43E-03

Total Cancer Risk = 7.38E-07

Table 20

Inhalation of VOC Vapors and Fugitive Dust by an Adolescent Trespasser (12-18 years old)

ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Ca * InhR * EF * ED}{BW * AT}$$

Ca - Concentration in air (mg/m^3) =	see below	calculated
InhR - Inhalation rate (m^3/day) =	10	MDEQ, 1998
EF - Exposure frequency (days/year) =	24	reasonable maximum
ED - Exposure duration (years) =	6	reasonable maximum
BW - Body weight (kg) =	56	US EPA, 1997
AT_n - Averaging time - noncarcinogenic (days) =	2190	reasonable maximum
AT_c - Averaging time - carcinogenic (days) =	25550	US EPA, 1991

Ca = Concentration of VOC in Air (mg/m^3) = Ei/(Hb*W*V)

Ei - Emission Rate of Component (mg/sec) = see below

Hb - Downwind Ht (m) = 7.54

W - Width (m) = 98.6

V - Wind speed (m/sec) = 5.86

Length (downwind distance) (m) = 98.6

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 98.6

$z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]$

Ei - Emission Rate for VOCs (mg/sec) = (Flux*A)/Cfb

Flux - Flux rate (mg/day-cm^2) = chem. specific

A - Affected area (cm^2) = 9.73E+07

CFb - Conversion factor (s/day) = 86400

Ca for chemical entrained on dust (mg/m^3) =	Cs * 1/PEF		
Cs - Concentration in soil (mg/kg) =	site specific	see below	
PEF - Particulate Emission Factor (m^3/kg) =	5.57E+08	calculated	

$PEF\ (m^3/kg) = (Q/C)*3600/(0.036*(1-V)*(U_m/U_t)^3*F(x)$

$Q/C\ (g/m^2\ per\ kg/m^3) = A*(\exp((\ln A_{site}-B)^2/C)$

Q/C - Dispersion factor (g/m^2 per kg/m^3) =	74.94	US EPA, 2001
V - Vegetative cover (%) =	0.5	site specific
U_m - Mean annual windspeed (m/sec) =	5.86	site specific
U_t - Equivalent threshold value of windspeed at 7m (m/s) =	11.32	US EPA, 2001
F(x) - Um/Ut-dependent function (unitless) =	1.94E-01	US EPA, 2001

A - dispersion constant (unitless) =	16.8653
B - dispersion constant (unitless) =	18.7848
C - dispersion constant (unitless) =	215.0624
Asite - affected area of site (acres) =	2.4

Constituent	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics									
ARSENIC, TOTAL	1.03E+01	NA	1.86E-08	2.18E-10	1.00E-04	2.18E-06	1.87E-11	1.51E+01	2.82E-10
Semivolatiles									
BENZO(A)PYRENE	6.70E-01	NA	1.20E-09	1.41E-11	1.20E-03	1.18E-08	1.21E-12	3.10E+00	3.75E-12
N-NITROSODIETHYLAMINE	7.80E-01	NA	1.40E-09	1.64E-11	5.40E-02	3.05E-10	1.41E-12	1.50E+02	2.11E-10
N-NITROSODIPHENYLAMINE	1.90E+03	NA	3.41E-06	4.01E-08	5.00E-02	8.01E-07	3.43E-09	NA	NA
Volatiles									
NAPHTHALENE	7.30E+02	2.23E+00	5.11E-04	6.00E-06	9.00E-04	6.67E-03	5.14E-07	NA	NA

NA - Not Applicable

Total Hazard Index = 6.67E-03 Total Cancer Risk = 4.97E-10

Table 21

Exposure via Inhalation of Vapors from Soil Infiltrating Into an Office Building

ATOFINA Chemicals, West Brine Field, Riverview, MI

C_{bldg} (mg/m^3) = a*Cso*CFa

α (unitless) = (((Dveff*Ab)/(Qbldg*Lt))*exp(Pe))/(exp(Pe)+((Dveff*Ab)/(Qbldg*Lt))+((Dveff*Ab)/(Qsoil*Lt))*(exp(Pe)-1)))

Ab (cm^2) = (L*W)+(2*(Zcr*L)+2*(Zcr*W))

Qbldg (cm^3/s) = (L*W*Hgt*ACH)/CFb

Pe (unitless) = (Qsoil*Lcr)/(Dcr*Acr)

Dveff (cm^2/s) = (D_{air}*((ev$^{3.33}$)/(et^2)))+((D_w/Hprime)*(ew$^{3.33}$/et^2))

H' (unitless) = H/(Rgb*T)

ev (unitless) = et - (thetam*pb)

ew (unitless) = et - ev

Qsoil (cm^3/s) = (2*π*ΔP*kv*Xcr)/(μ*ln((2*Zcr)/rcr))

rcr (cm) = (η*Ab)/Xcr

If Cas < Csi, then equilibrium vapor phase conc. (Cso) = Cas

If Cas ³ Csi, the equilibrium vapor phase conc. (Cso) = Csi

where Cas = Equilibrium conc. of VOC vapor in soil air

and Csi = Saturation vapor concentration

Csi (mg/cm^3) = (Mx*VP*MW*CFc)/(Rg*T)

Mx (unitless) = $RMF_i/\Sigma RMF_{i\to n}$

Cas (mg/cm^3 air) = ((H'*Cs*CFd)/((H'*(ev/pb))+thetam+Kd))*(1-exp(-u*τ)/u*τ)

u (days) = ln(2)/thalf

Intake (mg/kg-day) = (C_{bldg}*InhR*EF*ED)/(BW*AT)

Ab - Surface area of walls and floor below grade =	3.84E+06	cm^2
ACH - Air exchange rate =	2	exc/hour
Acr - Total area of cracks =	3.84E+02	cm^2
AT_c - Averaging time carcinogenic =	25,550	days
AT_n - Averaging time noncarcinogenic =	7,665	days
BW - Body weight =	70	kg
C_{bldg} - Concentration in building air =	see below	mg/m^3
CFa - Conversion factor =	1.00E+09	cm^3-mg/m^3-g
CFb - Conversion factor =	3 60E+03	s/hour
CFc - Conversion factor =	1.00E+03	mg/g
CFd - Conversion factor =	1.00E-03	kg/g
Cs - Concentration in soil =	see below	mg/kg
Cs_i - Concentration in soil of constituent *i* =	see below	mg/kg
Cso - Vapor phase concentration at the source =	see below	g/cm^3
D_{air} - Diffusivity in air =	chem. specific	cm^2/s
Dcr - Effective diffusion coefficient through the crack (»Dveff) =	see below	cm^2/s
Dveff - Effective diffusion coefficient through vadose zone =	see below	cm^2/s
D_w - Diffusivity in water =	chem. specific	cm^2/s
ED - Exposure duration =	21	years
EF - Exposure frequency =	245	shifts/year
et - Total soil porosity =	0.329	unitless
ev - Vapor-filled soil porosity =	0.048	unitless
ew - Water-filled soil porosity =	0.281	unitless
H - Henry's Law constant =	chem. specific	atm-m^3/mol
H' - Henry's Law constant =	chem. specific	unitless
Hgt - Building height =	244	cm
InhR - Inhalation rate =	10	m^3/shift
Kd - Soil-water partition coefficient =	see below	cm^3/g
kv - Soil permeability to vapor flow =	1.25E-12	cm^2

L - Building length =	1.93E+03	cm
Lcr - Building foundation thickness =	15	cm
Lt - Distance between contaminant source and building =	30.48	cm
MW - Molecular weight =	chem. specific	g/mol
MW_i - Molecular weight of constituent *i* =	chem. specific	g/mol
Mx - Mole fraction of constituent =	see below	unitless
pb - Bulk soil density =	1.86	g/cm^3
Pe - Peclet number =	see below	unitless
Qbldg - Building ventilation rate =	5.04E+05	cm^3/s
Qsoil - Convective flow rate from the soil into the building =	1.87E-03	cm^3/s
rcr - Radius of cracks =	4.97E+00	cm
Rg - Universal gas constant =	6.24E+04	mmHg-cm^3/mol-K
Rgb - Universal gas constant =	8.20E-05	atm-m^3/mol-K
RMF_i - Relative mole fraction =	$(Cs_i/\Sigma Cs_{i\to n})/MW_i$	mol/g
T - Temperature =	283.15	K
thalf - Half life of compound =	1.00E+06	days
thetam - Soil moisture content =	0.151	cm^3/g
u - Net degradation rate =	see below	days
VP - Vapor pressure =	chem. specific	mmHg
W - Building width =	1.93E+03	cm
Xcr - Length of cylinder modeling vapor flow =	7.71E+03	cm
Zcr - Building depth below grade to bottom of foundation =	15	cm
α - Attenuation coefficient =	see below	unitless
ΔP - Indoor/outdoor pressure difference =	10	g/cm-s^2
η - ratio of area of cracks to area of foundation (Acr/Ab) =	0.01	cm^2/cm^2
μ - Vapor viscosity =	1.80E-04	g/cm-s
τ - Time period =	7.67E+03	days

Table 21
Exposure via Inhalation of Vapors from Soil Infiltrating Into an Office Building
ATOFINA Chemicals, West Brine Field, Riverview, MI

Constituent	Concentration in Soil mg/kg	Equilibrium Concentration of VOC Vapor in Soil Air Cas g/cm^3 air	Saturation Vapor Concentration Csi mg/cm^3	Attenuation Coefficient (a) unitless	Peclet Number (Pe) unitless	Vapor Phase Concentration (Cso) g/cm^3	Concentration in Building (Cbldg) mg/m^3	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles													
NAPHTHALENE	7.17E+01	4.71E-05	3.41E-04	5.17E-08	7.45E-02	4.71E-05	2.43E-03	1.17E-04	9.00E-04	1.30E-01	7.00E-05	NA	NA

Total Hazard Index: 1.30E-01

C_{bldg} (mg/m³) = $\alpha * Cso * CFa$

α (unitless) = $(((Dteff * Ab)/(Qbldg * Lt)) * \exp(Pe))/(\exp(Pe) + ((Dteff * Ab)/(Qbldg * Lt)) + ((Dteff * Ab)/(Qsoil * Lt)) * (\exp(Pe) - 1$

Pe (unitless) = $(Qsoil * Lcr)/(Dcr * Acr)$

Dveff (cm²/s) = $(D_{air} * ((ev^{3.33})/(et^2))) + ((D_w/Hprime) * (ew^{3.33}/et^2))$

Dteff (cm²/s) = $Lt/(((hv + Lcr)/Dveff) + (ht/Dseff))$

Ab (cm²) = $(L * W) + (2 * (Zcr * L)) + 2 * (Zcr * W))$

Q_{bldg} (cm³/s) = $(L * W * Hgt * ACH)/CFb$

Dseff (cm²/s) = $(D_{air} * (evt^{3.33}/et^2)) + ((D_w/Hprime) * (ewt^{3.33}/et^2))$

H' (unitless) = $H/(Rgb * T)$

ev (unitless) = $et - (thetam * pb)$

ew (unitless) = $et - ev$

Qsoil (cm³/s) = $(2 * \pi * \Delta P * kv * Xcr)/(\mu * \ln((2 * Zcr)/rcr))$

rcr (cm) = $(\eta * Ab)/Xcr$

If Cas < Csi, then equilibrium vapor phase conc. (Cso) = Cas
If Cas ≥ Csi, the equilibrium vapor phase conc. (Cso) = Csi
where Cas = Equilibrium conc. of VOC vapor in soil air
and Csi = Saturation vapor concentration

If Cgw > Solubility (S), then Cgw' = S
If Cgw ≤ Solubility (S), then Cgw' = Cgw
where Cgw = Constituent concentration in groundwater
and Cgw' = Working groundwater concentration

Csi (g/cm³) = $(Mx * VP * MW)/(Rg * T)$

Mx (unitless) = $RMF_i/\Sigma RMF_{i \to n}$

Cas (g/cm³ air) = $H' * Cgw' * ((1 - \exp(-u * \tau))/(u * \tau)) * CFc$

u (days) = $\ln(2)/thalf$

Intake (mg/kg-day) = $(C_{bldg} * InhR * EF * ED)/(BW * AT)$

Ab - Surface area of building walls and floor below grade =	3.84E+06	cm²
ACH - Air exchange rate =	2	exc/hour
Acr - Total area of cracks =	3.84E+02	cm²
AT_c - Averaging time carcinogenic =	25,550	days
AT_n - Averaging time noncarcinogenic =	7,665	days
BW - Body weight =	70	kg
C_{bldg} - Concentration in building air =	see below	mg/m³
CFa - Conversion factor =	1.00E+09	cm³-mg/m³-g
CFb - Conversion factor =	3.60E+03	s/hour
CFc - Conversion factor =	1.00E-06	g-L/mg-cm³
Cgw' - Working groundwater concentration =	see below	mg/L
Cgw_i - Concentration in groundwater of constituent *i* =	see below	mg/L
Cso - Vapor phase concentration at the source =	see below	g/cm³
D_{air} - Diffusivity in air =	chem. specific	cm²/s
Dcr - Effective diffusion coefficient through the crack (≈Dveff) =	see below	cm²/s
Dseff - Effective diffusion coefficient through the tension-saturated zone =	see below	cm²/s
Dteff - Overall effective porous media diffusion coefficient =	see below	cm²/s
Dveff - Effective diffusion coefficient through vadose zone =	see below	cm²/s
D_w - Diffusivity in water =	chem. specific	cm²/s
ED - Exposure duration =	21	years
EF - Exposure frequency =	245	shifts/year
et - Total soil porosity =	0.306	unitless
ev - Vapor-filled soil porosity =	0.03	unitless
evt - Vapor-filled soil porosity in the tension-saturated zone =	0.0612	cm³/cm³
ew - Water-filled soil porosity =	0.28	unitless
ewt - Water-filled soil porosity in the tension-saturated zone =	0.2448	cm³/cm³
H - Henry's Law constant =	chem. specific	atm-m³/mol
H' - Henry's Law constant =	chem. specific	unitless
Hgt - Building height =	244	cm
ht - Thickness of tension-saturated zone =	30.7	cm

hv - Thickness of vadose zone below the foundation =	0.0	cm
InhR - Inhalation rate =	10	m³/shift
kv - Soil permeability to vapor flow =	1.25E-12	cm²
L - Building length =	1.93E+03	cm
Lcr - Building foundation thickness =	15	cm
Lt - Distance between contaminant source and building =	45.72	cm
MW - Molecular weight =	chem. specific	g/mol
MW_i - Molecular weight of constituent *i* =	chem. specific	g/mol
Mx - Mole fraction of constituent =	see below	unitless
pb - Bulk soil density =	1.86	g/cm³
Pe - Peclet number =	see below	unitless
Qbldg - Building ventilation rate =	5.04E+05	cm³/s
Qsoil - Convective flow rate from the soil into the building =	1.87E-03	cm³/s
rcr - Radius of cracks =	4.97E+00	cm
Rg - Universal gas constant =	6.24E+04	mmHg-cm³/mol-K
Rgb - Universal gas constant =	8.20E-05	atm-m³/mol-K
RMF_i - Relative mole fraction =	see below	mol/g
T - Temperature =	283.15	K
thalf - Half life of compound =	1.00E+06	days
thetam - Soil moisture content =	0.151	cm³/g
u - Net degradation rate =	see below	days
VP - Vapor pressure =	chem. specific	mmHg
W - Building width =	1.93E+03	cm
Xcr - Length of cylinder modeling vapor flow =	7.71E+03	cm
Zcr - Basement depth below grade to bottom of foundation =	15	cm
α - Attenuation coefficient =	see below	unitless
ΔP - Indoor/outdoor pressure difference =	10	g/cm-s²
η - ratio of area of cracks to area of basement (Acr/Ab) =	0.01	cm²/cm²
μ - Vapor viscosity =	1.80E-04	g/cm-s
τ - Time period =	7.67E+03	days

Table 22
Exposure via Inhalation of Vapors from Groundwater Infiltrating Into an Office Building
ATOFINA Chemicals, West Brine Field, Riverview, MI

Constituent	Concentration in Groundwater mg/L	Working Groundwater Concentration (Cgw') mg/L	Groundwater Concentration Corresponding to Csi mg/L	Attenuation Coefficient (α) unitless	Peclet Number (Pe) unitless	Vapor Phase Concentration (Cso) g/cm^3	Concentration in Building (Cbldg) mg/m^3	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Volatiles													
CHLOROFORM	4.07E-03	4.07E-03	8.85E+00	1.86E-08	2.22E-01	6.11E-10	1.14E-08	1.09E-09	8.60E-05	1.27E-05	3.27E-10	8.10E-02	2.65E-11

NA - Not Available

Total Hazard Index = 1.27E-05 Total Cancer Risk = 2.65E-11

Table 23
Dermal Exposure to Groundwater by a Utility Trench Worker
ATOFINA Chemicals, West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ET*EF*ED*CF}{BW*AT}$$

C_w - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	2570	calculated
Kp - Dermal permeability constant =	cm/hr	chemical specific	
ET - Exposure time =	hrs/day	4	reasonable assumption
EF - Exposure frequency =	days/year	10	reasonable assumption
ED - Exposure duration =	years	1	Carey, 1988
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging time - noncarcinogenic =	days	365	Carey, 1988
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Groundwater mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics								
ANTIMONY, TOTAL	1.84E-02	1.00E-03	7.39E-08	4.00E-04	1.85E-04	1.06E-09	NA	NA
ARSENIC, TOTAL	3.44E-02	4.79E-04	6.64E-08	3.00E-04	2.21E-04	9.48E-10	1.50E+00	1.42E-09
CADMIUM, TOTAL	7.79E-03	5.01E-04	1.57E-08	2.30E-03	6.83E-06	2.24E-10	NA	NA
CHROMIUM, TOTAL	9.58E-02	2.10E-03	8.09E-07	2.00E-02	4.05E-05	1.16E-08	NA	NA
LEAD, TOTAL	9.09E-02	8.03E-05	2.94E-08	2.80E-03	1.05E-05	4.20E-10	NA	NA
Semivolatiles								
BIS(2-ETHYLHEXYL)PHTHALATE	1.00E-02	3.30E-02	1.33E-06	2.00E-02	6.64E-05	1.90E-08	1.40E-02	2.66E-10
Volatiles								
CHLOROFORM	4.07E-03	1.30E-01	2.13E-06	1.00E-02	2.13E-04	3.04E-08	6.10E-03	1.85E-10

NA - Not Available

Total Hazard Index = 7.43E-04 Total Cancer Risk = 1.87E-09

Table 24

Utility Trench Worker Inhalation Exposures to Groundwater VOC Vapors in an Excavation Pit

ATOFINA Chemicals,West Brine Field, Riverview, MI

$$\text{Intake (mg/kg-day)} = \frac{Ca * InhR * EF * ED}{BW * AT}$$

Ca - Concentration in air =	mg/m^3	chem. specific	calculated
InhR - Inhalation rate =	m^3/day	20	USEPA 1991, HHEM
EF - Exposure frequency =	days/year	10	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Ca - Concentration in Air (mg/m^3) = (Eiw) / (Hb * W * V)

Eiw - Emission Rate for water (g/sec) = Ki*Ci*Ab*Mxw

Ki - Overall mas transfer coeff. (cm/sec) = 1 / ((1/(kil)) + (Ri*T)/(H*kig))

kil - liquid phase mass transfer coefficient (cm/sec) = IF(MW>65,(1/3600)*23.51*((Vcurr^0.969)/(Z^0.673))*(SQRT(32/MW)),(1/3600)*20*SQRT(44/MW))

kig - gas phase mass transfer coefficient (cm/sec) = IF(MW>65,(1/3600)*1137.5*(Vwind+Vcurr)*SQRT(18/MW),(1/3600)*3000*SQRT(18/MW))

Mxw - mole fraction of compound in water =	gmol/gmol	chem. specific
Ki - overall mass transfer coefficient =	cm/sec	chem. specific
Ci - liquid phase concentration =	g/cm^3	chem. specific
Ab - exposed area (bottom) =	cm^2	7.43E+04
T - absolute temp =	Kelvin	283.15
kil - liquid phase mass transfer coefficient =	cm/sec	chem. specific
Ri - ideal gas law constant =	atm-m^3/mol-K	8.20E-05
H - Henry's Law constant =	atm-m^3/mol	chem. specific
kig - gas phase mass transfer coefficient =	cm/sec	chem. specific

Ei - Emission Rate of Component =	mg/sec	chem. specific
Hb - Downwind Height =	m	0.77
W - Width =	m	1.2
V - Wind speed =	m/sec	0.586
Vcurr - Water current =	m/sec	0.01
Length (downwind distance) =	m	6.1
r - Roughness Ht. =	m	0.05
z - downwind distance =	m	6.10
z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]		
Z - Depth of water in trench =	cm	30.48

Chemical	Exposure Point Conc. in Groundwater mg/L	Overall Mass Transfer Coefficient cm/sec	Emission Rate for Water g/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Volatiles										
CHLOROFORM	4.07E-03	3.91E-06	1.18E-09	2.17E-09	1.70E-11	7.30E-02	2.33E-10	2.43E-13	8.10E-02	1.97E-14
						Total Hazard Index =	2.33E-10		Total Cancer Risk =	1.97E-14

Table 25
Toxic[illegible]enchmarks for the White-Tailed Deer
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Benchmark Toxicity Value mg/kg-day	Safety Factor	Surrogate Toxicity Value mg/kg-day	Source	Reference
DIOXINS					
2,3,7,8-TCDD	2.81E-07	NA	0.000001	NOAEL for rat based on reproduction	Sample *et al.*, 1996
INORGANICS					
Aluminum	2.93E-01	NA	1.93	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Antimony	1.90E-02	NA	0.125	NOAEL for laboratory mouse based on longevity	Sample *et al.*, 1996
Arsenic	1.91E-02	NA	0.126	NOAEL for laboratory mouse based on reproduction	Sample *et al.*, 1996
Barium	1.50E+00	NA	5.06	NOAEL for rat based on growth	Sample *et al.*, 1996
Beryllium	1.85E-01	NA	0.66	NOAEL for rat based on longevity/weight loss	Sample *et al.*, 1996
Cadmium	2.71E-01	NA	1	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Chromium	7.68E+02	NA	2737	NOAEL for rat based on reproduction and longevity	Sample *et al.*, 1996
Cobalt	5.05E+00	NA	18	NOAEL for rat based on respiratory and cardiovascular effects	ATSDR, 1990
Copper	4.27E+00	NA	11.71	NOAEL for mink based on reproduction	Sample *et al.*, 1996
Cyanide	1.57E+01	NA	68.7	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Lead	2.24E+00	NA	8	NOAEL for rat based on reproduction and longevity	Sample *et al.*, 1996
Manganese	2.47E+01	NA	88	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Mercury	2.00E+00	NA	13.2	NOAEL for mouse based on mortality	Sample *et al.*, 1996
Nickel	1.12E+01	NA	40	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Selenium	5.61E-02	NA	0.2	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Silver	2.75E+00	NA	18.1	NOAEL for mouse based on systemic effects	ATSDR, 1990
Thallium	2.10E-03	NA	0.0074	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Tin	3.55E+00	NA	23.4	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Vanadium	5.47E-02	NA	0.21	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Zinc	4.49E+01	NA	160	NOAEL for rat based on reproduction	Sample *et al.*, 1996
ORGANOCHLORINE PESTICIDES					
4,4-DDD	5.16E+00	NA	34	NOAEL for mouse based on respiratory and other effects	ATSDR, 1988
4,4-DDE	6.50E+01	NA	428	NOAEL for mouse based on respiratory and other effects	ATSDR, 1988
4,4-DDT	2.24E-01	NA	0.8	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Aldrin	5.61E-02	NA	0.2	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Chlordane	6.98E-01	NA	4.6	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Kepone	1.12E-01	NA	0.4	NOAEL for rat based on mortality	Sample *et al.*, 1996
SEMIVOLATILES					
2-Methylnaphthalene	4.57E+00	100	1630	LD_{50} value for rat based on mortality	NIOSH, 1995
Acenaphthene	4.91E+01	NA	175	NOAEL for laboratory mammal based on hepatotoxicity	IRIS, 1998
Acenaphthylene	4.77E+00	100	1700	LD_{50} value for laboratory mammal	Lewis, 1996
Anthracene	9.26E+02	NA	3300	Chronic toxicity value for laboratory mammal based on cancer.	Maughan, 1994
Benzo(a)anthracene	1.52E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	
Benzo(a)pyrene	1.52E-01	NA	1	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Benzo(g,h,i)perylene	1.52E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	

Table 25
Toxicity Benchmarks for the White-Tailed Deer
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Benchmark Toxicity Value mg/kg-day	Safety Factor	Surrogate Toxicity Value mg/kg-day	Source	Reference
Benzo(k)fluoranthene	1.52E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	
Bis(2-Ethylhexyl)phthalate	2.78E+00	NA	18.33	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Chrysene	4.86E-01	100	320	LD_{50} value for mouse based on mortality	ATSDR, 1990
Dibenz(a,h)anthracene	1.52E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	
Fluoranthene	3.79E+01	NA	250	Chronic toxicity value for laboratory mammal based on maternal effects	Maughan, 1994
Fluorene	1.90E+01	NA	125	NOAEL for mouse based on blood chemistry	IRIS, 1998
Indeno(1,2,3-cd)pyrene	1.52E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	
N-Nitrosodiethylamine	7.86E-01	100	280	LD_{50} value for rat	NTP, 2000
N-Nitrosodiphenylamine	4.57E+01	NA	301	NOAEL for mouse based on mortality	ATSDR, 1991
Naphthalene	8.09E+01	NA	533	Chronic toxicity value for laboratory mammal based on behavioral effects	Maughan, 1994
Phenanthrene	1.96E+00	100	700	LD_{50} value for laboratory mammal	Maughan, 1994
Phenol	7.94E+01	NA	523	NOAEL for mouse based on systemic effects	ATSDR, 1988
Pyrene	1.14E+01	NA	75	NOAEL for laboratory mammal based on kidney effects	IRIS, 1998
VOLATILES					
1,2-Dichloroethene	6.86E+00	NA	45.2	NOAEL for mouse based on weight, blood chemistry, and hepatotoxicity	Sample *et al.*, 1996
Carbon disulfide	4.55E+01	NA	300	NOAEL for mouse based on hepatic effects	ATSDR, 1990
Methylene chloride	1.64E+00	NA	5.85	NOAEL for rat based on liver histology	Sample *et al.*, 1996

Table 26
Toxicity Benchmarks for the Meadow Vole
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Benchmark Toxicity Value mg/kg-day	Safety Factor	Surrogate Toxicity Value mg/kg-day	Source	Reference
DIOXINS					
2,3,7,8-TCDD	1.77E-06	NA	0.000001	NOAEL for rat based on reproduction	Sample *et al.*, 1996
INORGANICS					
Aluminum	1.84E+00	NA	1.93	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Antimony	1.19E-01	NA	0.125	NOAEL for laboratory mouse based on longevity	Sample *et al.*, 1996
Arsenic	1.20E-01	NA	0.126	NOAEL for laboratory mouse based on reproduction	Sample *et al.*, 1996
Barium	9.43E+00	NA	5.06	NOAEL for rat based on growth	Sample *et al.*, 1996
Beryllium	1.17E+00	NA	0.66	NOAEL for rat based on longevity/weight loss	Sample *et al.*, 1996
Cadmium	1.70E+00	NA	1	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Chromium	4.83E+03	NA	2737	NOAEL for rat based on reproduction and longevity	Sample *et al.*, 1996
Cobalt	3.18E+01	NA	18	NOAEL for rat based on respiratory and cardiovascular effects	ATSDR, 1990
Copper	2.69E+01	NA	11.71	NOAEL for mink based on reproduction	Sample *et al.*, 1996
Cyanide	1.14E+02	NA	68.7	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Lead	1.41E+01	NA	8	NOAEL for rat based on reproduction and longevity	Sample *et al.*, 1996
Manganese	1.55E+02	NA	88	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Mercury	1.26E+01	NA	13.2	NOAEL for mouse based on mortality	Sample *et al.*, 1996
Nickel	7.06E+01	NA	40	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Selenium	3.53E-01	NA	0.2	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Silver	1.73E+01	NA	18.1	NOAEL for mouse based on systemic effects	ATSDR, 1990
Thallium	1.32E-02	NA	0.0074	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Tin	2.24E+01	NA	23.4	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Vanadium	3.44E-01	NA	0.21	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Zinc	2.83E+02	NA	160	NOAEL for rat based on reproduction	Sample *et al.*, 1996
ORGANOCHLORINE PESTICIDES					
4,4-DDD	3.25E+01	NA	34	NOAEL for mouse based on respiratory and other effects	ATSDR, 1988
4,4-DDE	4.09E+02	NA	428	NOAEL for mouse based on respiratory and other effects	ATSDR, 1988
4,4-DDT	1.41E+00	NA	0.8	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Aldrin	3.53E-01	NA	0.2	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Chlordane	4.40E+00	NA	4.6	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Kepone	7.06E-01	NA	0.4	NOAEL for rat based on mortality	Sample *et al.*, 1996
SEMIVOLATILES					
2-Methylnaphthalene	2.88E+01	100	1630	LD_{50} value for rat based on mortality	NIOSH, 1995
Acenaphthene	3.09E+02	NA	175	NOAEL for laboratory mammal based on hepatotoxicity	IRIS, 1998
Acenaphthylene	3.00E+01	100	1700	LD_{50} value for laboratory mammal	Lewis, 1996
Anthracene	5.83E+03	NA	3300	Chronic toxicity value for laboratory mammal based on cancer	Maughan, 1994
Benzo(a)anthracene	9.55E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	
Benzo(a)pyrene	9.55E-01	NA	1	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Benzo(g,h,i)perylene	9.55E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	

Table 26
Toxicity Benchmarks for the Meadow Vole
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Benchmark Toxicity Value mg/kg-day	Safety Factor	Surrogate Toxicity Value mg/kg-day	Source	Reference
Benzo(k)fluoranthene	9.55E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	
Bis(2-Ethylhexyl)phthalate	1.75E+01	NA	18.33	NOAEL for mouse based on reproduction	Sample *et al.*, 1996
Chrysene	3.06E+00	100	320	LD_{50} value for mouse based on mortality	ATSDR, 1990
Dibenz(a,h)anthracene	9.55E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	
Fluoranthene	4.41E+02	NA	250	Chronic toxicity value for laboratory mammal based on maternal effects	Maughan, 1994
Fluorene	1.19E+02	NA	125	NOAEL for mouse based on blood chemistry	IRIS, 1998
Indeno(1,2,3-cd)pyrene	9.55E-01	NA	1	Value based on toxicity data for benzo(a)pyrene	
N-Nitrosodiethylamine	4.94E+00	100	280	LD_{50} value for rat	NTP, 2000
N-Nitrosodiphenylamine	2.88E+02	NA	301	NOAEL for mouse based on mortality	ATSDR, 1991
Naphthalene	9.41E+02	NA	533	Chronic toxicity value for laboratory mammal based on behavioral effects	Maughan, 1994
Phenanthrene	1.24E+01	100	706	LD_{50} value for laboratory mammal	Maughan, 1994
Phenol	5.00E+02	NA	523	NOAEL for mouse based on systemic effects	ATSDR, 1988
Pyrene	1.32E+02	NA	75	NOAEL for laboratory mammal based on kidney effects	IRIS, 1998
VOLATILES					
1,2-Dichloroethene	4.32E+01	NA	45.2	NOAEL for mouse based on weight, blood chemistry, and hepatotoxicity	Sample *et al.*, 1996
Carbon disulfide	2.87E+02	NA	300	NOAEL for mouse based on hepatic effects	ATSDR, 1990
Methylene chloride	5.59E+00	NA	5.85	NOAEL for rat based on liver histology	Sample *et al.*, 1996

Table 27
Toxicity Benchmarks for the American Robin
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Benchmark Toxicity Value mg/kg-day	Safety Factor	Surrogate Toxicity Value mg/kg-day	Source	Reference
DIOXINS					
2,3,7,8-TCDD	1.40E-05	NA	0.000014	NOAEL for ring-necked pheasant based on reproduction	Sample *et al.*, 1996
INORGANICS					
Aluminum	1.10E+02	NA	109.7	NOAEL for ringed dove based on reproduction	Sample *et al.*, 1996
Antimony	1.25E-02	10	0.125	NOAEL for laboratory mouse based on longevity	Sample *et al.*, 1996
Arsenic	2.46E+00	NA	2.46	NOAEL for brown-headed cowbird based on mortality	Sample *et al.*, 1996
Barium	2.08E+01	NA	20.826	NOAEL for chicken based on mortality	Sample *et al.*, 1996
Beryllium	6.60E-02	10	0.66	NOAEL for rat based on longevity/weight loss	Sample *et al.*, 1996
Cadmium	1.45E+00	NA	1.45	NOAEL for mallard duck based on reproduction	Sample *et al.*, 1996
Chromium	1.00E+00	NA	1	NOAEL for black duck based on reproduction	Sample *et al.*, 1996
Cobalt	1.80E+00	10	18	NOAEL for rat based on respiratory and cardiovascular effects	ATSDR, 1990
Copper	4.70E+01	NA	46.97	NOAEL for chicken based on growth	Sample *et al.*, 1996
Cyanide	6.87E+00	10	68.7	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Lead	3.85E+00	NA	3.85	NOAEL for american kestrel based on reproduction	Sample *et al.*, 1996
Manganese	9.77E+02	NA	977	NOAEL for Japanese quail based on growth and behavior	Sample *et al.*, 1996
Mercury	4.50E-01	NA	0.45	NOAEL for Japanese quail based on reproduction	Sample *et al.*, 1996
Nickel	7.74E+01	NA	77.4	NOAEL for mallard duck based on mortality, growth and behavior	Sample *et al.*, 1996
Selenium	4.00E-01	NA	0.4	NOAEL for mallard duck based on reproduction	Sample *et al.*, 1996
Silver	1.81E+00	10	18.1	NOAEL for mouse based on systemic effects	ATSDR, 1990
Thallium	7.40E-04	10	0.0074	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Tin	6.76E+00	NA	6.76	NOAEL for Japanese quail based on reproduction	Sample *et al.*, 1996
Vanadium	1.14E+01	NA	11.38	NOAEL for mallard duck based on mortality and body weight	Sample *et al.*, 1996
Zinc	1.45E+01	NA	14.49	NOAEL for white leghorn hen based on reproduction	Sample *et al.*, 1996
ORGANOCHLORINE PESTICIDES					
4,4-DDD	3.40E+00	10	34	NOAEL for mouse based on respiratory and other effects	ATSDR, 1988
4,4-DDE	4.28E+01	10	428	NOAEL for mouse based on respiratory and other effects	ATSDR, 1988
4,4-DDT	2.80E-03	NA	0.0028	NOAEL for brown pelican based on reproduction	Sample *et al.*, 1996
Aldrin	2.00E-02	10	0.2	NOAEL for rat based on reproduction	Sample *et al.*, 1996
Chlordane	2.14E+00	NA	2.14	NOAEL for red-winged blackbird based on mortality	Sample *et al.*, 1996
Kepone	4.00E-02	10	0.4	NOAEL for rat based on mortality	Sample *et al.*, 1996
SEMIVOLATILES					
2-Methylnaphthalene	1.63E+00	1000	1630	LD_{50} value for rat based on mortality	NIOSH, 1995
Acenaphthene	1.55E+00	10	15.5	LOAEL for mallard based on hepatic stress	Patton and Dieter, 1980
Acenaphthylene	1.70E+00	1000	1700	LD_{50} value for laboratory mammal	Lewis, 1996
Anthracene	4.07E+01	10	407	LOAEL for mallard based on hepatic stress	Patton and Dieter, 1980
Benzo(a)anthracene	4.07E+01	10	407	Value based on toxicity data for benzo(a)pyrene	
Benzo(a)pyrene	4.07E+01	10	407	LOAEL for mallard based on hepatic stress	Patton and Dieter, 1980
Benzo(g,h,i)perylene	4.07E+01	10	407	Value based on toxicity data for benzo(a)pyrene	

Table 27
Toxicity Benchmarks for the American Robin
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Benchmark Toxicity Value mg/kg-day	Safety Factor	Surrogate Toxicity Value mg/kg-day	Source	Reference
Benzo(k)fluoranthene	4.07E+01	10	407	Value based on toxicity data for benzo(a)pyrene	
Bis(2-Ethylhexyl)phthalate	1.11E+00	NA	1.11	NOAEL for ringed dove based on reproduction	Sample *et al.* , 1996
Chrysene	4.07E+01	10	407	Value based on toxicity data for benzo(a)pyrene	
Dibenz(a,h)anthracene	4.07E+01	10	407	Value based on toxicity data for benzo(a)pyrene	
Fluoranthene	4.07E+01	10	407	LOAEL for mallard based on hepatic stress	Patton and Dieter, 1980
Fluorene	4.07E+01	10	407	LOAEL for mallard based on hepatic stress	Patton and Dieter, 1980
Indeno(1,2,3-cd)pyrene	4.07E+01	10	407	Value based on toxicity data for benzo(a)pyrene	
Naphthalene	1.80E+01	10	180	LOEL for mallard based on systemic toxicity	Eisler, 1987
N-Nitrosodiethylamine	2.80E-01	1000	280	LD_{50} value for rat	NTP, 2000
N-Nitrosodiphenylamine	3.01E+01	10	301	NOAEL for mouse based on mortality	ATSDR, 1991
Phenanthrene	4.07E+01	10	407	LOAEL for mallard based on hepatic stress	Patton and Dieter, 1980
Phenol	5.23E+01	10	523	NOAEL for mouse based on systemic effects	ATSDR, 1988
Pyrene	4.07E+01	10	407	LOAEL for mallard based on hepatic stress	Patton and Dieter, 1980
VOLATILES					
1,2-Dichloroethene	4.52E+00	10	45.2	NOAEL for mouse based on weight, blood chemistry, & hepatotoxicity	Sample *et al.* , 1996
Carbon disulfide	3.00E+01	10	300	NOAEL for mouse based on hepatic effects	ATSDR, 1990
Methylene chloride	5.85E-01	10	5.85	NOAEL for rat based on liver histology	Sample et al., 1996

Table 28

Statistical Summary of Constituents in Surface Soil (1-3 feet bgs) for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
DETECTED CONSTITUENTS												
Dioxins												
2,3,7,8-TCDD (TEQ)	3	2	66.67	5.25E-06	1.53E-05	1.28E-05	0.00004789	1.69E-05	9.44E-06	3.13E-05	5.92E-03	Normal/Lognormal
Inorganics												
ALUMINUM	14	14	100	3.10E+00	1.18E+04	6.71E+03	0.00E+00	1.99E+04	5.13E+03	1.42E+04	1.95E+06	Normal
ANTIMONY	15	1	6.67	1.30E+00	3.26E+00	3.06E+00	8.00E+00	1.30E+00	9.01E-01	3.67E+00	4.23E+00	Unknown
ARSENIC	16	16	100	1.70E+00	8.65E+00	7.48E+00	0.00E+00	1.56E+01	3.85E+00	1.03E+01	1.33E+01	Normal
BARIUM	16	16	100	1.44E+01	8.17E+01	7.05E+01	0.00E+00	1.49E+02	3.83E+01	9.85E+01	1.23E+02	Normal/Lognormal
BERYLLIUM	16	5	31.25	4.00E-02	3.22E-01	2.74E-01	6.70E-01	6.30E-01	1.55E-01	3.90E-01	5.17E-01	Unknown
CADMIUM	16	2	12.5	5.70E-01	3.47E-01	3.19E-01	6.70E-01	1.00E+00	1.97E-01	4.33E-01	4.53E-01	Unknown
CHROMIUM	16	16	100	2.40E+00	1.88E+01	1.64E+01	0.00E+00	3.20E+01	7.74E+00	2.22E+01	2.91E+01	Normal
COBALT	16	16	100	5.50E-01	9.12E+00	7.20E+00	0.00E+00	1.57E+01	4.12E+00	1.09E+01	2.08E+01	Normal
COPPER	16	16	100	9.20E+00	3.44E+01	2.51E+01	0.00E+00	1.47E+02	3.81E+01	5.11E+01	4.92E+01	Unknown
IRON	13	13	100	1.55E+04	2.77E+04	2.62E+04	0.00E+00	5.66E+04	1.05E+04	3.29E+04	3.35E+04	Normal/Lognormal
LEAD	16	16	100	7.30E+00	3.07E+01	1.78E+01	0.00E+00	1.57E+02	4.60E+01	5.09E+01	4.77E+01	Unknown
MANGANESE	13	13	100	3.28E+02	5.34E+02	4.82E+02	0.00E+00	1.28E+03	2.97E+02	6.80E+02	6.82E+02	Unknown
MERCURY	16	5	31.25	1.40E-01	1.53E-01	9.42E-02	1.30E-01	9.75E-01	2.33E-01	2.55E-01	2.24E-01	Unknown
NICKEL	16	16	100	5.00E+00	4.18E+01	2.99E+01	0.00E+00	2.40E+02	5.38E+01	6.54E+01	6.26E+01	Unknown
SELENIUM	16	2	12.5	3.90E-01	3.22E-01	2.80E-01	6.70E-01	9.80E-01	1.93E-01	4.07E-01	4.53E-01	Unknown
THALLIUM	16	1	6.25	2.40E-01	5.09E-01	4.33E-01	1.30E+00	2.40E-01	1.94E-01	5.94E-01	8.83E-01	Unknown
TIN	3	3	100	8.10E-01	1.40E+00	1.32E+00	0.00E+00	1.90E+00	5.51E-01	2.33E+00	8.64E+00	Normal/Lognormal
VANADIUM	16	16	100	2.70E+00	2.47E+01	1.96E+01	0.00E+00	4.08E+01	1.23E+01	3.01E+01	4.96E+01	Normal
ZINC	16	16	100	2.10E+01	9.55E+01	8.16E+01	0.00E+00	3.15E+02	6.54E+01	1.24E+02	1.31E+02	Lognormal
Semivolatile Organic Compounds (Non-Pesticides)												
3&4-METHYLPHENOL	5	1	20	1.40E+00	8.68E+01	1.37E+01	4.75E+02	1.40E+00	1.03E+02	1.85E+02	8.71E+12	Normal/Lognormal
ANTHRACENE	20	1	5	3.00E-01	6.84E+01	1.01E+00	1.50E+03	3.00E-01	1.82E+02	1.39E+02	4.46E+03	Unknown
BENZO(A)ANTHRACENE	20	1	5	9.60E-01	6.85E+01	1.07E+00	1.50E+03	9.60E-01	1.82E+02	1.39E+02	4.38E+03	Unknown
BENZO(A)PYRENE	20	2	10	4.50E-01	6.85E+01	1.09E+00	1.50E+03	6.70E-01	1.82E+02	1.39E+02	4.13E+03	Unknown
BENZO(B)FLUORANTHENE	20	2	10	5.40E-01	6.85E+01	1.12E+00	1.50E+03	9.90E-01	1.82E+02	1.39E+02	4.14E+03	Unknown
BENZO(G,H,I)PERYLENE	20	1	5	5.60E-01	6.84E+01	1.04E+00	1.50E+03	5.60E-01	1.82E+02	1.39E+02	4.35E+03	Unknown
BENZO(K)FLUORANTHENE	20	1	5	5.60E-01	6.84E+01	1.04E+00	1.50E+03	5.60E-01	1.82E+02	1.39E+02	4.35E+03	Unknown
BIS(2-ETHYLHEXYL)PHTHALATE	20	1	5	1.90E-01	6.84E+01	9.86E-01	1.50E+03	1.90E-01	1.82E+02	1.39E+02	4.65E+03	Unknown
BUTYLBENZYLPHTHALATE	20	1	5	2.10E-01	6.84E+01	9.91E-01	1.50E+03	2.10E-01	1.82E+02	1.39E+02	4.60E+03	Unknown
CHRYSENE	20	1	5	1.20E+00	6.85E+01	1.08E+00	1.50E+03	1.20E+00	1.82E+02	1.39E+02	4.43E+03	Unknown
DIBENZO(A,H)ANTHRACENE	20	1	5	1.70E-01	6.84E+01	9.80E-01	1.50E+03	1.70E-01	1.82E+02	1.39E+02	4.71E+03	Unknown
FLUORANTHENE	20	2	10	5.40E-01	6.85E+01	1.14E+00	1.50E+03	1.50E+00	1.81E+02	1.39E+02	4.24E+03	Unknown
FLUORENE	20	1	5	1.00E-01	6.84E+01	9.55E-01	1.50E+03	1.00E-01	1.82E+02	1.39E+02	5.09E+03	Unknown
INDENO(1,2,3-CD)PYRENE	20	1	5	7.60E-01	6.85E+01	1.06E+00	1.50E+03	7.60E-01	1.82E+02	1.39E+02	4.35E+03	Unknown

Table 28

Statistical Summary of Constituents in Surface Soil (1-3 feet bgs) for Use in the Ecological Risk Assessment

ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
NAPHTHALENE	19	2	10.53	1.40E+02	9.85E+01	1.18E+00	1.50E+03	7.30E+02	2.34E+02	1.92E+02	2.48E+04	Unknown
N-NITROSODIETHYLAMINE	5	1	20	7.80E-01	8.67E+01	1.22E+01	4.75E+02	7.80E-01	1.03E+02	1.85E+02	6.13E+13	Normal/Lognormal
N-NITROSODIPHENYLAMINE	19	2	10.53	4.70E-02	1.90E+02	1.17E+00	1.80E+03	1.90E+03	4.89E+02	3.85E+02	1.07E+05	Unknown
PHENANTHRENE	20	1	5	9.80E-01	6.85E+01	1.07E+00	1.50E+03	9.80E-01	1.82E+02	1.39E+02	4.38E+03	Unknown
PHENOL	19	4	21.05	5.70E+01	1.40E+03	1.65E+00	2.10E+01	1.55E+04	4.09E+03	3.02E+03	6.50E+06	Unknown
PYRENE	20	2	10	4.70E-01	6.85E+01	1.15E+00	1.50E+03	2.00E+00	3.81E+02	1.39E+02	4.37E+03	Unknown
Volatile Organic Compounds												
1,2-DICHLOROETHENE (TOTAL)	6	1	16.67	1.30E+00	4.47E+00	4.68E-01	2.50E+01	1.30E+00	6.05E+00	9.45E+00	8.59E+10	Normal/Lognormal
2-BUTANONE	5	3	60	1.00E+00	1.78E+01	8.94E+00	9.70E+01	1.00E+01	1.94E+01	3.64E+01	6.34E+03	Normal/Lognormal
4-METHYL-2-PENTANONE	6	1	16.67	3.70E-02	1.26E+01	5.18E-01	9.70E+01	3.70E-02	2.01E+01	2.92E+01	2.10E+13	Normal/Lognormal
ACETONE	6	1	16.67	9.00E-01	1.39E+01	5.30E+00	9.70E+01	9.00E-01	1.92E+01	2.97E+01	1.50E+03	Normal/Lognormal
CARBON DISULFIDE	6	2	33.33	5.30E-02	9.76E+00	4.94E-01	2.50E+01	3.40E+01	1.33E+01	2.07E+01	1.07E+15	Normal/Lognormal
ETHYLBENZENE	6	2	33.33	1.00E-02	4.24E+00	2.04E-01	2.50E+01	8.85E-01	6.22E+00	9.35E+00	2.30E+12	Lognormal
METHYLENE CHLORIDE	6	1	16.67	5.90E+00	5.07E+00	2.29E-01	2.50E+01	5.90E+00	6.01E+00	1.00E+01	6.12E+15	Normal/Lognormal
TETRACHLOROETHENE	5	2	40	1.60E-02	5.11E+00	6.13E-01	2.50E+01	3.60E-02	6.53E+00	1.13E+01	8.18E+11	Normal/Lognormal
TOLUENE	6	2	33.33	2.20E-02	4.29E+00	4.85E-01	2.50E+01	2.20E-01	6.18E+00	9.37E+00	6.21E+07	Lognormal
TRICHLOROETHENE	5	2	40	7.00E-03	5.10E+00	4.17E-01	2.50E+01	1.20E-02	6.54E+00	1.13E+01	6.94E+15	Normal/Lognormal
XYLENES (TOTAL)	6	2	33.33	8.00E-03	6.34E+00	2.66E-01	4.90E+01	4.80E-02	1.02E+01	1.47E+01	1.63E+13	Normal/Lognormal
CONSTITUENTS NOT DETECTED												
2,4,5-T	3	0	0	0.00E+00	1.65E-01	9.01E-02	6.90E-01	0.00E+00	1.67E-01	4.46E-01	2.51E+09	Normal/Lognormal
2,4,5-TP (SILVEX)	2	0	0	0.00E+00	2.39E-01	2.14E-01	6.90E-01	0.00E+00	1.50E-01	9.10E-01	7.23E+04	Unknown
2,4-D	2	0	0	0.00E+00	2.39E+00	2.14E+00	6.90E+00	0.00E+00	1.50E+00	9.10E+00	7.23E+05	Unknown
CYANIDE, TOTAL	3	0	0	0.00E+00	2.75E-01	2.71E-01	6.60E-01	0.00E+00	5.50E-02	3.68E-01	4.46E-01	Normal/Lognormal
SILVER, TOTAL	16	0	0	0.00E+00	5.02E-01	4.21E-01	1.30E+00	0.00E+00	2.05E-01	5.92E-01	8.83E-01	Unknown
DIMETHOATE	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
DISULFOTON	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
ETHYL PARATHION	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
FAMPHUR	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
METHYL PARATHION	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
O,O,O-TRIETHYL PHOSPHOROTHIOATE	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
PHORATE	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
SULFOTEPP	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
ZINOPHOS	3	0	0	0.00E+00	1.08E+01	5.15E+00	5.20E+01	0.00E+00	1.34E+01	3.33E+01	8.69E+11	Normal/Lognormal
AROCLOR-1016	3	0	0	0.00E+00	8.18E+01	3.42E+01	3.15E+02	0.00E+00	7.73E+01	2.12E+02	5.66E+20	Normal/Lognormal
AROCLOR-1221	3	0	0	0.00E+00	8.18E+01	3.42E+01	3.15E+02	0.00E+00	7.73E+01	2.12E+02	5.66E+20	Normal/Lognormal
AROCLOR-1232	3	0	0	0.00E+00	8.18E+01	3.42E+01	3.15E+02	0.00E+00	7.73E+01	2.12E+02	5.66E+20	Normal/Lognormal
AROCLOR-1242	3	0	0	0.00E+00	8.18E+01	3.42E+01	3.15E+02	0.00E+00	7.73E+01	2.12E+02	5.66E+20	Normal/Lognormal

Table 28

Statistical Summary of Constituents in Surface Soil (1-3 feet bgs) for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
AROCLOR-1248	3	0	0	0.00E+00	8.18E+01	3.42E+01	3.15E+02	0.00E+00	7.73E+01	2.12E+02	5.66E+20	Normal/Lognormal
AROCLOR-1254	3	0	0	0.00E+00	1.62E+02	6.78E+01	6.30E+02	0.00E+00	1.55E+02	4.23E+02	8.62E+20	Normal/Lognormal
AROCLOR-1260	3	0	0	0.00E+00	1.62E+02	6.78E+01	6.30E+02	0.00E+00	1.55E+02	4.23E+02	8.62E+20	Normal/Lognormal
4,4'-DDD	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
4,4'-DDE	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
4,4'-DDT	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
ALDRIN	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
ALPHA-BHC	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
ALPHA-CHLORDANE	3	0	0	0.00E+00	8.18E+01	3.42E+01	3.15E+02	0.00E+00	7.73E+01	2.12E+02	5.66E+20	Normal/Lognormal
BETA-BHC	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
DELTA-BHC	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
DIELDRIN	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
ENDOSULFAN I	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
ENDOSULFAN II	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
ENDOSULFAN SULFATE	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
ENDRIN	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
ENDRIN ALDEHYDE	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
GAMMA-BHC (LINDANE)	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
GAMMA-CHLORDANE	3	0	0	0.00E+00	8.18E+01	3.42E+01	3.15E+02	0.00E+00	7.73E+01	2.12E+02	5.66E+20	Normal/Lognormal
HEPTACHLOR	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
HEPTACHLOR EPOXIDE	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
ISODRIN	3	0	0	0.00E+00	8.18E+00	3.42E+00	3.15E+01	0.00E+00	7.73E+00	2.12E+01	5.66E+19	Normal/Lognormal
KEPONE	3	0	0	0.00E+00	1.62E+01	6.78E+00	6.30E+01	0.00E+00	1.55E+01	4.23E+01	8.62E+19	Normal/Lognormal
METHOXYCHLOR	3	0	0	0.00E+00	8.18E+01	3.42E+01	3.15E+02	0.00E+00	7.73E+01	2.12E+02	5.66E+20	Normal/Lognormal
TOXAPHENE	3	0	0	0.00E+00	1.62E+02	6.78E+01	6.30E+02	0.00E+00	1.55E+02	4.23E+02	8.62E+20	Normal/Lognormal
1,2,4,5-TETRACHLOROBENZENE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
1,2,4-TRICHLOROBENZENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
1,2-DICHLOROBENZENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
1,3,5-TRINITROBENZENE	5	0	0	0.00E+00	8.66E+02	9.28E+01	4.75E+03	0.00E+00	1.03E+03	1.85E+03	2.56E+17	Normal/Lognormal
1,3-DICHLOROBENZENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
1,3-DINITROBENZENE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
1,4-DICHLOROBENZENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
1,4-DIOXANE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
1,4-NAPHTHOQUINONE	5	0	0	0.00E+00	4.25E+02	4.60E+01	2.35E+03	0.00E+00	5.07E+02	9.09E+02	1.05E+17	Normal/Lognormal
1-NAPHTHYLAMINE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
2,2'-OXYBIS(1-CHLOROPROPANE)	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2,3,4,6-TETRACHLOROPHENOL	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
2,4,5-TRICHLOROPHENOL	19	0	0	0.00E+00	2.13E+02	1.65E+00	3.70E+03	0.00E+00	5.04E+02	4.13E+02	1.69E+05	Unknown

Table 28
Statistical Summary of Constituents in Surface Soil (1-3 feet bgs) for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
2,4,6-TRICHLOROPHENOL	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2,4-DICHLOROPHENOL	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2,4-DIMETHYLPHENOL	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2,4-DINITROPHENOL	19	0	0	0.00E+00	2.15E+02	4.87E+00	3.70E+03	0.00E+00	5.03E+02	4.15E+02	1.58E+04	Unknown
2,4-DINITROTOLUENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2,6-DICHLOROPHENOL	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
2,6-DINITROTOLUENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2-ACETYLAMINOFLUORENE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
2-AMINONAPHTHALENE (BETA NAPHT	5	0	0	0.00E+00	2.16E+02	2.32E+01	1.19E+03	0.00E+00	2.57E+02	4.60E+02	6.15E+16	Normal/Lognormal
2-CHLORONAPHTHALENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2-CHLOROPHENOL	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2-METHYLNAPHTHALENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2-METHYLPHENOL	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2-NITROANILINE	19	0	0	0.00E+00	2.15E+02	4.87E+00	3.70E+03	0.00E+00	5.03E+02	4.15E+02	1.58E+04	Unknown
2-NITROPHENOL	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
2-PICOLINE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
3,3'-DICHLOROBENZIDINE	19	0	0	0.00E+00	8.87E+01	3.65E+00	1.50E+03	0.00E+00	2.03E+02	1.69E+02	2.67E+03	Unknown
3,3'-DIMETHYLBENZIDINE	5	0	0	0.00E+00	4.25E+02	4.60E+01	2.35E+03	0.00E+00	5.07E+02	9.09E+02	1.05E+17	Normal/Lognormal
3-METHYLCHOLANTHRENE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
3-NITROANILINE	19	0	0	0.00E+00	2.15E+02	4.87E+00	3.70E+03	0.00E+00	5.03E+02	4.15E+02	1.58E+04	Unknown
4,6-DINITRO-2-METHYLPHENOL	19	0	0	0.00E+00	2.15E+02	4.87E+00	3.70E+03	0.00E+00	5.03E+02	4.15E+02	1.58E+04	Unknown
4-AMINOBIPHENYL	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
4-BROMOPHENYL-PHENYLETHER	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
4-CHLORO-3-METHYLPHENOL	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
4-CHLOROANILINE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
4-CHLOROPHENYL-PHENYLETHER	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
4-METHYLPHENOL	17	0	0	0.00E+00	8.05E+01	1.31E+00	1.50E+03	0.00E+00	1.95E+02	1.63E+02	3.29E+04	Unknown
4-NITROANILINE	19	0	0	0.00E+00	2.15E+02	4.87E+00	3.70E+03	0.00E+00	5.03E+02	4.15E+02	1.58E+04	Unknown
4-NITROPHENOL	19	0	0	0.00E+00	2.15E+02	4.87E+00	3.70E+03	0.00E+00	5.03E+02	4.15E+02	1.58E+04	Unknown
4-NITROQUINOLINE-1-OXIDE	5	0	0	0.00E+00	4.25E+02	4.60E+01	2.35E+02	0.00E+00	5.07E+02	9.09E+02	1.05E+17	Normal/Lognormal
5-NITRO-O-TOLUIDINE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
7,12-DIMETHYLBENZ(A)ANTHRACENE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
A,A-DIMETHYLPHENETHYLAMINE	5	0	0	0.00E+00	4.25E+02	4.60E+01	2.35E+03	0.00E+00	5.07E+02	9.09E+02	1.05E+17	Normal/Lognormal
ACENAPHTHENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
ACENAPHTHYLENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
ACETOPHENONE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
ANILINE	5	0	0	0.00E+00	4.25E+02	4.60E+01	2.35E+03	0.00E+00	5.07E+02	9.09E+02	1.05E+17	Normal/Lognormal
ARAMITE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal

Table 28

Statistical Summary of Constituents in Surface Soil (1-3 feet bgs) for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
BENZYL ALCOHOL	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
BIS(2-CHLOROETHOXY)METHANE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
BIS(2-CHLOROETHYL)ETHER	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
CARBAZOLE	17	0	0	0.00E+00	8.05E+01	1.31E+00	1.50E+03	0.00E+00	1.95E+02	1.63E+02	3.29E+04	Unknown
CHLOROBENZILATE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
DI-N-BUTYLPHTHALATE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
DI-N-OCTYLPHTHALATE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
DIALLATE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
DIBENZOFURAN	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
DIETHYLPHTHALATE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
DIMETHYLPHTHALATE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
DINOSEB	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
DIPHENYLAMINE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
ETHYLMETHANESULFONATE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
HEXACHLOROBENZENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
HEXACHLOROBUTADIENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
HEXACHLOROCYCLOPENTADIENE	19	0	0	0.00E+00	7.46E+01	3.16E+00	1.50E+03	0.00E+00	1.85E+02	1.48E+02	1.98E+03	Unknown
HEXACHLOROETHANE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
HEXACHLOROPHENE	5	0	0	0.00E+00	7.76E+02	8.90E+01	3.85E+03	0.00E+00	8.73E+02	1.61E+03	9.63E+16	Normal/Lognormal
HEXACHLOROPROPENE	5	0	0	0.00E+00	4.25E+02	4.60E+01	2.35E+03	0.00E+00	5.07E+02	9.09E+02	1.05E+17	Normal/Lognormal
ISOPHORONE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
ISOSAFROLE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
METHAPYRILENE	5	0	0	0.00E+00	2.16E+02	2.32E+01	1.19E+03	0.00E+00	2.57E+02	4.60E+02	6.15E+16	Normal/Lognormal
METHYLMETHANESULFONATE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
N-NITROSODI-N-BUTYLAMINE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
N-NITROSODI-N-PROPYLAMINE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
N-NITROSODIMETHYLAMINE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
N-NITROSOMETHYLETHYLAMINE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
N-NITROSOMORPHOLINE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
N-NITROSOPIPERIDINE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
N-NITROSOPYRROLIDINE	5	0	0	0.00E+00	4.25E+02	4.60E+01	2.35E+03	0.00E+00	5.07E+02	9.09E+02	1.05E+17	Normal/Lognormal
NITROBENZENE	19	0	0	0.00E+00	7.20E+01	1.08E+00	1.50E+03	0.00E+00	1.86E+02	1.46E+02	8.28E+03	Unknown
O-TOLUIDINE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
P-DIMETHYLAMINOAZOBENZENE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
P-PHENYLENEDIAMINE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
PENTACHLOROBENZENE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
PENTACHLORONITROBENZENE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
PENTACHLOROPHENOL	19	0	0	0.00E+00	2.13E+02	1.65E+00	3.79E+03	0.00E+00	5.04E+02	4.13E+02	1.69E+05	Unknown

Table 28

Statistical Summary of Constituents in Surface Soil (1-3 feet bgs) for Use in the Ecological Risk Assessment

ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
PHENACETIN	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
PRONAMIDE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
PYRIDINE	5	0	0	0.00E+00	1.74E+02	1.86E+01	9.55E+02	0.00E+00	2.07E+02	3.71E+02	5.24E+16	Normal/Lognormal
SAFROLE	5	0	0	0.00E+00	8.66E+01	9.28E+00	4.75E+02	0.00E+00	1.03E+02	1.85E+02	2.56E+16	Normal/Lognormal
1,1,1,2-TETRACHLOROETHANE	5	0	0	0.00E+00	5.41E+00	1.45E-01	5.00E+01	0.00E+00	1.10E+01	1.59E+01	1.65E+16	Lognormal
1,1,1-TRICHLOROETHANE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
1,1,2,2-TETRACHLOROETHANE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
1,1,2-TRICHLOROETHANE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
1,1-DICHLOROETHANE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
1,1-DICHLOROETHENE	5	0	0	0.00E+00	5.10E+00	2.67E-01	2.50E+01	0.00E+00	6.54E+00	1.13E+01	1.87E+21	Normal/Lognormal
1,2,3-TRICHLOROPROPANE	5	0	0	0.00E+00	5.41E+00	1.45E-01	5.00E+01	0.00E+00	1.10E+01	1.59E+01	1.65E+16	Lognormal
1,2-DIBROMO-3-CHLOROPROPANE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal
1,2-DIBROMOETHANE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal
1,2-DICHLOROETHANE	5	0	0	0.00E+00	5.10E+00	2.67E-01	2.50E+01	0.00E+00	6.54E+00	1.13E+01	1.87E+21	Normal/Lognormal
1,2-DICHLOROPROPANE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
2-CHLORO-1,3-BUTADIENE	5	0	0	0.00E+00	5.41E+01	1.45E+00	5.00E+02	0.00E+00	1.10E+02	1.59E+02	1.65E+17	Lognormal
2-HEXANONE	6	0	0	0.00E+00	1.26E+01	3.83E-01	9.70E+01	0.00E+00	2.01E+01	2.92E+01	3.42E+15	Normal/Lognormal
ACETONITRILE	5	0	0	0.00E+00	5.41E+01	1.45E+00	5.00E+02	0.00E+00	1.10E+02	1.59E+02	1.65E+17	Lognormal
ACROLEIN	5	0	0	0.00E+00	2.70E+02	7.27E+00	2.50E+03	0.00E+00	5.49E+02	7.94E+02	8.25E+17	Lognormal
ACRYLONITRILE	5	0	0	0.00E+00	5.41E+01	1.45E+00	5.00E+02	0.00E+00	1.10E+02	1.59E+02	1.65E+17	Lognormal
ALLYL CHLORIDE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal
BENZENE	5	0	0	0.00E+00	5.02E+00	2.42E-01	2.50E+01	0.00E+00	6.60E+00	1.13E+01	7.84E+20	Normal/Lognormal
BROMODICHLOROMETHANE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
BROMOFORM	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
BROMOMETHANE	6	0	0	0.00E+00	8.59E+00	3.42E-01	5.00E+01	0.00E+00	1.25E+01	1.89E+01	2.02E+14	Lognormal
CARBON TETRACHLORIDE	5	0	0	0.00E+00	5.10E+00	2.67E-01	2.50E+01	0.00E+00	6.54E+00	1.13E+01	1.87E+21	Normal/Lognormal
CHLOROBENZENE	5	0	0	0.00E+00	5.10E+00	2.67E-01	2.50E+01	0.00E+00	6.54E+00	1.13E+01	1.87E+21	Normal/Lognormal
CHLOROETHANE	6	0	0	0.00E+00	8.59E+00	3.42E-01	5.00E+01	0.00E+00	1.25E+01	1.89E+01	2.02E+14	Lognormal
CHLOROFORM	5	0	0	0.00E+00	5.10E+00	2.67E-01	2.50E+01	0.00E+00	6.54E+00	1.13E+01	1.87E+21	Normal/Lognormal
CHLOROMETHANE	6	0	0	0.00E+00	8.59E+00	3.42E-01	5.00E+01	0.00E+00	1.25E+01	1.89E+01	2.02E+14	Lognormal
CIS-1,3-DICHLOROPROPENE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
DIBROMOCHLOROMETHANE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
DIBROMOMETHANE	5	0	0	0.00E+00	5.41E+00	1.45E-01	5.00E+01	0.00E+00	1.10E+01	1.59E+01	1.65E+16	Lognormal
DICHLORODIFLUOROMETHANE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal
ETHYLMETHACRYLATE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal
IODOMETHANE	5	0	0	0.00E+00	5.25E+00	1.31E-01	5.00E+01	0.00E+00	1.11E+01	1.58E+01	2.53E+15	Lognormal
ISOBUTANOL	5	0	0	0.00E+00	1.08E+03	2.89E+01	1.00E+04	0.00E+00	2.20E+03	3.18E+03	3.47E+18	Lognormal
METHACRYLONITRILE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal

Table 28

Statistical Summary of Constituents in Surface Soil (1-3 feet bgs) for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
METHYLMETHACRYLATE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal
PENTACHLOROETHANE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal
PROPIONITRILE	5	0	0	0.00E+00	2.70E+01	7.27E-01	2.50E+02	0.00E+00	5.49E+01	7.94E+01	8.25E+16	Lognormal
STYRENE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
TRANS-1,3-DICHLOROPROPENE	6	0	0	0.00E+00	4.25E+00	1.70E-01	2.50E+01	0.00E+00	6.21E+00	9.36E+00	9.31E+13	Lognormal
TRANS-1,4-DICHLORO-2-BUTENE	5	0	0	0.00E+00	1.08E+01	2.89E-01	1.00E+02	0.00E+00	2.20E+01	3.18E+01	3.47E+16	Lognormal
TRICHLOROFLUOROMETHANE	5	0	0	0.00E+00	5.41E+00	1.45E-01	5.00E+01	0.00E+00	1.10E+01	1.59E+01	1.65E+16	Lognormal
VINYL ACETATE	5	0	0	0.00E+00	5.41E+00	1.45E-01	5.00E+01	0.00E+00	1.10E+01	1.59E+01	1.65E+16	Lognormal
VINYL CHLORIDE	5	0	0	0.00E+00	1.03E+01	5.36E-01	5.00E+01	0.00E+00	1.32E+01	2.29E+01	4.19E+21	Normal/Lognormal

Table 29

Statistical Summary of Constituents in Sediment for Use in the Ecological Risk Assessment

ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
DETECTED CONSTITUENTS												
Dioxins												
2,3,7,8-TCDD (TEQ)	3	3	100	1.75E-06	6.02E-06	4.35E-06	0.00E+00	1.26E-05	5.75E-06	1.57E-05	6.48E-02	Normal/Lognormal
Inorganics												
ANTIMONY	2	2	100	2.40E+00	0.00E+00	3.50E+00	3.32E+00	4.60E+00	1.56E+00	1.04E+01	8.84E+02	Unknown
ARSENIC	3	3	100	3.50E+00	9.38E+00	8.09E+00	0.00E+00	1.32E+01	5.17E+00	1.81E+01	1.41E+03	Normal/Lognormal
BARIUM	3	3	100	3.06E+01	9.53E+01	7.53E+01	0.00E+00	1.76E+02	7.40E+01	2.20E+02	1.31E+05	Normal/Lognormal
BERYLLIUM	3	3	100	5.80E-01	9.48E-01	9.06E-01	0.00E+00	1.17E+00	3.21E-01	1.49E+00	3.91E+00	Normal/Lognormal
CADMIUM	3	3	100	6.30E-01	1.10E+00	9.92E-01	0.00E+00	1.80E+00	6.20E-01	2.14E+00	1.66E+01	Normal/Lognormal
CHROMIUM	3	3	100	1.12E+01	2.50E+01	2.25E+01	0.00E+00	3.30E+01	1.20E+01	4.52E+01	7.75E+02	Normal/Lognormal
COBALT	3	3	100	1.80E+00	8.63E+00	6.20E+00	0.00E+00	1.56E+01	6.90E+00	2.03E+01	1.08E+06	Normal/Lognormal
COPPER	3	3	100	1.09E+01	4.62E+01	3.26E+01	0.00E+00	9.37E+01	4.27E+01	1.18E+02	2.56E+06	Normal/Lognormal
CYANIDE	3	1	33.33	6.60E+00	2.35E+00	6.75E-01	6.00E-01	6.60E+00	3.68E+00	8.56E+00	6.27E+16	Normal/Lognormal
LEAD	3	3	100	1.12E+02	1.50E+02	1.47E+02	0.00E+00	1.77E+02	3.39E+01	2.07E+02	2.80E+02	Normal/Lognormal
MERCURY	3	3	100	5.00E-02	1.03E-01	9.44E-02	0.00E+00	1.40E-01	4.73E-02	1.83E-01	1.87E+00	Normal/Lognormal
NICKEL	3	3	100	6.00E+00	2.47E+01	1.90E+01	0.00E+00	3.82E+01	1.67E+01	5.28E+01	3.51E+05	Normal/Lognormal
SELENIUM	3	3	100	2.00E-01	6.57E-01	5.15E-01	0.00E+00	1.20E+00	5.06E-01	1.51E+00	1.36E+03	Normal/Lognormal
SILVER	3	2	66.67	6.80E-01	6.27E-01	3.93E-01	1.60E-01	1.12E+00	5.22E-01	1.51E+00	8.10E+07	Normal/Lognormal
THALLIUM	3	1	33.33	2.50E-01	1.50E-01	1.34E-01	2.40E-01	2.50E-01	8.89E-02	3.00E-01	3.40E+00	Normal/Lognormal
TIN	3	1	33.33	3.80E+00	1.58E+00	9.40E-01	1.12E+00	3.80E+00	1.92E+00	4.82E+00	2.01E+06	Normal/Lognormal
VANADIUM	3	3	100	8.00E+00	2.86E+01	2.29E+01	0.00E+00	4.38E+01	1.85E+01	5.98E+01	8.21E+04	Normal/Lognormal
ZINC	3	3	100	7.77E+01	2.23E+02	1.88E+02	0.00E+00	3.25E+02	1.29E+02	4.40E+02	6.36E+04	Normal/Lognormal
Pesticides												
4,4'-DDD	3	3	100	2.30E-02	9.60E-02	6.28E-02	0.00E+00	2.15E-01	1.04E-01	2.71E-01	1.74E+04	Normal/Lognormal
4,4'-DDE	3	2	66.67	7.30E-03	2.29E-01	6.78E-02	1.40E-01	6.10E-01	3.31E-01	7.88E-01	3.59E+19	Normal/Lognormal
4,4'-DDT	3	1	33.33	7.65E-02	6.42E-02	6.27E-02	1.40E-01	7.65E-02	1.61E-02	9.13E-02	1.36E-01	Normal/Lognormal
ALDRIN	3	1	33.33	4.70E-02	3.50E-02	3.36E-02	7.00E-02	4.70E-02	1.20E-02	5.52E-02	1.19E-01	Normal/Lognormal
ALPHA-CHLORDANE	3	3	100	7.30E-03	1.59E-02	1.29E-02	0.00E+00	3.10E-02	1.31E-02	3.80E-02	4.23E+00	Normal/Lognormal
GAMMA-CHLORDANE	3	3	100	1.70E-02	2.30E-02	2.16E-02	0.00E+00	3.50E-02	1.04E-02	4.05E-02	1.17E-01	Unknown
ISODRIN	3	1	33.33	8.80E-03	2.23E-02	1.92E-02	7.00E-02	8.80E-03	1.31E-02	4.44E-02	2.49E+00	Normal/Lognormal
KEPONE	3	1	33.33	6.90E-01	2.69E-01	1.30E-01	1.40E-01	6.90E-01	3.65E-01	8.84E-01	1.26E+08	Normal/Lognormal
Semivolatile Organic Compounds (Non-Pesticides)												
2-METHYLNAPHTHALENE	3	2	66.67	1.20E-01	1.56E-01	1.53E-01	3.80E-01	1.58E-01	3.50E-02	2.15E-01	2.80E-01	Normal/Lognormal
ACENAPHTHENE	3	3	100	8.90E-02	1.68E-01	1.55E-01	0.00E+00	2.40E-01	7.57E-02	2.96E-01	1.87E+00	Normal/Lognormal
ACENAPHTHYLENE	3	1	33.33	6.50E-02	2.08E-01	1.72E-01	5.90E-01	6.50E-02	1.25E-01	4.19E-01	1.75E+02	Normal/Lognormal
ANTHRACENE	3	3	100	2.90E-01	5.20E-01	4.80E-01	0.00E+00	7.80E-01	2.46E-01	9.35E-01	5.15E+00	Normal/Lognormal
BENZO(A)ANTHRACENE	3	3	100	1.40E+00	1.62E+00	1.61E+00	0.00E+00	1.80E+00	2.02E-01	1.96E+00	2.10E+00	Normal/Lognormal
BENZO(A)PYRENE	3	3	100	1.40E+00	1.57E+00	1.56E+00	0.00E+00	1.70E+00	1.53E-01	1.82E+00	1.90E+00	Normal/Lognormal
BENZO(B)FLUORANTHENE	3	3	100	1.80E+00	2.30E+00	2.27E+00	0.00E+00	2.60E+00	4.36E-01	3.03E+00	3.72E+00	Normal/Lognormal
BENZO(G,H,I)PERYLENE	3	3	100	8.40E-01	1.06E+00	1.05E+00	0.00E+00	1.25E+00	2.07E-01	1.41E+00	1.72E+00	Normal/Lognormal

Table 29
Statistical Summary of Constituents in Sediment for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
BENZO(K)FLUORANTHENE	3	3	100	8.40E-01	9.00E-01	8.99E-01	0.00E+00	9.40E-01	5.29E-02	9.89E-01	1.01E+00	Normal/Lognormal
BIS(2-ETHYLHEXYL)PHTHALATE	3	3	100	7.40E-01	1.61E+00	1.46E+00	0.00E+00	2.20E+00	7.71E-01	2.91E+00	4.33E+01	Normal/Lognormal
BUTYLBENZYLPHTHALATE	3	2	66.67	1.70E-01	3.12E-01	2.82E-01	5.30E-01	5.00E-01	1.70E-01	5.98E-01	4.88E+00	Normal/Lognormal
CHRYSENE	3	3	100	1.60E+00	2.13E+00	2.10E+00	0.00E+00	2.50E+00	4.73E-01	2.93E+00	3.92E+00	Normal/Lognormal
DIBENZO(A,H)ANTHRACENE	3	3	100	2.10E-01	2.70E-01	2.66E-01	0.00E+00	3.10E-01	5.29E-02	3.59E-01	4.46E-01	Normal/Lognormal
DIBENZOFURAN	3	3	100	7.80E-02	1.23E-01	1.16E-01	0.00E+00	1.80E-01	5.22E-02	2.11E-01	6.42E-01	Normal/Lognormal
DI-N-BUTYLPHTHALATE	3	1	33.33	1.10E-01	2.58E-01	2.15E-01	9.50E-01	1.10E-01	1.92E-01	5.82E-01	4.34E+01	Normal/Lognormal
FLUORANTHENE	3	3	100	1.90E+00	2.75E+00	2.66E+00	0.00E+00	3.60E+00	8.50E-01	4.18E+00	7.46E+00	Normal/Lognormal
FLUORENE	3	3	100	1.20E-01	1.73E-01	1.67E-01	0.00E+00	2.30E-01	5.51E-02	2.66E-01	4.83E-01	Normal/Lognormal
INDENO(1,2,3-CD)PYRENE	3	3	100	9.50E-01	1.33E+00	1.30E+00	0.00E+00	1.55E+00	3.33E-01	1.89E+00	2.86E+00	Normal/Lognormal
NAPHTHALENE	3	2	66.67	6.90E-02	1.19E-01	1.08E-01	3.80E-01	9.70E-02	6.33E-02	2.25E-01	1.42E+00	Normal/Lognormal
PHENANTHRENE	3	3	100	1.20E+00	1.58E+00	1.56E+00	0.00E+00	1.85E+00	3.40E-01	2.16E+00	2.82E+00	Normal/Lognormal
PYRENE	3	3	100	2.30E+00	3.52E+00	3.39E+00	0.00E+00	4.20E+00	1.06E+00	5.30E+00	1.05E+01	Normal/Lognormal
Volatile Organic Compounds												
METHYLENE CHLORIDE	3	2	66.67	9.00E-03	8.00E-03	7.52E-03	9.00E-03	1.05E-02	3.12E-03	1.33E-02	5.41E-02	Normal/Lognormal
CONSTITUENTS NOT DETECTED												
2,4,5-T	3	0	0	0.00E+00	1.94E-01	1.15E-01	6.00E-01	0.00E+00	1.52E-01	4.51E-01	1.28E+09	Normal/Lognormal
2,4,5-TP (SILVEX)	3	0	0	0.00E+00	1.49E-01	9.04E-02	6.00E-01	0.00E+00	1.42E-01	3.87E-01	1.62E+07	Normal/Lognormal
2,4-D	3	0	0	0.00E+00	1.50E+00	9.12E-01	6.00E+00	0.00E+00	1.41E+00	3.88E+00	1.80E+08	Normal/Lognormal
DIMETHOATE	3	0	0	0.00E+00	4.97E-01	4.89E-01	1.20E+00	0.00E+00	1.05E-01	6.74E-01	8.43E-01	Normal/Lognormal
DISULFOTON	3	0	0	0.00E+00	5.07E-01	4.99E-01	1.20E+00	0.00E+00	1.07E-01	6.87E-01	8.78E-01	Normal/Lognormal
ETHYL PARATHION	3	0	0	0.00E+00	5.07E-01	4.99E-01	1.20E+00	0.00E+00	1.07E-01	6.87E-01	8.78E-01	Normal/Lognormal
FAMPHUR	3	0	0	0.00E+00	5.07E-01	4.99E-01	1.20E+00	0.00E+00	1.07E-01	6.87E-01	8.78E-01	Normal/Lognormal
METHYL PARATHION	3	0	0	0.00E+00	5.07E-01	4.99E-01	1.20E+00	0.00E+00	1.07E-01	6.87E-01	8.78E-01	Normal/Lognormal
O,O,O-TRIETHYL PHOSPHOROTHIOATE	3	0	0	0.00E+00	5.07E-01	4.99E-01	1.20E+00	0.00E+00	1.07E-01	6.87E-01	8.78E-01	Normal/Lognormal
PHORATE	3	0	0	0.00E+00	5.07E-01	4.99E-01	1.20E+00	0.00E+00	1.07E-01	6.87E-01	8.78E-01	Normal/Lognormal
SULFOTEPP	3	0	0	0.00E+00	5.08E-01	5.00E-01	1.20E+00	0.00E+00	1.08E-01	6.90E-01	8.85E-01	Normal/Lognormal
ZINOPHOS	3	0	0	0.00E+00	5.08E-01	5.00E-01	1.20E+00	0.00E+00	1.08E-01	6.90E-01	8.85E-01	Normal/Lognormal
AROCLOR-1016	3	0	0	0.00E+00	3.00E-01	2.95E-01	7.00E-01	0.00E+00	6.24E-02	4.05E-01	5.19E-01	Normal/Lognormal
AROCLOR-1221	3	0	0	0.00E+00	3.00E-01	2.95E-01	7.00E-01	0.00E+00	6.24E-02	4.05E-01	5.19E-01	Normal/Lognormal
AROCLOR-1232	3	0	0	0.00E+00	3.00E-01	2.95E-01	7.00E-01	0.00E+00	6.24E-02	4.05E-01	5.19E-01	Normal/Lognormal
AROCLOR-1242	3	0	0	0.00E+00	3.00E-01	2.95E-01	7.00E-01	0.00E+00	6.24E-02	4.05E-01	5.19E-01	Normal/Lognormal
AROCLOR-1248	3	0	0	0.00E+00	3.00E-01	2.95E-01	7.00E-01	0.00E+00	6.24E-02	4.05E-01	5.19E-01	Normal/Lognormal
AROCLOR-1254	3	0	0	0.00E+00	5.95E-01	5.86E-01	1.40E+00	0.00E+00	1.23E-01	8.02E-01	1.01E+00	Normal/Lognormal
AROCLOR-1260	3	0	0	0.00E+00	5.95E-01	5.86E-01	1.40E+00	0.00E+00	1.23E-01	8.02E-01	1.01E+00	Normal/Lognormal
ALPHA-BHC	3	0	0	0.00E+00	3.00E-02	2.95E-02	7.00E-02	0.00E+00	6.24E-03	4.05E-02	5.19E-02	Normal/Lognormal
BETA-BHC	3	0	0	0.00E+00	3.00E-02	2.95E-02	7.00E-02	0.00E+00	6.24E-03	4.05E-02	5.19E-02	Normal/Lognormal
DELTA-BHC	3	0	0	0.00E+00	3.00E-02	2.95E-02	7.00E-02	0.00E+00	6.24E-03	4.05E-02	5.19E-02	Normal/Lognormal
DIELDRIN	3	0	0	0.00E+00	5.95E-02	5.86E-02	1.40E-01	0.00E+00	1.23E-02	8.02E-02	1.01E-01	Normal/Lognormal

Table 29
Statistical Summary of Constituents in Sediment for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
ENDOSULFAN I	3	0	0	0.00E+00	3.00E-02	2.95E-02	7.00E-02	0.00E+00	6.24E-03	4.05E-02	5.19E-02	Normal/Lognormal
ENDOSULFAN II	3	0	0	0.00E+00	5.95E-02	5.86E-02	1.40E-01	0.00E+00	1.23E-02	8.02E-02	1.01E-01	Normal/Lognormal
ENDOSULFAN SULFATE	3	0	0	0.00E+00	5.95E-02	5.86E-02	1.40E-01	0.00E+00	1.23E-02	8.02E-02	1.01E-01	Normal/Lognormal
ENDRIN	3	0	0	0.00E+00	5.95E-02	5.86E-02	1.40E-01	0.00E+00	1.23E-02	8.02E-02	1.01E-01	Normal/Lognormal
ENDRIN ALDEHYDE	3	0	0	0.00E+00	5.95E-02	5.86E-02	1.40E-01	0.00E+00	1.23E-02	8.02E-02	1.01E-01	Normal/Lognormal
GAMMA-BHC (LINDANE)	3	0	0	0.00E+00	3.00E-02	2.95E-02	7.00E-02	0.00E+00	6.24E-03	4.05E-02	5.19E-02	Normal/Lognormal
HEPTACHLOR	3	0	0	0.00E+00	3.00E-02	2.95E-02	7.00E-02	0.00E+00	6.24E-03	4.05E-02	5.19E-02	Normal/Lognormal
HEPTACHLOR EPOXIDE	3	0	0	0.00E+00	3.00E-02	2.95E-02	7.00E-02	0.00E+00	6.24E-03	4.05E-02	5.19E-02	Normal/Lognormal
METHOXYCHLOR	3	0	0	0.00E+00	3.00E-01	2.95E-01	7.00E-01	0.00E+00	6.24E-02	4.05E-01	5.19E-01	Normal/Lognormal
TOXAPHENE	3	0	0	0.00E+00	5.95E-01	5.86E-01	1.40E+00	0.00E+00	1.23E-01	8.02E-01	1.01E+00	Normal/Lognormal
1,2,4,5-TETRACHLOROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
1,2,4-TRICHLOROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
1,2-DICHLOROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
1,3,5-TRINITROBENZENE	3	0	0	0.00E+00	2.50E+00	2.46E+00	5.90E+00	0.00E+00	5.41E-01	3.41E+00	4.46E+00	Normal/Lognormal
1,3-DICHLOROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
1,3-DINITROBENZENE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
1,4-DICHLOROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
1,4-DIOXANE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
1,4-NAPHTHOQUINONE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
1-NAPHTHYLAMINE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
2,2'-OXYBIS(1-CHLOROPROPANE)	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2,3,4,6-TETRACHLOROPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2,4,5-TRICHLOROPHENOL	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
2,4,6-TRICHLOROPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2,4-DICHLOROPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2,4-DIMETHYLPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2,4-DINITROPHENOL	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
2,4-DINITROTOLUENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2,6-DICHLOROPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2,6-DINITROTOLUENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2-ACETYLAMINOFLUORENE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
2-AMINONAPHTHALENE	3	0	0	0.00E+00	6.27E-01	6.16E-01	1.50E+00	0.00E+00	1.37E-01	8.57E-01	1.11E+00	Normal/Lognormal
2-CHLORONAPHTHALENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2-CHLOROPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2-METHYLPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2-NITROANILINE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
2-NITROPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
2-PICOLINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
3&4-METHYLPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
3,3'-DICHLOROBENZIDINE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal

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ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
3,3'-DIMETHYLBENZIDINE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
3-METHYLCHOLANTHRENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
3-NITROANILINE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
4,6-DINITRO-2-METHYLPHENOL	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
4-AMINOBIPHENYL	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
4-BROMOPHENYL-PHENYLETHER	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
4-CHLORO-3-METHYLPHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
4-CHLOROANILINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
4-CHLOROPHENYL-PHENYLETHER	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
4-NITROANILINE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
4-NITROPHENOL	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
4-NITROQUINOLINE-1-OXIDE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
5-NITRO-O-TOLUIDINE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
7,12-DIMETHYLBENZ(A)ANTHRACENE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
A,A-DIMETHYLPHENETHYLAMINE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
ACETOPHENONE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
ANILINE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
ARAMITE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
BENZYL ALCOHOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
BIS(2-CHLOROETHOXY)METHANE	3	0	0	0.00E+00	2.49E-01	2.45E-01	5.90E-01	0.00E+00	5.38E-02	3.40E-01	4.42E-01	Normal/Lognormal
BIS(2-CHLOROETHYL)ETHER	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
CHLOROBENZILATE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
DI-N-OCTYLPHTHALATE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
DIALLATE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
DIETHYLPHTHALATE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
DIMETHYLPHTHALATE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
DINOSEB	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
DIPHENYLAMINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
ETHYLMETHANESULFONATE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
HEXACHLOROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
HEXACHLOROBUTADIENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
HEXACHLOROCYCLOPENTADIENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
HEXACHLOROETHANE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
HEXACHLOROPHENE	3	0	0	0.00E+00	2.50E+00	2.46E+00	5.90E+00	0.00E+00	5.41E-01	3.41E+00	4.46E+00	Normal/Lognormal
HEXACHLOROPROPENE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
ISOPHORONE	3	0	0	0.00E+00	2.52E-01	2.47E-01	5.90E-01	0.00E+00	5.48E-02	3.44E-01	4.54E-01	Normal/Lognormal
ISOSAFROLE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
METHAPYRILENE	3	0	0	0.00E+00	6.27E-01	6.16E-01	1.50E+00	0.00E+00	1.37E-01	8.57E-01	1.11E+00	Normal/Lognormal
METHYLMETHANESULFONATE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
N-NITROSODI-N-BUTYLAMINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal

Table 29
Statistical Summary of Constituents in Sediment for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
N-NITROSODI-N-PROPYLAMINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
N-NITROSODIETHYLAMINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
N-NITROSODIMETHYLAMINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
N-NITROSODIPHENYLAMINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
N-NITROSOMETHYLETHYLAMINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
N-NITROSOMORPHOLINE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
N-NITROSOPIPERIDINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
N-NITROSOPYRROLIDINE	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
NITROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
O-TOLUIDINE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
P-DIMETHYLAMINOAZOBENZENE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
P-PHENYLENEDIAMINE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
PENTACHLOROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
PENTACHLORONITROBENZENE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
PENTACHLOROPHENOL	3	0	0	0.00E+00	1.26E+00	1.24E+00	3.00E+00	0.00E+00	2.81E-01	1.73E+00	2.30E+00	Normal/Lognormal
PHENACETIN	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
PHENOL	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
PRONAMIDE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
PYRIDINE	3	0	0	0.00E+00	5.03E-01	4.94E-01	1.20E+00	0.00E+00	1.12E-01	6.93E-01	9.21E-01	Normal/Lognormal
SAFROLE	3	0	0	0.00E+00	2.50E-01	2.46E-01	5.90E-01	0.00E+00	5.41E-02	3.41E-01	4.46E-01	Normal/Lognormal
1,1,1,2-TETRACHLOROETHANE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
1,1,1-TRICHLOROETHANE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
1,1,2,2-TETRACHLOROETHANE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
1,1,2-TRICHLOROETHANE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
1,1-DICHLOROETHANE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
1,1-DICHLOROETHENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
1,2,3-TRICHLOROPROPANE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
1,2-DIBROMO-3-CHLOROPROPANE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
1,2-DIBROMOETHANE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
1,2-DICHLOROETHANE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
1,2-DICHLOROETHENE (TOTAL)	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
1,2-DICHLOROPROPANE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
2-BUTANONE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
2-CHLORO-1,3-BUTADIENE	3	0	0	0.00E+00	7.67E-02	7.56E-02	1.80E-01	0.00E+00	1.53E-02	1.02E-01	1.27E-01	Normal/Lognormal
2-HEXANONE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
4-METHYL-2-PENTANONE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
ACETONE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
ACETONITRILE	3	0	0	0.00E+00	7.67E-02	7.56E-02	1.80E-01	0.00E+00	1.53E-02	1.02E-01	1.27E-01	Normal/Lognormal
ACROLEIN	3	0	0	0.00E+00	3.83E-01	3.77E-01	9.00E-01	0.00E+00	7.97E-02	5.18E-01	6.59E-01	Normal/Lognormal
ACRYLONITRILE	3	0	0	0.00E+00	7.67E-02	7.56E-02	1.80E-01	0.00E+00	1.53E-02	1.02E-01	1.27E-01	Normal/Lognormal

Table 29
Statistical Summary of Constituents in Sediment for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Log Mean mg/kg	Maximum SQL mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Log 95% UCL mg/kg	Distribution 99% Confidence
ALLYL CHLORIDE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
BENZENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
BROMODICHLOROMETHANE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
BROMOFORM	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
BROMOMETHANE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
CARBON DISULFIDE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
CARBON TETRACHLORIDE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
CHLOROBENZENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
CHLOROETHANE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
CHLOROFORM	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
CHLOROMETHANE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
CIS-1,3-DICHLOROPROPENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
DIBROMOCHLOROMETHANE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
DIBROMOMETHANE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
DICHLORODIFLUOROMETHANE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
ETHYLBENZENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
ETHYLMETHACRYLATE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
IODOMETHANE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
ISOBUTANOL	3	0	0	0.00E+00	1.53E+00	1.51E+00	3.60E+00	0.00E+00	3.06E-01	2.05E+00	2.53E+00	Normal/Lognormal
METHACRYLONITRILE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
METHYLMETHACRYLATE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
PENTACHLOROETHANE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
PROPIONITRILE	3	0	0	0.00E+00	3.83E-02	3.77E-02	9.00E-02	0.00E+00	7.97E-03	5.18E-02	6.59E-02	Normal/Lognormal
STYRENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
TETRACHLOROETHENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
TOLUENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
TRANS-1,3-DICHLOROPROPENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
TRANS-1,4-DICHLORO-2-BUTENE	3	0	0	0.00E+00	1.53E-02	1.51E-02	3.60E-02	0.00E+00	3.06E-03	2.05E-02	2.53E-02	Normal/Lognormal
TRICHLOROETHENE	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal
TRICHLOROFLUOROMETHANE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
VINYL ACETATE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
VINYL CHLORIDE	3	0	0	0.00E+00	7.67E-03	7.56E-03	1.80E-02	0.00E+00	1.53E-03	1.02E-02	1.27E-02	Normal/Lognormal
XYLENES (TOTAL)	3	0	0	0.00E+00	3.83E-03	3.78E-03	9.00E-03	0.00E+00	7.64E-04	5.12E-03	6.33E-03	Normal/Lognormal

Table 30
Statistical Summary of Constituents in Surface Water for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Log Mean mg/L	Maximum SQL mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Log 95% UCL mg/L	Distribution 99% Confidence
DETECTED CONSTITUENTS												
Inorganics												
ARSENIC, SOLUBLE	3	1	33.33	1.50E-03	1.00E-03	9.39E-04	1.70E-03	1.50E-03	4.44E-04	1.75E-03	5.50E-03	Normal/Lognormal
BARIUM, SOLUBLE	3	3	100	4.18E-02	5.00E-02	4.97E-02	0.00E+00	5.58E-02	7.32E-03	6.24E-02	6.94E-02	Normal/Lognormal
BARIUM, TOTAL	3	3	100	4.35E-02	5.10E-02	5.06E-02	0.00E+00	5.71E-02	6.88E-03	6.25E-02	6.81E-02	Normal/Lognormal
CADMIUM, SOLUBLE	3	1	33.33	2.15E-03	1.42E-03	1.33E-03	2.10E-03	2.15E-03	6.35E-04	2.49E-03	7.03E-03	Unknown
COPPER, SOLUBLE	3	1	33.33	2.20E-03	1.25E-03	1.07E-03	1.50E-03	2.20E-03	8.37E-04	2.64E-03	4.55E-02	Unknown
COPPER, TOTAL	3	3	100	2.10E-03	2.40E-03	2.39E-03	0.00E+00	2.60E-03	2.65E-04	2.85E-03	3.01E-03	Normal/Lognormal
SELENIUM, SOLUBLE	3	2	66.67	1.85E-03	1.62E-03	1.52E-03	1.80E-03	2.10E-03	6.33E-04	2.68E-03	1.15E-02	Normal/Lognormal
VANADIUM, TOTAL	3	1	33.33	1.85E-03	1.18E-03	1.10E-03	1.70E-03	1.85E-03	5.77E-04	2.16E-03	7.76E-03	Unknown
Semivolatile Organic Compounds												
BIS(2-ETHYLHEXYL)PHTHALATE	3	1	33.33	1.00E-02	6.67E-03	6.30E-03	1.00E-02	1.00E-02	2.89E-03	1.15E-02	2.99E-02	Unknown
CONSTITUENTS NOT DETECTED												
2,3,7,8-TCDD	3	0	0	0.00E+00	6.48E-07	5.82E-07	2.10E-06	0.00E+00	3.66E-07	1.26E-06	1.39E-05	Normal/Lognormal
2,4,5-T	3	0	0	0.00E+00	5.58E-05	5.58E-05	1.15E-04	0.00E+00	1.44E-06	5.83E-05	5.84E-05	Unknown
2,4,5-TP (SILVEX)	3	0	0	0.00E+00	5.58E-05	5.58E-05	1.15E-04	0.00E+00	1.44E-06	5.83E-05	5.84E-05	Unknown
2,4-D	3	0	0	0.00E+00	5.58E-04	5.58E-04	1.15E-03	0.00E+00	1.44E-05	5.83E-04	5.84E-04	Unknown
ANTIMONY, SOLUBLE	3	0	0	0.00E+00	8.00E-03	8.00E-03	1.60E-02	0.00E+00	0.00E+00	8.00E-03	8.00E-03	Unknown
ANTIMONY, TOTAL	3	0	0	0.00E+00	8.00E-03	8.00E-03	1.60E-02	0.00E+00	0.00E+00	8.00E-03	8.00E-03	Unknown
ARSENIC, TOTAL	3	0	0	0.00E+00	6.50E-04	6.50E-04	1.30E-03	0.00E+00	0.00E+00	6.50E-04	6.50E-04	Unknown
BERYLLIUM, SOLUBLE	3	0	0	0.00E+00	2.00E-04	2.00E-04	4.00E-04	0.00E+00	0.00E+00	2.00E-04	2.00E-04	Unknown
BERYLLIUM, TOTAL	3	0	0	0.00E+00	2.00E-04	2.00E-04	4.00E-04	0.00E+00	0.00E+00	2.00E-04	2.00E-04	Unknown
CADMIUM, TOTAL	3	0	0	0.00E+00	1.05E-03	1.05E-03	2.10E-03	0.00E+00	0.00E+00	1.05E-03	1.05E-03	Unknown
CHROMIUM, SOLUBLE	3	0	0	0.00E+00	8.50E-04	8.50E-04	1.70E-03	0.00E+00	0.00E+00	8.50E-04	8.50E-04	Unknown
CHROMIUM, TOTAL	3	0	0	0.00E+00	8.50E-04	8.50E-04	1.70E-03	0.00E+00	0.00E+00	8.50E-04	8.50E-04	Unknown
COBALT, SOLUBLE	3	0	0	0.00E+00	1.40E-03	1.40E-03	2.80E-03	0.00E+00	0.00E+00	1.40E-03	1.40E-03	Unknown
COBALT, TOTAL	3	0	0	0.00E+00	1.40E-03	1.40E-03	2.80E-03	0.00E+00	0.00E+00	1.40E-03	1.40E-03	Unknown
CYANIDE, TOTAL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
LEAD, SOLUBLE	3	0	0	0.00E+00	3.70E-04	3.69E-04	8.20E-04	0.00E+00	3.46E-05	4.28E-04	4.42E-04	Unknown
LEAD, TOTAL	3	0	0	0.00E+00	8.33E-04	8.21E-04	2.00E-03	0.00E+00	1.76E-04	1.13E-03	1.42E-03	Normal/Lognormal
MERCURY, SOLUBLE	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
MERCURY, TOTAL	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
NICKEL, SOLUBLE	3	0	0	0.00E+00	3.35E-03	3.35E-03	6.70E-03	0.00E+00	0.00E+00	3.35E-03	3.35E-03	Unknown
NICKEL, TOTAL	3	0	0	0.00E+00	3.35E-03	3.35E-03	6.70E-03	0.00E+00	0.00E+00	3.35E-03	3.35E-03	Unknown
SELENIUM, TOTAL	3	0	0	0.00E+00	9.00E-04	9.00E-04	1.80E-03	0.00E+00	0.00E+00	9.00E-04	9.00E-04	Unknown
SILVER, SOLUBLE	3	0	0	0.00E+00	9.00E-04	9.00E-04	1.80E-03	0.00E+00	0.00E+00	9.00E-04	9.00E-04	Unknown
SILVER, TOTAL	3	0	0	0.00E+00	9.00E-04	9.00E-04	1.80E-03	0.00E+00	0.00E+00	9.00E-04	9.00E-04	Unknown
THALLIUM, SOLUBLE	3	0	0	0.00E+00	6.50E-04	6.50E-04	1.30E-03	0.00E+00	0.00E+00	6.50E-04	6.50E-04	Unknown

Table 30

Statistical Summary of Constituents in Surface Water for Use in the Ecological Risk Assessment

ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Log Mean mg/L	Maximum SQL mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Log 95% UCL mg/L	Distribution 99% Confidence
THALLIUM, TOTAL	3	0	0	0.00E+00	6.50E-04	6.50E-04	1.30E-03	0.00E+00	0.00E+00	6.50E-04	6.50E-04	Unknown
TIN, SOLUBLE	3	0	0	0.00E+00	4.35E-03	4.35E-03	8.70E-03	0.00E+00	0.00E+00	4.35E-03	4.35E-03	Unknown
TIN, TOTAL	3	0	0	0.00E+00	4.35E-03	4.35E-03	8.70E-03	0.00E+00	0.00E+00	4.35E-03	4.35E-03	Unknown
VANADIUM, SOLUBLE	3	0	0	0.00E+00	8.50E-04	8.50E-04	1.70E-03	0.00E+00	0.00E+00	8.50E-04	8.50E-04	Unknown
ZINC, SOLUBLE	3	0	0	0.00E+00	3.58E-03	3.52E-03	8.95E-03	0.00E+00	7.80E-04	4.89E-03	5.88E-03	Normal/Lognormal
ZINC, TOTAL	3	0	0	0.00E+00	4.94E-03	4.93E-03	1.09E-02	0.00E+00	4.88E-04	5.76E-03	6.00E-03	Normal/Lognormal
DIMETHOATE	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
DISULFOTON	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
ETHYL PARATHION	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
FAMPHUR	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
METHYL PARATHION	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
O,O,O-TRIETHYL PHOSPHOROTHIOATE	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
PHORATE	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
SULFOTEPP	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
ZINOPHOS	3	0	0	0.00E+00	1.00E-03	1.00E-03	2.00E-03	0.00E+00	0.00E+00	1.00E-03	1.00E-03	Unknown
AROCLOR-1016	3	0	0	0.00E+00	2.50E-04	2.50E-04	5.00E-04	0.00E+00	0.00E+00	2.50E-04	2.50E-04	Unknown
AROCLOR-1221	3	0	0	0.00E+00	2.50E-04	2.50E-04	5.00E-04	0.00E+00	0.00E+00	2.50E-04	2.50E-04	Unknown
AROCLOR-1232	3	0	0	0.00E+00	2.50E-04	2.50E-04	5.00E-04	0.00E+00	0.00E+00	2.50E-04	2.50E-04	Unknown
AROCLOR-1242	3	0	0	0.00E+00	2.50E-04	2.50E-04	5.00E-04	0.00E+00	0.00E+00	2.50E-04	2.50E-04	Unknown
AROCLOR-1248	3	0	0	0.00E+00	2.50E-04	2.50E-04	5.00E-04	0.00E+00	0.00E+00	2.50E-04	2.50E-04	Unknown
AROCLOR-1254	3	0	0	0.00E+00	5.00E-04	5.00E-04	1.00E-03	0.00E+00	0.00E+00	5.00E-04	5.00E-04	Unknown
AROCLOR-1260	3	0	0	0.00E+00	5.00E-04	5.00E-04	1.00E-03	0.00E+00	0.00E+00	5.00E-04	5.00E-04	Unknown
4,4'-DDD	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
4,4'-DDE	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
4,4'-DDT	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
ALDRIN	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown
ALPHA-BHC	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown
ALPHA-CHLORDANE	3	0	0	0.00E+00	2.50E-04	2.50E-04	5.00E-04	0.00E+00	0.00E+00	2.50E-04	2.50E-04	Unknown
BETA-BHC	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown
DELTA-BHC	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown
DIELDRIN	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
ENDOSULFAN I	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown
ENDOSULFAN II	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
ENDOSULFAN SULFATE	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
ENDRIN	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
ENDRIN ALDEHYDE	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
GAMMA-BHC (LINDANE)	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown
GAMMA-CHLORDANE	3	0	0	0.00E+00	2.50E-04	2.50E-04	5.00E-04	0.00E+00	0.00E+00	2.50E-04	2.50E-04	Unknown
HEPTACHLOR	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown

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ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Log Mean mg/L	Maximum SQL mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Log 95% UCL mg/L	Distribution 99% Confidence
HEPTACHLOR EPOXIDE	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown
ISODRIN	3	0	0	0.00E+00	2.50E-05	2.50E-05	5.00E-05	0.00E+00	0.00E+00	2.50E-05	2.50E-05	Unknown
KEPONE	3	0	0	0.00E+00	5.00E-05	5.00E-05	1.00E-04	0.00E+00	0.00E+00	5.00E-05	5.00E-05	Unknown
METHOXYCHLOR	3	0	0	0.00E+00	2.50E-04	2.50E-04	5.00E-04	0.00E+00	0.00E+00	2.50E-04	2.50E-04	Unknown
TOXAPHENE	3	0	0	0.00E+00	5.00E-04	5.00E-04	1.00E-03	0.00E+00	0.00E+00	5.00E-04	5.00E-04	Unknown
1,2,4,5-TETRACHLOROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
1,2,4-TRICHLOROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
1,2-DICHLOROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
1,3,5-TRINITROBENZENE	3	0	0	0.00E+00	5.00E-02	5.00E-02	1.00E-01	0.00E+00	0.00E+00	5.00E-02	5.00E-02	Unknown
1,3-DICHLOROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
1,3-DINITROBENZENE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
1,4-DICHLOROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
1,4-DIOXANE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
1,4-NAPHTHOQUINONE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
1-NAPHTHYLAMINE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
2,2-OXYBIS(1-CHLOROPROPANE)	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2,3,4,6-TETRACHLOROPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2,4,5-TRICHLOROPHENOL	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
2,4,6-TRICHLOROPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2,4-DICHLOROPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2,4-DIMETHYLPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2,4-DINITROPHENOL	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
2,4-DINITROTOLUENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2,6-DICHLOROPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2,6-DINITROTOLUENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2-ACETYLAMINOFLUORENE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
2-AMINONAPHTHALENE	3	0	0	0.00E+00	1.25E-02	1.25E-02	2.50E-02	0.00E+00	0.00E+00	1.25E-02	1.25E-02	Unknown
2-CHLORONAPHTHALENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2-CHLOROPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2-METHYLNAPHTHALENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2-METHYLPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2-NITROANILINE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
2-NITROPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2-PICOLINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
3&4-METHYLPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
3,3'-DICHLOROBENZIDINE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
3,3'-DIMETHYLBENZIDINE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
3-METHYLCHOLANTHRENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
3-NITROANILINE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown

Table 30

Statistical Summary of Constituents in Surface Water for Use in the Ecological Risk Assessment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Log Mean mg/L	Maximum SQL mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Log 95% UCL mg/L	Distribution 99% Confidence
4,6-DINITRO-2-METHYLPHENOL	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
4-AMINOBIPHENYL	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
4-BROMOPHENYL-PHENYLETHER	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
4-CHLORO-3-METHYLPHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
4-CHLOROANILINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
4-CHLOROPHENYL-PHENYLETHER	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
4-NITROANILINE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
4-NITROPHENOL	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
4-NITROQUINOLINE-1-OXIDE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
5-NITRO-O-TOLUIDINE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
7,12-DIMETHYLBENZ(A)ANTHRACENE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
A,A-DIMETHYLPHENETHYLAMINE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
ACENAPHTHENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ACENAPHTHYLENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ACETOPHENONE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ANILINE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
ANTHRACENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ARAMITE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
BENZO(A)ANTHRACENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
BENZO(A)PYRENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
BENZO(B)FLUORANTHENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
BENZO(G,H,I)PERYLENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
BENZO(K)FLUORANTHENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
BENZYL ALCOHOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
BIS(2-CHLOROETHOXY)METHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
BIS(2-CHLOROETHYL)ETHER	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
BUTYLBENZYLPHTHALATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
CHLOROBENZILATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
CHRYSENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DI-N-BUTYLPHTHALATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DI-N-OCTYLPHTHALATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DIALLATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DIBENZO(A,H)ANTHRACENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DIBENZOFURAN	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DIETHYLPHTHALATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DIMETHYLPHTHALATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DINOSEB	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
DIPHENYLAMINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ETHYLMETHANESULFONATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown

Table 30

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Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Log Mean mg/L	Maximum SQL mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Log 95% UCL mg/L	Distribution 99% Confidence
FLUORANTHENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
FLUORENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
HEXACHLOROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
HEXACHLOROBUTADIENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
HEXACHLOROCYCLOPENTADIENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
HEXACHLOROETHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
HEXACHLOROPHENE	3	0	0	0.00E+00	5.00E-02	5.00E-02	1.00E-01	0.00E+00	0.00E+00	5.00E-02	5.00E-02	Unknown
HEXACHLOROPROPENE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
INDENO(1,2,3-CD)PYRENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ISOPHORONE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ISOSAFROLE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
METHAPYRILENE	3	0	0	0.00E+00	1.25E-02	1.25E-02	2.50E-02	0.00E+00	0.00E+00	1.25E-02	1.25E-02	Unknown
METHYLMETHANESULFONATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
N-NITROSODI-N-BUTYLAMINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
N-NITROSODI-N-PROPYLAMINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
N-NITROSODIETHYLAMINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
N-NITROSODIMETHYLAMINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
N-NITROSODIPHENYLAMINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
N-NITROSOMETHYLETHYLAMINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
N-NITROSOMORPHOLINE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
N-NITROSOPIPERIDINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
N-NITROSOPYRROLIDINE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
NAPHTHALENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
NITROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
O-TOLUIDINE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
P-DIMETHYLAMINOAZOBENZENE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
P-PHENYLENEDIAMINE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
PENTACHLOROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
PENTACHLORONITROBENZENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
PENTACHLOROPHENOL	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
PHENACETIN	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
PHENANTHRENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
PHENOL	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
PRONAMIDE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
PYRENE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
PYRIDINE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
SAFROLE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
1,1,1,2-TETRACHLOROETHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
1,1,1-TRICHLOROETHANE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown

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Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Log Mean mg/L	Maximum SQL mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Log 95% UCL mg/L	Distribution 99% Confidence
1,1,2,2-TETRACHLOROETHANE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
1,1,2-TRICHLOROETHANE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
1,1-DICHLOROETHANE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
1,1-DICHLOROETHENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
1,2,3-TRICHLOROPROPANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
1,2-DIBROMO-3-CHLOROPROPANE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
1,2-DIBROMOETHANE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
1,2-DICHLOROETHANE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
1,2-DICHLOROETHENE (TOTAL)	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
1,2-DICHLOROPROPANE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
2-BUTANONE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
2-CHLORO-1,3-BUTADIENE	3	0	0	0.00E+00	5.00E-02	5.00E-02	1.00E-01	0.00E+00	0.00E+00	5.00E-02	5.00E-02	Unknown
2-HEXANONE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
4-METHYL-2-PENTANONE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ACETONE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ACETONITRILE	3	0	0	0.00E+00	5.00E-02	5.00E-02	1.00E-01	0.00E+00	0.00E+00	5.00E-02	5.00E-02	Unknown
ACROLEIN	3	0	0	0.00E+00	2.50E-01	2.50E-01	5.00E-01	0.00E+00	0.00E+00	2.50E-01	2.50E-01	Unknown
ACRYLONITRILE	3	0	0	0.00E+00	5.00E-02	5.00E-02	1.00E-01	0.00E+00	0.00E+00	5.00E-02	5.00E-02	Unknown
ALLYL CHLORIDE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
BENZENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
BROMODICHLOROMETHANE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
BROMOFORM	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
BROMOMETHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
CARBON DISULFIDE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
CARBON TETRACHLORIDE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
CHLOROBENZENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
CHLOROETHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
CHLOROFORM	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
CHLOROMETHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
CIS-1,3-DICHLOROPROPENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
DIBROMOCHLOROMETHANE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
DIBROMOMETHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
DICHLORODIFLUOROMETHANE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
ETHYLBENZENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
ETHYLMETHACRYLATE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
IODOMETHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
ISOBUTANOL	3	0	0	0.00E+00	1.00E+00	1.00E+00	2.00E+00	0.00E+00	0.00E+00	1.00E+00	1.00E+00	Unknown
METHACRYLONITRILE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
METHYLENE CHLORIDE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown

Table 30

Statistical Summary of Constituents in Surface Water for Use in the Ecological Risk Assessment

ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Total Number of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Log Mean mg/L	Maximum SQL mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Log 95% UCL mg/L	Distribution 99% Confidence
METHYLMETHACRYLATE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
PENTACHLOROETHANE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
PROPIONITRILE	3	0	0	0.00E+00	2.50E-02	2.50E-02	5.00E-02	0.00E+00	0.00E+00	2.50E-02	2.50E-02	Unknown
STYRENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
TETRACHLOROETHENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
TOLUENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
TRANS-1,3-DICHLOROPROPENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
TRANS-1,4-DICHLORO-2-BUTENE	3	0	0	0.00E+00	1.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	1.00E-02	1.00E-02	Unknown
TRICHLOROETHENE	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown
TRICHLOROFLUOROMETHANE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
VINYL ACETATE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
VINYL CHLORIDE	3	0	0	0.00E+00	5.00E-03	5.00E-03	1.00E-02	0.00E+00	0.00E+00	5.00E-03	5.00E-03	Unknown
XYLENES (TOTAL)	3	0	0	0.00E+00	2.50E-03	2.50E-03	5.00E-03	0.00E+00	0.00E+00	2.50E-03	2.50E-03	Unknown

Table 31
Ecological Screening of Constituents in Soil
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detected Concentration mg/kg	US EPA Region 5 Soil EDQL mg/kg	ORNL Soil Screening Benchmark mg/kg	COPC?
Dioxins				
2,3,7,8-TCDD (TEQ)	1.69E-05	1.99E-07		YES-COPC
Inorganics				
Aluminum	1.99E+04	NA	6.00E+02	YES-COPC
Antimony	1.30E+00	1.42E-01		YES-COPC
Arsenic	1.56E+01	5.70E+00		YES-COPC
Barium	1.49E+02	1.04E+00		YES-COPC
Beryllium	6.30E-01	1.06E+00		no
Cadmium	1.00E+00	2.22E-03		YES-COPC
Chromium	3.20E+01	4.00E-01		YES-COPC
Cobalt	1.57E+01	1.40E-01		YES-COPC
Copper	1.47E+02	3.13E-01		YES-COPC
Iron	5.66E+04	NA	2.00E+02	YES-COPC
Lead	1.57E+02	5.37E-02		YES-COPC
Manganese	1.28E+03	NA	1.00E+02	YES-COPC
Mercury	9.75E-01	1.00E-01		YES-COPC
Nickel	2.40E+02	1.36E+01		YES-COPC
Selenium	9.80E-01	2.77E-02		YES-COPC
Thallium	2.40E-01	5.69E-02		YES-COPC
Tin	1.90E+00	7.62E+00		no
Vanadium	4.08E+01	1.59E+00		YES-COPC
Zinc	3.15E+02	6.62E+00		YES-COPC
Semivolatile Organic Compounds, Non-Pesticides				
3 and 4-Methylphenol	1.40E+00	3.49E+00		no
Anthracene	3.00E-01	1.48E+03		no
Benzo(a)anthracene	9.60E-01	5.21E+00		no
Benzo(a)pyrene	6.70E-01	1.52E+00		no
Benzo(b)fluoranthene	9.90E-01	5.98E+01		no
Benzo(g,h,i)perylene	5.60E-01	1.19E+02		no
Benzo(k)fluoranthene	5.60E-01	5.98E+01		no
Bis(2-Ethylhexyl)phthalate	1.90E-01	9.26E-01		no
Butylbenzylphththalate	2.10E-01	2.39E-01		no
Chrysene	1.20E+00	4.73E+00		no
Dibenz(a,h)anthracene	1.70E-01	1.84E+01		no
Fluoranthene	1.50E+00	1.22E+02		no
Fluorene	1.00E-01	1.22E+02		no
Indeno(1,2,3-cd)pyrene	7.60E-01	1.09E+02		no
N-Nitrosodiethylamine	7.30E+02	9.94E-02		YES-COPC
N-Nitrosodiphenylamine	7.80E-01	6.93E-02		YES-COPC
Naphthalene	1.90E+03	5.45E-01		YES-COPC
Phenanthrene	9.80E-01	4.57E+01		no
Phenol	1.55E+04	1.20E+02		YES-COPC
Pyrene	2.00E+00	7.85E+01		no
Volatile Organic Compounds				
1,2-Dichloroethene, total	1.30E+00	7.84E-01		YES-COPC
2-Butanone	1.00E+01	8.96E+01		no
4-Methyl-2-pentanone	3.70E-02	4.43E+02		no
Acetone	9.00E-01	2.50E+00		no

Table 31
Ecological Screening of Constituents in Soil
ATOFINA Chemicals, West Brine Field, Riverview, MI

Analyte	Maximum Detected Concentration mg/kg	US EPA Region 5 Soil EDQL mg/kg	ORNL Soil Screening Benchmark mg/kg	COPC?
Carbon disulfide	3.40E+01	9.41E-02		YES-COPC
Ethylbenzene	8.85E-01	5.16E+00		no
Methylene chloride	5.90E+00	4.05E+00		YES-COPC
Tetrachloroethene	3.60E-02	9.92E+00		no
Toluene	2.20E-01	5.45E+00		no
Trichloroethene	1.20E-02	1.24E+01		no
Xylenes, total	4.80E-02	1.00E+01		no

NA - Not Available

Table 32
Ecological Screening of Constituents in Sediment
ATOFINA Chemicals, West Brine Field, Riverview, MI

Constituent	Maximum Detected Concentration mg/kg	US EPA Region 5 Sediment EDQL mg/kg	COPC?
Dioxins			
2,3,7,8-TCDD (TEQ)	1.26E-05	3.30E-06	YES
Inorganics			
Antimony	4.60E+00		
Arsenic	1.32E+01	5.90E+00	YES
Barium	1.76E+02		
Beryllium	1.17E+00		
Cadmium	1.80E+00	5.96E-01	YES
Chromium	3.30E+01	2.60E+01	YES
Cobalt	1.56E+01	5.00E+01	no
Copper	9.37E+01	1.60E+01	YES
Cyanide	6.60E+00	1.00E-04	YES
Lead	1.77E+02	3.10E+01	YES
Mercury	1.40E-01	1.74E-01	no
Nickel	3.82E+01	1.60E+01	YES
Selenium	1.20E+00		
Silver	1.12E+00	5.00E-01	YES
Thallium	2.50E-01		
Tin	3.80E+00		
Vanadium	4.38E+01		
Zinc	3.25E+02	1.20E+02	YES
Semivolatile Organic Compounds, Organochlorine Pesticides			
4,4'-DDD	2.15E-01	5.53E-03	YES
4,4'-DDE	6.10E-01	1.42E-03	YES
4,4'-DDT	7.65E-02	1.19E-03	YES
Aldrin	4.70E-02	2.00E-03	YES
Alpha-Chlordane	3.10E-02	4.50E-03	YES
Gamma-Chlordane	3.50E-02	4.50E-03	YES
Isodrin	8.80E-03	5.52E-02	no
Kepone	6.90E-01	3.31E-03	YES
Semivolatile Organic Compounds, Non-Pesticides			
2-Methylnaphthalene	1.58E-01	2.02E-02	YES
Acenaphthene	2.40E-01	6.71E-03	YES
Acenaphthylene	6.50E-02	5.87E-03	YES
Anthracene	7.80E-01	4.69E-02	YES
Benzo(a)anthracene	1.80E+00	3.17E-02	YES
Benzo(a)pyrene	1.70E+00	3.19E-02	YES
Benzo(b)fluoranthene	2.60E+00	1.04E+01	no
Benzo(g,h,i)perylene	1.25E+00	1.70E-01	YES
Benzo(k)fluoranthene	9.40E-01	2.40E-01	YES
Bis(2-Ethylhexyl)phthalate	2.20E+00	1.82E-01	YES
Butylbenzylphthalate	5.00E-01	4.19E+00	no
Chrysene	2.50E+00	5.71E-02	YES
Dibenz(a,h)anthracene	3.10E-01	6.22E-03	YES
Dibenzofuran	1.80E-01	1.52E+00	no
Di-n-butylphthalate	1.10E-01	1.11E-01	no
Fluoranthene	3.60E+00	1.11E-01	YES
Fluorene	2.30E-01	2.12E-02	YES
Indeno(1,2,3-cd)pyrene	1.55E+00	2.00E-01	YES
Naphthalene	9.70E-02	3.46E-02	YES
Phenanthrene	1.85E+00	4.19E-02	YES
Pyrene	4.20E+00	5.30E-02	YES
Volatile Organic Compounds			
Methylene chloride	1.05E-02	1.26E+00	no

Table 33
Ecological Screening of Constituents in Surface Water
ATOFINA Chemicals, West Brine Field, Riverview, MI

Constituent	Maximum Detected Concentration mg/L	US EPA Region 5 Surface Water EDQL mg/L	COPC?
Inorganics			
Arsenic	1.50E-03	5.30E-02	no
Barium	5.71E-02	5.00E+00	no
Cadmium	2.15E-03	6.60E-04	YES
Copper	2.60E-03	1.60E+01	no
Selenium	2.10E-03	5.00E-03	no
Vanadium	1.85E-03	1.90E-02	no
Semivolatile Organic Compounds, Non-Pesticides			
Bis(2-Ethylhexyl)phthalate	1.00E-02	2.10E-03	YES

Table 34
Uptake Factors for Ecological COPCs
ATOFINA Chemicals, West Brine Field, Riverview, MI

Constituent	Soil-Invertebrate Uptake Factor (UF_{s-i})	Reference	Soil-Plant Uptake Factor (UF_{s-p})	Reference
Dioxins/Furans				
2,3,7,8-TCDD	1.17E+01	Sample *et al.*, 1998	5.62E-03	Travis and Arms, 1988
Inorganics				
Aluminum	5.30E-02	Sample *et al.*, 1998	4.00E-03	Baes *et al*., 1984
Antimony	1.00E+00	No data (assumed value)	2.00E-01	Baes *et al*., 1984
Arsenic	2.58E-01	Sample *et al.*, 1998	3.71E-02	Bechtel-Jacobs, 1998
Barium	3.60E-01	Beyer and Stafford 1993	1.50E-01	Baes *et al*., 1984
Cadmium	1.71E+01	Sample *et al.*, 1998	5.14E-01	Bechtel-Jacobs, 1998
Chromium	1.10E+00	Sample *et al.*, 1998	7.50E-03	Baes *et al*., 1984
Cobalt	1.00E+00	No data (assumed value)	2.00E-02	Baes *et al*., 1984
Copper	7.54E-01	Sample *et al.*, 1998	1.23E-01	Bechtel-Jacobs, 1998
Iron	3.80E-02	Sample *et al.*, 1998	4.00E-03	Baes *et al*., 1984
Lead	9.50E-01	Roberts and Dorough 1985	3.77E-02	Bechtel-Jacobs, 1998
Manganese	6.40E-02	Sample *et al.*, 1998	2.50E-01	Baes *et al*., 1984
Mercury	5.23E+00	Sample *et al.*, 1998	3.44E-01	Bechtel-Jacobs, 1998
Nickel	1.66E+00	Sample *et al.*, 1998	3.42E-02	Bechtel-Jacobs, 1998
Selenium	1.80E+00	Sample *et al.*, 1998	5.67E-01	Bechtel-Jacobs, 1998
Thallium	1.00E+00	No data (assumed value)	4.00E-03	Baes *et al*., 1984
Vanadium	3.90E-02	Sample *et al.*, 1998	5.50E-03	Baes *et al*., 1984
Zinc	5.77E+00	Sample *et al.*, 1998	3.58E-01	Bechtel-Jacobs, 1998
Semivolatiles				
N-Nitrosodiethylamine	4.65E-01	Connell 1990	2.04E+01	Travis and Arms, 1988
N-Nitrosodiphenylamine	6.07E-01	Connell 1990	9.45E-01	Travis and Arms, 1988
Naphthalene	6.49E-01	Connell 1990	4.37E-01	Travis and Arms, 1988
Phenol	5.21E-01	Connell 1990	5.55E+00	Travis and Arms, 1988
Volatiles				
1,2-Dichloroethene	5.45E-01	Connell 1990	3.26E+00	Travis and Arms, 1988
Carbon disulfide	5.64E-01	Connell 1990	2.19E+00	Travis and Arms, 1988
Methylene chloride	5.08E-01	Connell 1990	7.34E+00	Travis and Arms, 1988

Table 35
Incidental Ingestion of Soil by the White-Tailed Deer
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Soil				
Intake (mg/kg-day) =	$\frac{C_s * IngR_f * CF * PS * EF_s * SFF}{BW}$			
C_s - Concentration in soil =		mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =		kg/day	1.7	Sample and Suter, 1994
CF - Plant wet-to-dry weight conversion factor =			0.18	USEPA 1993, WEFH
PS - Soil consumed as a proportion of food intake =			0.02	Beyer *et al.*, 1994
EF_s - Proportion of time exposed to soil =			0.99	site-specific
SFF - Site foraging factor =			0.13	Sample and Suter, 1994
BW - Body weight =		kg	56.5	Sample and Suter, 1994

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins				
2,3,7,8-TCDD (TEQ)	1.69E-05	2.35E-10	2.81E-07	8.37E-04
Inorganics				
Aluminum	1.42E+04	1.98E-01	2.93E-01	6.76E-01
Antimony	1.30E+00	1.81E-05	1.90E-02	9.54E-04
Arsenic	1.03E+01	1.44E-04	1.91E-02	7.51E-03
Barium	1.23E+02	1.71E-03	1.50E+00	1.14E-03
Cadmium	4.53E-01	6.32E-06	2.71E-01	2.33E-05
Chromium	2.22E+01	3.09E-04	7.68E+02	4.03E-07
Cobalt	1.09E+01	1.52E-04	5.05E+00	3.01E-05
Copper	4.92E+01	6.86E-04	4.27E+00	1.61E-04
Iron	3.35E+04	4.67E-01	NA	
Lead	4.77E+01	6.65E-04	2.24E+00	2.96E-04
Manganese	6.82E+02	9.51E-03	2.47E+01	3.85E-04
Mercury	2.24E-01	3.12E-06	2.00E+00	1.56E-06
Nickel	6.26E+01	8.73E-04	1.12E+01	7.78E-05
Selenium	4.53E-01	6.32E-06	5.61E-02	1.13E-04
Thallium	2.40E-01	3.35E-06	2.10E-03	1.59E-03
Vanadium	3.01E+01	4.20E-04	5.47E-02	7.67E-03
Zinc	1.31E+02	1.83E-03	4.49E+01	4.07E-05
Semivolatiles				
N-Nitrosodiethylamine	7.80E-01	1.09E-05	7.86E-01	1.38E-05
N-Nitrosodiphenylamine	1.90E+03	2.65E-02	4.57E+01	5.80E-04
Naphthalene	7.30E+02	1.02E-02	8.09E+01	1.26E-04
Phenol	1.55E+04	2.16E-01	7.94E+01	2.72E-03
Volatiles				
1,2-Dichloroethene	1.30E+00	1.81E-05	6.86E+00	2.64E-06
Carbon disulfide	3.40E+01	4.74E-04	4.55E+01	1.04E-05
Methylene chloride	5.90E+00	8.22E-05	1.64E+00	5.01E-05
NA - Not Available			**Hazard Index =**	**7.00E-01**

Table 36
Incidental Ingestion of Sediment by the White-Tailed Deer
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Sediment				
Intake (mg/kg-day) =	$\frac{C_d * IngR_f * CF * PD * EF_d * SFF}{BW}$			
C_d - Concentration in sediment =		mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =		kg/day	1.7	Sample and Suter, 1994
CF - Plant wet-to-dry weight conversion factor =			0.18	USEPA 1993, WEFH
PD - Sediment consumed as a proportion of food intake =			0.02	Beyer *et al.*, 1994
EF_d - Proportion of time exposed to sediment =			0.01	site-specific
SFF - Site foraging factor =			0.13	Sample and Suter, 1994
BW - Body weight =		kg	56.5	Sample and Suter, 1994

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins				
2,3,7,8-TCDD (TEQ)	1.26E-05	1.77E-12	2.81E-07	6.30E-06
Inorganics				
Antimony	4.60E+00	6.48E-07	1.90E-02	3.41E-05
Arsenic	1.32E+01	1.86E-06	1.91E-02	9.72E-05
Barium	1.76E+02	2.48E-05	1.50E+00	1.65E-05
Beryllium	1.17E+00	1.65E-07	1.85E-01	8.90E-07
Cadmium	1.80E+00	2.53E-07	2.71E-01	9.37E-07
Chromium	3.30E+01	4.65E-06	7.68E+02	6.05E-09
Copper	9.37E+01	1.32E-05	4.27E+00	3.09E-06
Cyanide	6.60E+00	9.29E-07	1.57E+01	5.92E-08
Lead	1.77E+02	2.49E-05	2.24E+00	1.11E-05
Nickel	3.82E+01	5.38E-06	1.12E+01	4.79E-07
Selenium	1.20E+00	1.69E-07	5.61E-02	3.01E-06
Silver	1.12E+00	1.58E-07	2.75E+00	5.74E-08
Thallium	2.50E-01	3.52E-08	2.10E-03	1.68E-05
Tin	3.80E+00	5.35E-07	3.55E+00	1.51E-07
Vanadium	4.38E+01	6.17E-06	5.47E-02	1.13E-04
Zinc	3.25E+02	4.58E-05	4.49E+01	1.02E-06
Organochlorine Pesticides				
4,4`-DDD	2.15E-01	3.03E-08	5.16E+00	5.87E-09
4,4`-DDE	6.10E-01	8.59E-08	6.50E+01	1.32E-09
4,4`-DDT	7.65E-02	1.08E-08	2.24E-01	4.80E-08
Aldrin	4.70E-02	6.62E-09	5.61E-02	1.18E-07
Alpha-Chlordane	3.10E-02	4.37E-09	6.98E-01	6.25E-09
Gamma-Chlordane	3.50E-02	4.93E-09	6.98E-01	7.06E-09
Kepone	6.90E-01	9.72E-08	1.12E-01	8.66E-07
Semivolatiles				
2-Methylnaphthalene	1.58E-01	2.22E-08	4.57E+00	4.87E-09
Acenaphthene	2.40E-01	3.38E-08	4.91E+01	6.88E-10
Acenaphthylene	6.50E-02	9.15E-09	4.77E+00	1.92E-09
Anthracene	7.80E-01	1.10E-07	9.26E+02	1.19E-10
Benzo(a)anthracene	1.80E+00	2.53E-07	1.52E-01	1.67E-06
Benzo(a)pyrene	1.70E+00	2.39E-07	1.52E-01	1.58E-06
Benzo(g,h,i)perylene	1.25E+00	1.76E-07	1.52E-01	1.16E-06
Benzo(k)fluoranthene	9.40E-01	1.32E-07	1.52E-01	8.72E-07
Bis(2-Ethylhexyl)phthalate	2.20E+00	3.10E-07	2.78E+00	1.11E-07
Chrysene	2.50E+00	3.52E-07	4.86E-01	7.25E-07
Dibenz(a,h)anthracene	3.10E-01	4.37E-08	1.52E-01	2.88E-07
Fluoranthene	3.60E+00	5.07E-07	3.79E+01	1.34E-08
Fluorene	2.30E-01	3.24E-08	1.90E+01	1.71E-09
Indeno(1,2,3-cd)pyrene	1.55E+00	2.18E-07	1.52E-01	1.44E-06
Naphthalene	9.70E-02	1.37E-08	8.09E+01	1.69E-10
Phenanthrene	1.85E+00	2.61E-07	1.96E+00	1.33E-07
Pyrene	4.20E+00	5.91E-07	1.14E+01	5.19E-08
			Hazard Index =	**3.14E-04**

Table 37
Ingestion of Surface Water by the White-Tailed Deer
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Surface Water				
Intake (mg/kg-day) =	$\frac{C_w * IngR_w * SFF}{BW}$			
C_w - Concentration in surface water =		mg/L	chem spec.	
$IngR_w$ - Ingestion rate for surface water =		L/day	3.7	Sample and Suter, 1994
SFF - Site foraging factor =			0.13	Sample and Suter, 1994
BW - Body weight =		kg	56.5	Sample and Suter, 1994

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Inorganics				
Cadmium	2.15E-03	1.83E-05	2.71E-01	6.76E-05
Semivolatiles				
Bis(2-Ethylhexyl)phthalate	1.00E-02	8.51E-05	2.78E+00	3.06E-05
			Hazard Index =	**9.82E-05**

Table 38
Ingestion of Vegetation by the White-Tailed Deer
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Vegetation			
Intake (mg/kg-day) = $\frac{C_v * IngR_f * PV * EF_s * SFF}{BW}$			
C_v - Concentration in soil-dwelling vegetation =	mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =	kg/day	1.7	Sample and Suter, 1994
PV - Percent of plants in receptor diet =		1.00	Sample and Suter, 1994
EF_s - Proportion of time exposed to soil =		0.99	site-specific
SFF - Site foraging factor =		0.13	Sample and Suter, 1994
BW - Body weight =	kg	56.5	Sample and Suter, 1994

Constituent	Concentration in Soil mg/kg	Concentration in Soil-Dwelling Vegetation mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins					
2,3,7,8-TCDD (TEQ)	1.69E-05	9.48E-08	3.67E-10	2.81E-07	1.31E-03
Inorganics					
Aluminum	1.42E+04	5.68E+01	2.20E-01	2.93E-01	7.51E-01
Antimony	1.30E+00	2.60E-01	1.01E-03	1.90E-02	5.30E-02
Arsenic	1.03E+01	3.82E-01	1.48E-03	1.91E-02	7.74E-02
Barium	1.23E+02	1.85E+01	7.14E-02	1.50E+00	4.77E-02
Cadmium	4.53E-01	2.33E-01	9.02E-04	2.71E-01	3.33E-03
Chromium	2.22E+01	1.67E-01	6.45E-04	7.68E+02	8.40E-07
Cobalt	1.09E+01	2.18E-01	8.44E-04	5.05E+00	1.67E-04
Copper	4.92E+01	6.05E+00	2.34E-02	4.27E+00	5.49E-03
Iron	3.35E+04	1.34E+02	5.19E-01	NA	
Lead	4.77E+01	1.80E+00	6.96E-03	2.24E+00	3.10E-03
Manganese	6.82E+02	1.71E+02	6.60E-01	2.47E+01	2.67E-02
Mercury	2.24E-01	7.71E-02	2.98E-04	2.00E+00	1.49E-04
Nickel	6.26E+01	2.14E+00	8.29E-03	1.12E+01	7.39E-04
Selenium	4.53E-01	2.57E-01	9.95E-04	5.61E-02	1.77E-02
Thallium	2.40E-01	9.60E-04	3.72E-06	2.10E-03	1.77E-03
Vanadium	3.01E+01	1.66E-01	6.41E-04	5.47E-02	1.17E-02
Zinc	1.31E+02	4.69E+01	1.82E-01	4.49E+01	4.05E-03
Semivolatiles					
N-Nitrosodiethylamine	7.80E-01	1.59E+01	6.17E-02	7.86E-01	7.86E-02
N-Nitrosodiphenylamine	1.90E+03	1.80E+03	6.95E+00	4.57E+01	1.52E-01
Naphthalene	7.30E+02	3.19E+02	1.23E+00	8.09E+01	1.53E-02
Phenol	1.55E+04	8.60E+04	3.33E+02	7.94E+01	4.19E+00
Volatiles					
1,2-Dichloroethene	1.30E+00	4.24E+00	1.64E-02	6.86E+00	2.39E-03
Carbon disulfide	3.40E+01	7.43E+01	2.88E-01	4.55E+01	6.32E-03
Methylene chloride	5.90E+00	4.33E+01	1.68E-01	1.64E+00	1.02E-01

NA - Not Available

Hazard Index = 5.56E+00

Table 39
Incidental Ingestion of Soil by the Meadow Vole
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Soil				
Intake (mg/kg-day) =	$\frac{C_s * IngR_f * CF * PS * EF_s * SFF}{BW}$			
C_s - Concentration in soil =		mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =		kg/day	0.005	USEPA 1993, WEFH
CF - Plant wet-to-dry weight conversion factor =			0.18	USEPA 1993, WEFH
PS - Soil consumed as a proportion of food intake =			0.024	Beyer *et al.*, 1994
EF_s - Proportion of time exposed to soil =			0.99	site-specific
SFF - Site foraging factor =			1.00	US EPA 1993, WEFH
BW - Body weight =		kg	0.036	USEPA 1993, WEFH

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins				
2,3,7,8-TCDD (TEQ)	1.69E-05	1.00E-08	1.77E-06	5.67E-03
Inorganics				
Aluminum	1.42E+04	8.43E+00	1.84E+00	4.57E+00
Antimony	1.30E+00	7.72E-04	1.19E-01	6.47E-03
Arsenic	1.03E+01	6.12E-03	1.20E-01	5.08E-02
Barium	1.23E+02	7.31E-02	9.43E+00	7.74E-03
Cadmium	4.53E-01	2.69E-04	1.70E+00	1.58E-04
Chromium	2.22E+01	1.32E-02	4.83E+03	2.73E-06
Cobalt	1.09E+01	6.47E-03	3.18E+01	2.04E-04
Copper	4.92E+01	2.92E-02	2.69E+01	1.09E-03
Iron	3.35E+04	1.99E+01	NA	NA
Lead	4.77E+01	2.83E-02	1.41E+01	2.01E-03
Manganese	6.82E+02	4.05E-01	1.55E+02	2.61E-03
Mercury	2.24E-01	1.33E-04	1.26E+01	1.06E-05
Nickel	6.26E+01	3.72E-02	7.06E+01	5.26E-04
Selenium	4.53E-01	2.69E-04	3.53E-01	7.62E-04
Thallium	2.40E-01	1.43E-04	1.32E-02	1.08E-02
Vanadium	3.01E+01	1.79E-02	3.44E-01	5.19E-02
Zinc	1.31E+02	7.78E-02	2.83E+02	2.75E-04
Semivolatiles				
N-Nitrosodiethylamine	7.80E-01	4.63E-04	4.94E+00	9.37E-05
N-Nitrosodiphenylamine	1.90E+03	1.13E+00	2.88E+02	3.92E-03
Naphthalene	7.30E+02	4.34E-01	9.41E+02	4.61E-04
Phenol	1.55E+04	9.21E+00	5.00E+02	1.84E-02
Volatiles				
1,2-Dichloroethene	1.30E+00	7.72E-04	4.32E+01	1.79E-05
Carbon disulfide	3.40E+01	2.02E-02	2.87E+02	7.05E-05
Methylene chloride	5.90E+00	3.50E-03	5.59E+00	6.27E-04
NA - Not Available			**Hazard Index =**	**4.74E+00**

Table 40
Incidental Ingestion of Sediment by the Meadow Vole
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Sediment			
Intake (mg/kg-day) =	$\frac{C_d * IngR_f * CF * PD * EF_d * SFF}{BW}$		
C_d - Concentration in sediment =	mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =	kg/day	0.005	USEPA 1993, WEFH
CF - Plant wet-to-dry weight conversion factor =		0.18	USEPA 1993, WEFH
PD - Sediment consumed as a proportion of food intake =		0.024	Beyer *et al.* , 1994
EF_d - Proportion of time exposed to sediment =		0.01	site-specific
SFF - Site foraging factor =		1.00	US EPA 1993, WEFH
BW - Body weight =	kg	0.036	USEPA 1993, WEFH

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins				
2,3,7,8-TCDD (TEQ)	1.26E-05	7.54E-11	1.77E-06	4.27E-05
Inorganics				
Antimony	4.60E+00	2.76E-05	1.19E-01	2.31E-04
Arsenic	1.32E+01	7.92E-05	1.20E-01	6.58E-04
Barium	1.76E+02	1.06E-03	9.43E+00	1.12E-04
Beryllium	1.17E+00	7.02E-06	1.17E+00	6.02E-06
Cadmium	1.80E+00	1.08E-05	1.70E+00	6.34E-06
Chromium	3.30E+01	1.98E-04	4.83E+03	4.10E-08
Copper	9.37E+01	5.62E-04	2.69E+01	2.09E-05
Cyanide	6.60E+00	3.96E-05	1.14E+02	3.47E-07
Lead	1.77E+02	1.06E-03	1.41E+01	7.52E-05
Nickel	3.82E+01	2.29E-04	7.06E+01	3.24E-06
Selenium	1.20E+00	7.20E-06	3.53E-01	2.04E-05
Silver	1.12E+00	6.72E-06	1.73E+01	3.89E-07
Thallium	2.50E-01	1.50E-06	1.32E-02	1.14E-04
Tin	3.80E+00	2.28E-05	2.24E+01	1.02E-06
Vanadium	4.38E+01	2.63E-04	3.44E-01	7.63E-04
Zinc	3.25E+02	1.95E-03	2.83E+02	6.90E-06
Organochlorine Pesticides				
4,4'-DDD	2.15E-01	1.29E-06	3.25E+01	3.97E-08
4,4'-DDE	6.10E-01	3.66E-06	4.09E+02	8.95E-09
4,4'-DDT	7.65E-02	4.59E-07	1.41E+00	3.25E-07
Aldrin	4.70E-02	2.82E-07	3.53E-01	7.99E-07
Alpha-Chlordane	3.10E-02	1.86E-07	4.40E+00	4.23E-08
Gamma-Chlordane	3.50E-02	2.10E-07	4.40E+00	4.78E-08
Kepone	6.90E-01	4.14E-06	7.06E-01	5.86E-06
Semivolatiles				
2-Methylnaphthalene	1.58E-01	9.48E-07	2.88E+01	3.29E-08
Acenaphthene	2.40E-01	1.44E-06	3.09E+02	4.66E-09
Acenaphthylene	6.50E-02	3.90E-07	3.00E+01	1.30E-08
Anthracene	7.80E-01	4.68E-06	5.83E+03	8.03E-10
Benzo(a)anthracene	1.80E+00	1.08E-05	9.55E-01	1.13E-05
Benzo(a)pyrene	1.70E+00	1.02E-05	9.55E-01	1.07E-05
Benzo(g,h,i)perylene	1.25E+00	7.50E-06	9.55E-01	7.85E-06
Benzo(k)fluoranthene	9.40E-01	5.64E-06	9.55E-01	5.90E-06
Bis(2-Ethylhexyl)phthalate	2.20E+00	1.32E-05	1.75E+01	7.54E-07
Chrysene	2.50E+00	1.50E-05	3.06E+00	4.91E-06
Dibenz(a,h)anthracene	3.10E-01	1.86E-06	9.55E-01	1.95E-06
Fluoranthene	3.60E+00	2.16E-05	4.41E+02	4.89E-08
Fluorene	2.30E-01	1.38E-06	1.19E+02	1.16E-08
Indeno(1,2,3-cd)pyrene	1.55E+00	9.30E-06	9.55E-01	9.73E-06
Naphthalene	9.70E-02	5.82E-07	9.41E+02	6.18E-10
Phenanthrene	1.85E+00	1.11E-05	1.24E+01	8.98E-07
Pyrene	4.20E+00	2.52E-05	1.32E+02	1.90E-07
			Hazard Index =	**2.12E-03**

Table 41
Ingestion of Surface Water by the Meadow Vole
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Surface Water			
Intake (mg/kg-day) = $\frac{C_w * IngR_w * SFF}{BW}$			
C_w - Concentration in surface water =	mg/L	chem spec.	
$IngR_w$ - Ingestion rate for surface water =	L/day	0.006	USEPA 1993, WEFH
SFF - Site foraging factor =		1.00	US EPA 1993, WEFH
BW - Body weight =	kg	0.036	USEPA 1993, WEFH

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Inorganics				
Cadmium	2.15E-03	3.58E-04	1.70E+00	2.10E-04
Semivolatiles				
Bis(2-Ethylhexyl)phthalate	1.00E-02	1.67E-03	1.75E+01	9.52E-05
			Hazard Index =	**3.06E-04**

Table 42
Ingestion of Vegetation by the Meadow Vole
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Vegetation			
Intake (mg/kg-day) = $\frac{C_v * IngR_f * PV * EF_s * SFF}{BW}$			
C_v - Concentration in soil-dwelling vegetation =	mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =	kg/day	0.005	USEPA 1993, WEFH
PV - Percent of plants in receptor diet =		1.00	USEPA 1993, WEFH
EF_s - Proportion of time exposed to soil =		0.99	site-specific
SFF - Site foraging factor =		1.00	US EPA 1993, WEFH
BW - Body weight =	kg	0.036	USEPA 1993, WEFH

Constituent	Concentration in Soil mg/kg	Concentration in Soil-Dwelling Vegetation mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins					
2,3,7,8-TCDD (TEQ)	1.69E-05	9.48E-08	1.30E-08	1.77E-06	7.38E-03
Inorganics					
Aluminum	1.42E+04	5.68E+01	7.81E+00	1.84E+00	4.24E+00
Antimony	1.30E+00	2.60E-01	3.58E-02	1.19E-01	2.99E-01
Arsenic	1.03E+01	3.82E-01	5.25E-02	1.20E-01	4.36E-01
Barium	1.23E+02	1.85E+01	2.54E+00	9.43E+00	2.69E-01
Cadmium	4.53E-01	2.33E-01	3.20E-02	1.70E+00	1.88E-02
Chromium	2.22E+01	1.67E-01	2.29E-02	4.83E+03	4.74E-06
Cobalt	1.09E+01	2.18E-01	3.00E-02	3.18E+01	9.43E-04
Copper	4.92E+01	6.05E+00	8.32E-01	2.69E+01	3.10E-02
Iron	3.35E+04	1.34E+02	1.84E+01	NA	NA
Lead	4.77E+01	1.80E+00	2.47E-01	1.41E+01	1.75E-02
Manganese	6.82E+02	1.71E+02	2.34E+01	1.55E+02	1.51E-01
Mercury	2.24E-01	7.71E-02	1.06E-02	1.26E+01	8.40E-04
Nickel	6.26E+01	2.14E+00	2.94E-01	7.06E+01	4.17E-03
Selenium	4.53E-01	2.57E-01	3.53E-02	3.53E-01	1.00E-01
Thallium	2.40E-01	9.60E-04	1.32E-04	1.32E-02	1.00E-02
Vanadium	3.01E+01	1.66E-01	2.28E-02	3.44E-01	6.61E-02
Zinc	1.31E+02	4.69E+01	6.45E+00	2.83E+02	2.28E-02
Semivolatiles					
N-Nitrosodiethylamine	7.80E-01	1.59E+01	2.19E+00	4.94E+00	4.43E-01
N-Nitrosodiphenylamine	1.90E+03	1.80E+03	2.47E+02	2.88E+02	8.58E-01
Naphthalene	7.30E+02	3.19E+02	4.38E+01	9.41E+02	4.66E-02
Phenol	1.55E+04	8.60E+04	1.18E+04	5.00E+02	2.37E+01
Volatiles					
1,2-Dichloroethene	1.30E+00	4.24E+00	5.82E-01	4.32E+01	1.35E-02
Carbon disulfide	3.40E+01	7.43E+01	1.02E+01	2.87E+02	3.56E-02
Methylene chloride	5.90E+00	4.33E+01	5.95E+00	5.59E+00	1.06E+00
NA - Not Applicable				**Hazard Index =**	**3.18E+01**

Table 43
Incidental Ingestion of Soil by the American Robin
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Soil			
Intake (mg/kg-day) =	$\frac{C_s * IngR_f * CF * PS * EF_s * SFF}{BW}$		
C_s - Concentration in soil =	mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =	kg/day	0.011	USEPA 1993, WEFH
CF - Food wet-to-dry weight conversion factor =		0.20	USEPA 1993, WEFH
PS - Soil consumed as a proportion of food intake =		0.104	Beyer *et al.* , 1994
EF_s - Proportion of time exposed to soil =		0.99	site-specific
SFF - Site foraging factor =		1.00	US EPA 1993, WEFH
BW - Body weight =	kg	0.080	USEPA 1993, WEFH

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins				
2,3,7,8-TCDD (TEQ)	1.69E-05	4.77E-08	1.40E-05	3.41E-03
Inorganics				
Aluminum	1.42E+04	4.02E+01	1.10E+02	3.67E-01
Antimony	1.30E+00	3.68E-03	1.25E-02	2.94E-01
Arsenic	1.03E+01	2.92E-02	2.46E+00	1.19E-02
Barium	1.23E+02	3.48E-01	2.08E+01	1.67E-02
Cadmium	4.53E-01	1.28E-03	1.45E+00	8.85E-04
Chromium	2.22E+01	6.29E-02	1.00E+00	6.29E-02
Cobalt	1.09E+01	3.09E-02	1.80E+00	1.71E-02
Copper	4.92E+01	1.39E-01	4.70E+01	2.97E-03
Iron	3.35E+04	9.49E+01	NA	NA
Lead	4.77E+01	1.35E-01	3.85E+00	3.51E-02
Manganese	6.82E+02	1.93E+00	9.77E+02	1.98E-03
Mercury	2.24E-01	6.34E-04	4.50E-01	1.41E-03
Nickel	6.26E+01	1.77E-01	7.74E+01	2.29E-03
Selenium	4.53E-01	1.28E-03	4.00E-01	3.21E-03
Thallium	2.40E-01	6.80E-04	7.40E-04	9.18E-01
Vanadium	3.01E+01	8.52E-02	1.14E+01	7.49E-03
Zinc	1.31E+02	3.71E-01	1.45E+01	2.56E-02
Semivolatiles				
N-Nitrosodiethylamine	7.80E-01	2.21E-03	2.80E-01	7.89E-03
N-Nitrosodiphenylamine	1.90E+03	5.38E+00	3.01E+01	1.79E-01
Naphthalene	7.30E+02	2.07E+00	1.80E+01	1.15E-01
Phenol	1.55E+04	4.39E+01	5.23E+01	8.39E-01
Volatiles				
1,2-Dichloroethene	1.30E+00	3.68E-03	4.52E+00	8.14E-04
Carbon disulfide	3.40E+01	9.63E-02	3.00E+01	3.21E-03
Methylene chloride	5.90E+00	1.67E-02	5.85E-01	2.86E-02
			Hazard Index =	**2.95E+00**

NA - Not Available

Table 44
Incidental Ingestion of Sediment by the American Robin
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Sediment			
Intake (mg/kg-day) =	$\frac{C_d * IngR_f * CF * PD * EF_d * SFF}{BW}$		
C_d - Concentration in sediment =	mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =	kg/day	0.011	USEPA 1993, WEFH
CF - Food wet-to-dry weight conversion factor =		0.20	USEPA 1993, WEFH
PD - Sediment consumed as a proportion of food intake =		0.104	Beyer *et al.* , 1994
EF_d - Proportion of time exposed to sediment =		0.01	site-specific
SFF - Site foraging factor =		1.00	US EPA 1993, WEFH
BW - Body weight =	kg	0.080	USEPA 1993, WEFH

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins				
2,3,7,8-TCDD (TEQ)	1.26E-05	3.59E-10	1.40E-05	2.57E-05
Inorganics				
Antimony	4.60E+00	1.32E-04	1.25E-02	1.05E-02
Arsenic	1.32E+01	3.78E-04	2.46E+00	1.53E-04
Barium	1.76E+02	5.03E-03	2.08E+01	2.42E-04
Beryllium	1.17E+00	3.35E-05	6.60E-02	5.07E-04
Cadmium	1.80E+00	5.15E-05	1.45E+00	3.55E-05
Chromium	3.30E+01	9.44E-04	1.00E+00	9.44E-04
Copper	9.37E+01	2.68E-03	4.70E+01	5.71E-05
Cyanide	6.60E+00	1.89E-04	6.87E+00	2.75E-05
Lead	1.77E+02	5.06E-03	3.85E+00	1.31E-03
Nickel	3.82E+01	1.09E-03	7.74E+01	1.41E-05
Selenium	1.20E+00	3.43E-05	4.00E-01	8.58E-05
Silver	1.12E+00	3.20E-05	1.81E+00	1.77E-05
Thallium	2.50E-01	7.15E-06	7.40E-04	9.66E-03
Tin	3.80E+00	1.09E-04	6.76E+00	1.61E-05
Vanadium	4.38E+01	1.25E-03	1.14E+01	1.10E-04
Zinc	3.25E+02	9.30E-03	1.45E+01	6.41E-04
Organochlorine Pesticides				
4,4`-DDD	2.15E-01	6.15E-06	3.40E+00	1.81E-06
4,4`-DDE	6.10E-01	1.74E-05	4.28E+01	4.08E-07
4,4`-DDT	7.65E-02	2.19E-06	2.80E-03	7.81E-04
Aldrin	4.70E-02	1.34E-06	2.00E-02	6.72E-05
Alpha-Chlordane	3.10E-02	8.87E-07	2.14E+00	4.14E-07
Gamma-Chlordane	3.50E-02	1.00E-06	2.14E+00	4.68E-07
Kepone	6.90E-01	1.97E-05	4.00E-02	4.93E-04
Semivolatiles				
2-Methylnaphthalene	1.58E-01	4.52E-06	1.63E+00	2.77E-06
Acenapthene	2.40E-01	6.86E-06	1.55E+00	4.43E-06
Acenaphthylene	6.50E-02	1.86E-06	1.70E+00	1.09E-06
Anthracene	7.80E-01	2.23E-05	4.07E+01	5.48E-07
Benzo(a)anthracene	1.80E+00	5.15E-05	4.07E+01	1.26E-06
Benzo(a)pyrene	1.70E+00	4.86E-05	4.07E+01	1.19E-06
Benzo(g,h,i)perylene	1.25E+00	3.58E-05	4.07E+01	8.78E-07
Benzo(k)fluoranthene	9.40E-01	2.69E-05	4.07E+01	6.61E-07
Bis(2-Ethylhexyl)phthalate	2.20E+00	6.29E-05	1.11E+00	5.67E-05
Chrysene	2.50E+00	7.15E-05	4.07E+01	1.76E-06
Dibenz(a,h)anthracene	3.10E-01	8.87E-06	4.07E+01	2.18E-07
Fluoranthene	3.60E+00	1.03E-04	4.07E+01	2.53E-06
Fluorene	2.30E-01	6.58E-06	4.07E+01	1.62E-07
Indeno(1,2,3-cd)pyrene	1.55E+00	4.43E-05	4.07E+01	1.09E-06
Naphthalene	9.70E-02	2.77E-06	1.80E+01	1.54E-07
Phenanthrene	1.85E+00	5.29E-05	4.07E+01	1.30E-06
Pyrene	4.20E+00	1.20E-04	4.07E+01	2.95E-06
			Hazard Index =	**2.58E-02**

Table 45
Ingestion of Surface Water by the American Robin
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Surface Water				
Intake (mg/kg-day) =	$\frac{C_w * IngR_w * SFF}{BW}$			
C_w - Concentration in surface water =		mg/L	chem spec.	
$IngR_w$ - Ingestion rate for surface water =		L/day	0.011	USEPA 1993, WEFH
SFF - Site foraging factor =			1.00	US EPA 1993, WEFH
BW - Body weight =		kg	0.080	USEPA 1993, WEFH

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Inorganics				
Cadmium	2.15E-03	2.96E-04	1.45E+00	2.04E-04
Semivolatiles				
Bis(2-Ethylhexyl)phthalate	1.00E-02	1.38E-03	1.11E+00	1.24E-03
			Hazard Index =	**1.44E-03**

Table 46
Ingestion of Vegetation by the American Robin
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Vegetation			
Intake (mg/kg-day) = $\frac{C_v * IngR_f * PV * EF_s * SFF}{BW}$			
C_v - Concentration in soil-dwelling vegetation =	mg/kg	chem. spec.	
$IngR_f$ - Food ingestion rate for receptor =	kg/day	0.011	USEPA 1993, WEFH
PV - Percent of plants in receptor diet =		0.52	USEPA 1993, WEFH
EF_s - Proportion of time exposed to soil =		0.99	site-specific
SFF - Site foraging factor =		1.00	US EPA 1993, WEFH
BW - Body weight =	kg	0.080	USEPA 1993, WEFH

Constituent	Concentration in Soil mg/kg	Concentration in Soil-Dwelling Vegetation mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins					
2,3,7,8-TCDD (TEQ)	1.69E-05	9.48E-08	6.71E-09	1.40E-05	4.79E-04
Inorganics					
Aluminum	1.42E+04	5.68E+01	4.02E+00	1.10E+02	3.67E-02
Antimony	1.30E+00	2.60E-01	1.84E-02	1.25E-02	1.47E+00
Arsenic	1.03E+01	3.82E-01	2.70E-02	2.46E+00	1.10E-02
Barium	1.23E+02	1.85E+01	1.31E+00	2.08E+01	6.27E-02
Cadmium	4.53E-01	2.33E-01	1.65E-02	1.45E+00	1.14E-02
Chromium	2.22E+01	1.67E-01	1.18E-02	1.00E+00	1.18E-02
Cobalt	1.09E+01	2.18E-01	1.54E-02	1.80E+00	8.57E-03
Copper	4.92E+01	6.05E+00	4.28E-01	4.70E+01	9.12E-03
Iron	3.35E+04	1.34E+02	9.49E+00	NA	NA
Lead	4.77E+01	1.80E+00	1.27E-01	3.85E+00	3.31E-02
Manganese	6.82E+02	1.71E+02	1.21E+01	9.77E+02	1.24E-02
Mercury	2.24E-01	7.71E-02	5.45E-03	4.50E-01	1.21E-02
Nickel	6.26E+01	2.14E+00	1.52E-01	7.74E+01	1.96E-03
Selenium	4.53E-01	2.57E-01	1.82E-02	4.00E-01	4.55E-02
Thallium	2.40E-01	9.60E-04	6.80E-05	7.40E-04	9.18E-02
Vanadium	3.01E+01	1.66E-01	1.17E-02	1.14E+01	1.03E-03
Zinc	1.31E+02	4.69E+01	3.32E+00	1.45E+01	2.29E-01
Semivolatiles					
N-Nitrosodiethylamine	7.80E-01	1.59E+01	1.13E+00	2.80E-01	4.03E+00
N-Nitrosodiphenylamine	1.90E+03	1.80E+03	1.27E+02	3.01E+01	4.22E+00
Naphthalene	7.30E+02	3.19E+02	2.26E+01	1.80E+01	1.25E+00
Phenol	1.55E+04	8.60E+04	6.09E+03	5.23E+01	1.16E+02
Volatiles					
1,2-Dichloroethene	1.30E+00	4.24E+00	3.00E-01	4.52E+00	6.63E-02
Carbon disulfide	3.40E+01	7.43E+01	5.26E+00	3.00E+01	1.75E-01
Methylene chloride	5.90E+00	4.33E+01	3.06E+00	5.85E-01	5.24E+00

NA - Not Applicable

Hazard Index = 1.33E+02

Table 47
Ingestion of Soil Invertebrates by the American Robin
ATOFINA Chemicals, West Brine Field, Riverview, MI

Ingestion of Soil Invertebrates			
Intake (mg/kg-day) =	$\frac{C_s * SI * IngR_f * PI * SFF}{BW}$		
C_s - Concentration in soil =	mg/kg	chem. spec.	
SI - Soil-to-invertebrate uptake factor =		chem. spec	Various[1]
$IngR_f$ - Food ingestion rate for receptor =	kg/day	0.011	USEPA 1993, WEFH
PI - Proportion of invertebrates in diet =		0.48	USEPA 1993, WEFH
SFF - Site foraging factor =		1.00	US EPA 1993, WEFH
BW - Body weight =	kg	0.08	USEPA 1993, WEFH

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Benchmark Toxicity Values mg/kg-day	Ecological Hazard Quotient
Dioxins				
2,3,7,8-TCDD (TEQ)	1.69E-05	1.31E-05	1.40E-05	9.33E-01
Inorganics				
Aluminum	1.42E+04	4.97E+01	1.10E+02	4.53E-01
Antimony	1.30E+00	8.58E-02	1.25E-02	6.86E+00
Arsenic	1.03E+01	1.75E-01	2.46E+00	7.13E-02
Barium	1.23E+02	2.92E+00	2.08E+01	1.40E-01
Cadmium	4.53E-01	5.11E-01	1.45E+00	3.53E-01
Chromium	2.22E+01	1.61E+00	1.00E+00	1.61E+00
Cobalt	1.09E+01	7.19E-01	1.80E+00	4.00E-01
Copper	4.92E+01	2.45E+00	4.70E+01	5.21E-02
Iron	3.35E+04	8.40E+01	NA	NA
Lead	4.77E+01	2.99E+00	3.85E+00	7.77E-01
Manganese	6.82E+02	2.88E+00	9.77E+02	2.95E-03
Mercury	2.24E-01	7.73E-02	4.50E-01	1.72E-01
Nickel	6.26E+01	6.84E+00	7.74E+01	8.84E-02
Selenium	4.53E-01	5.38E-02	4.00E-01	1.34E-01
Thallium	2.40E-01	1.58E-02	7.40E-04	2.14E+01
Vanadium	3.01E+01	7.75E-02	1.14E+01	6.81E-03
Zinc	1.31E+02	4.99E+01	1.45E+01	3.44E+00
Semivolatiles				
N-Nitrosodiethylamine	7.80E-01	2.39E-02	2.80E-01	8.55E-02
N-Nitrosodiphenylamine	1.90E+03	7.61E+01	3.01E+01	2.53E+00
Naphthalene	7.30E+02	3.12E+01	1.80E+01	1.74E+00
Phenol	1.55E+04	5.33E+02	5.23E+01	1.02E+01
Volatiles				
1,2-Dichloroethene	1.30E+00	4.68E-02	4.52E+00	1.03E-02
Carbon disulfide	3.40E+01	1.27E+00	3.00E+01	4.22E-02
Methylene chloride	5.90E+00	1.98E-01	5.85E-01	3.38E-01
NA - Not Applicable			**Hazard Index =**	**5.18E+01**

[1]Roberts and Dorough, 1985; Connell, 1990; Beyer and Stafford, 1993; Sample *et al.*, 1998

Table 48
Summary of Hazards Posed to Ecological Receptors
ATOFINA Chemicals, West Brine Field, Riverview, MI

White-Tailed Deer

Exposure Pathway	Ecological Hazard Index	Risk "Drivers"
Incidental Soil Ingestion	7.00E-01	---
Incidental Sediment Ingestion	3.14E-04	---
Ingestion of Surface Water	9.82E-05	---
Ingestion of Vegetation	5.56E+00	Phenol

Meadow Vole

Exposure Pathway	Ecological Hazard Index	Risk "Drivers"
Incidental Soil Ingestion	4.74E+00	Aluminum
Incidental Sediment Ingestion	2.12E-03	---
Ingestion of Surface Water	3.06E-04	---
Ingestion of Vegetation	3.18E+01	Phenol, Aluminum

American Robin

Exposure Pathway	Ecological Hazard Index	Risk "Drivers"
Incidental Soil Ingestion	2.95E+00	---
Incidental Sediment Ingestion	3.14E-04	---
Ingestion of Surface Water	1.44E-03	---
Ingestion of Soil Invertebrates	5.18E+01	Thallium, Phenol, Antimony
Ingestion of Vegetation	1.33E+02	Phenol

APPENDIX K

DEED RESTRICTIONS

DECLARATION OF RESTRICTIONS
AND
NOTICE OF STATUTORY OBLIGATIONS

THIS Declaration of Restrictions and Notice of Statutory Obligations ("Declaration") is executed and recorded as of 4, 2001, by ATOFINA Chemicals, Inc. ("ATOFINA'), a Delaware corporation, with principal offices at 2000 Market Street, Philadelphia, Pennsylvania

ATOFINA is the owner of several parcs of real property located in Riverview, Wayne County, Michigan, and Wyandotte, Wayne Coun, Michigan, all of which are more particularly described in Exhibit A attached hereto (the "Property").

Notice is hereby given in accordance with Michigan Administrative Code Rule 299.9525, promulgated pursuant to Part 111, Hazardous Waste Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended ("NREPA"), that the Property has been used to manage hazardous waste, and that it is subject to the corrective action requirements of Part 111 of NREPA and the Resource Conservation and Recovery Act, 42 USCA 4251 *et seq.* (ROSA), as amended by the 1984 hazardous and solid waste amendments.

ATOFINA hereby declares that, from and after the date hereof, the permissible uses of the Property shall be restricted to the land use categories of Industrial and Commercial II, as defined in Section 20120a(1) of Part 201 of NREPA, and the Michigan Department of Environmental Quality ("MDEQ"), Operational Memorandum 18, Revision 1, dated June 7,2000. See Exhibit B for descriptions of the land use categories of Industrial and Commercial II. Cleanup criteria and associated land-use descriptions are located in the Government Documents section of the State of Michigan Library. The use of any groundwater located upon the Property for any purpose shall be prohibited.

The foregoing restrictions on each parcel of the Prope shall benefit each of the other parcels of the Prope, and shall inure exclusively to the benefit of ATOFIN and to ATOFINA's successors, lessees, assigns, agents, employees, and all persons acting under any of their direction and control. These restrictions do not create any interests or enforcement rights for any governmental agency or for any member of the public.

The restrictions set forth in this Declaration shall be perpetual, shall run with the land, and shall be binding upon the future owner of all or any portion of each of the parcels which comprise the Property. It shall be the obligation of each and every owner of any portion of the Property to provide a copy of this Declaration to all of its heirs, successors, lessees, assigns and transferees.

This Declaration shall be effective withstanding any modification of its terms, until terminated or rescinded.

ATOFINA may amend this declaration by endirc written ncUce to the Environmental Protection Agency ("EPA"), F.ec:cr' V, of such cr:pcsed amered eclaracr,. If the EPA does not object to the

amendment within thirty (30) days after receipt of such notice, then the amended Declaration may be recorded and shall take effect immediately upon recording.

The undersigned person executing this Declaration represents and certifies that he or she is duly authorized and has been empowered to execute and deliver this Declaration.

Signed in the presence of:

ATOFINA Chemicals, Inc., a Delaware corporation

m e : C E . . *i ? i - I - 1*

Sy.

Name:

Its: REGIONAL MANUFACTURING DIRECTOR

" N a m e : ;

ACKNOWLEDGMENT

STATE OF _____

SS.

COUNTY OF_____

Thç foregoing instrument was acknowledd before me this /5 day of _____ 2001, by *4. ,April,* of ATOFINA Chemicals, Inc., a Delaware corporacn, onbehaif of the corporation.

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Notary7±Uc, i ,, ,, County

S t a t e Y 7 7 J 1 -

My commission ekpires: '- C

JANICE M. LECNARD
*Ncry Public, Wayre Ccuiy, **Mi***
My nric E.xplrs ¼g. **2., X4**

Prepared by
Suzanne T. Croissant
Dickinson Wright PLLC
38525 Wccdward Avenue, Suite 2000
8lccmfield Hills, Michigan 48304

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EXHIBIT A

Legal Descriptions c The Property

PARCEL A:

THAT PART OF THE NORTHWEST I/4 OF FRACTIONAL SECTION 5, DESCRIBED *AS:* BEGINNING AT THE INTERSECTION OF THE NORTH SECTION LINE AND THE WESTERLY LINE OF WEST JEFFERSON AVENUE, 106 FEET *WIDE,* AND PROCEEDING THENCE NORTH 89 DEGREES 45 MINUTES WEST ALONG THE NORTH SECTION LINE, 1614.71 FEET; THENCE SOUTH 14 DEGREES 30 MINUTES WEST ALONG THE EASTERLY LINE OF THE DT AND I RAILROAD RIGHT-OF-WAY, 1651.08 FEET; THENCE NORTH 66 DEGREES 55 MINUTES 45 SEOONDS EAST, 244.79 FEET; THENCE SOUTH 89 DEGREES 43 MINUTE EAST, 937.15 FEET; THENCE ALONG THE WESTERLY LINE OF WEST JEFFERSON AVENUE NORTH 29 DEGREES 07 MINUTES EAST, 838.16 FEET AND NORTH 31 DEGREES 01 MINUTE EAST, 893.98 FEET TO THE PLACE OF BEGINNING, EXCEPTING THEREFROM 078 ACRES LYING WITHIN THE RIGHT-OF-WAY, 24 FEET WIDE, OWNED BY THE 'dWANDOT1E SOUTHERN RAILROAD COMPANY, AS NOW LOCATED.

Tax Parcel No 51 007 99 0003 000

PARCEL B:

THAT PART OF FRACTIONAL SECTION 5, DESCRIBED AS: BEGINNING AT THE INTERSECTION OF THE EASTERLY LINE OF WEST JEFFERSON AVENUE, 106 FEET WIDE, AND THE NORTH SECTION LINE AND PROCEEDING THENCE SOUTH 89 DEGREES 43 MINUTES EAST ALONG SAID NORTH LINE, 646.48; THENCE SOUTH 33 DEGREES 17 MINUTES 30 SECONDS WEST, 170.38 FEET; THENCE SOUTH 56 DEGREES 42 MINUTES 30 SECONDS EAST, 149.55 FEET; THENCE SOUTH 33 DEGREES 02 MINUTES 30 SECONDS WEST, 275.14 FEET; THENCE SOUTH 56 DEGREES 49 MINUTES 30 SECONDS EAST, 27.16 FEET; THENCE NORTH 33 DEGREES 10 MINUTES 30 SECONDS EAST, 163.98 FEET; THENCE SOUTH 56 DEGREES 46 MINUTES 30 SECONDS EAST, 154.34 FEET; THENCE NORTH 33 DEGREES 13 MINUTES 30 SECONDS EAST, 62.41 FEET; THENCE SOUTH 56 DEGREES 46 MINUTES 30 SECONDS EAST, 62.05 FEET; THENCE SOUTH 33 DEGREES 04 MINUTES 30 SECONDS WEST, 164.49 FEET; THENCE SOUTH 56 DEGREES 55 MINUTES 30 SECONDS EAST, 139.98 FEET; THENCE NORTH 33 DEGREES 04 MINUTES 30 SECONDS EAST, 300 FEET; THENCE NORTH 56 DEGREES 55 MINUTES 30 SECONDS WEST, 62.55 FEET; THENCE NORTH 33 DEGREES 04 MINUTES 30 SECONDS EASE, 100.66 FEET; THENCE SOUTH 56 DEGREES 45 MINUTES 30 SECONDS EAST, 85.59 FEET; THENCE NORTH 33 DEGREES 22 MINUTES 30 SECONDS EAST, 14.63 FEET; THENCE NORTH 17 DEGREES 32 MINUTES 45 SECONDS EAST, 77.65 FEET; THENCE NORTH 56 DEGREES 42 MINUTES 45 SECONDS WEST, 165.10 FEET; Thence SOUTH 89 DEGREES 43 MINUTES EAST ALONG THE NORTH Section LINE, 371.20 FEET; THENCE SOUTH 31 DEGREES 41 MINUTES 30.4 SECONDS 'NEST ALONG THE US. HARBOR LINE, 1760.64 FEET; THENCE SOUTH 89 DEGREES 43 MINUTES WEST, 1402.36 FEET; THENCE ALONG THE EASTERLY LINE OF JEFFERSON AVENUE NORTH 29 DEGREES 07 MINUTES EAST, 776.04 FEET AND NORTH 31 DEGREES 01 MINUTES EAST, 955.24 FEET TO THE PLACE OF BEGINNING. EXCEPTING 7.49 ACRES THEREFROM LYING Within THE 24 FOOT RIGHT-OFWAY OWNED BY THE WYANDOTTE SOUTHERN RAILROAD COMPANY, AS NOW LOCATED.

Tax Parcel No. 51 007 99 0001 CCC

THAT PART OF THE NORTHEAST 1/4 OF FRACTIONAL SECTION 5, DESCRIBED AS: BEGINNING AT A POINT ON THE NORTH SECTION LINE DISTANT SOUTH 89 DEGREES 43 MINUTE EAST, 646.48 FEET FROM THE INTERSECTION OF SAID LINE AND THE EASTERLY LINE OF WEST JEFFERSON AVENUE, 106 FEET WIDE, AND PROCEEDING THENCE SOUTH 89 DEGREES 43 MINUTES EAST ALONG SAID NORTH LINE, 438.00 FEET; THENCE SOUTH 56 DEGREES 42 MINUTES 45 SECONDS EAST, 165.10 FEET; THENCE SOUTH 17 DEGREES 32 MINUTES 45 SECONDS WEST, 77.65 FEET; THENCE SOUTH 33 DEGREES 22 MINUTES 30 SECONDS WEST, 146.63 FEET: THENCE NORTH 56 DEGREES 46 MINUTES 30 SECONDS WEST, 85.59 FEET; THENCE SOUTH 33 DEGREES 04 MINUTES 30 SECONDS WEST, 100.66 FEET; THENCE SOUTH 56 DEGREES 55 MINUTES 30 SECONDS EAST, 62.55 FEET; THENCE SOUTH 33 DEGREES 04 MINUTES 30 SECONDS WEST, 300 FEET; THENCE NORTH 56 DEGREES 55 MINUTES 30 SECONDS *VIEST,* 139.98 FEET; THENCE NORTH 33 DEGREES 04 MINUTES 30 SECONDS EAST, 164.49 FEET; THENCE NORTH 56 DEGREES 46 MINUTES 30 SECONDS WEST, 62.05 FEET; THENCE SOUTH 33 DEGREES 13 MINUTES 30 SECONDS WEST, 62.41 FEET; THENCE NORTH 56 DEGREES 46 MINUTES 30 SECONDS WEST, 154.4 FEET; THENCE SOUTH 33 DEGREES 10 MINUTES WEST, 163.95 FEET; THENCE NORTH 56 DEGREES 49 MINUTES 30 SECONDS WEST, 27.16 FEET; THENCE NORTH 33 DEGREES 32 MINUTES 30 SECONDS EAST, 275.14 FEET; THENCE NORTH 56 DEGREES 42 MINUTES 30 SECONDS WEST, 149.55 FEET; THENCE NORTH 33 DEGREES 17 MINUTES 30 SECONDS EAST, 170.38 FEET TO THE PLACE OF BEGINNING.

Tax Parcel No. 51 007 99 0002 000

THAT PART OF FRACTIONAL SECTION 5, DESCRIBED AS BEGINNING AT A POINT ON THE U.S. HARBOR LINE DISTANT SOUTH 31 DEGREES 41 MINUTES 30.4 SECONDS WEST, 1760.64 FEET FROM THE INTERSECTION OF SAID LINE WITH THE NORTH LINE OF FRACTIONAL SECTION 5 AND PROCEEDING THENCE SOUTH 31 DEGREES 41 MINUTES 30.4 SECONDS WEST ALONG THE U.S. HARBOR LINE, 433.28 FEET; THENCE NORTH 89 DEGREES 43 MINUTES 00 SECONDS WEST, 703.23 FEET; THENCE NORTH 71 DEGREES 58 MINUTES 56 SECONDS WEST, 604,93 FEET TO THE EASTERLY LINE OF RIVER ROAD; THENCE NORTH 28 DEGREES 55 MINUTES 40 SECONDS EAST ALONG SAID LINE, 213.03 FEET; THENCE SOUTH 89 DEGREES 43 MINUTES EAST, 1402.36 FEET TO THE POINT OF BEGINNING.

Tax Parcel No. 51 007 99 0005 000

PARCEL C:

THAT PART OF SECTION 5 AND 6 DESCRIBED AS BEGINNING AT A POINT ON THE SOUTH LINE OF PENNSYLVANIA ROAD, DISTANT SOUTH 83 DEGREES 57 MINUTES EAST ALONG THE NORTH SECTION LINE, 693 FEET AND SOUTH 0 DEGREES 18 MINUTES WEST, 60 FEET FROM THE NORTH 1/4 CORNER OF SEOTIONS AND PROCEEDING THENCE SOUTH as DEGREES 57 MINUTES EAST ALONG SAID SOUTH LINE, 1832.17 FEET; THENCE SOUTH C DEGREES 13 MINUTES WEST, 103 FEET; THENCE NORTH 88 DEGREES 57 MINUTES WEST, 46.79 FEET; THENCE SOUTH 0 DEGREES 18 MINUTES WEST, 735.04 FEET; THENCE SOUTH 88 DEGREES 57 MINUTES EAST, 402.41 FEE; THENCE SOUTH 15 DEGREES 27 MINUTES WEST ALONG THE WESTERLY LINE OF ELECTRIC AVENUE, 1004.91 FEET; THENCE NORTH 88 DEGREES 57 MINUTES WEST ALONG THE NORTH LINE OF OOLV1N AVENUE, 1925.32 FEET; THENCE NORTH 0 DEGREES 18 MINUTES EAST ALONG THE EAST LINE OF *CLARK AVENUE,* 1811.47 FEET TO THE POINT OF BEGINNING.

Tax Parcel Nc. 51 010 99 0002 000

THAT FART OF THE NORTHEAST OF SECTION 6, DESCRIBED AS BEGINNING AT A POINT ON THE SOUTH LINE OF COLVIN AVENUE, DISTANT SOUTH 88 DEGREES 57 MINUTES EAST, 663 FEET AND SOUTH 0 DEGREES 18 MINUTES *WEST,* 1931.47 FEET AND SOUTH 88 DEGREES 57 MINUTES EAST, 692.17 FEET FROM THE NORTH 1/4 CORNER OF SECTION 6 AND PROCEEDING THENCE SOUTH 83 DEGREES 57 MINUTES EAST ALONG SAID SOUTH LINE, 794.55 FEET; THENCE SOUTH 14 DEGREES 44 MNUTES WEST, 133.12 FEET; THENCE NORTH 88 DEGREES 57 MINUTES WEST, 760.21 FEET; THENCE NORTH 0 DEGREES 18 MINUTES EAST ALONG THE EAST LINE OF KRAUSE AVENUE, 134.20 FEET TO THE POINT OF BEGINNING.

Tax Parcel No. 51 010 99 0004 000

THAT PART OF THE NORTHEAST 1/4 OF SECTION 6, DESCRIBED AS BEGINNING AT A POINT ON THE SOUTH LINE OF COLVIN AVENUE, DISTANT SOUTH 83 DEGREES 57 MINUTES EAST, 663.0 FEET AND SOUTH 0 DEGREES 18 MINUTES WEST, 1931.47 FEET AND SOUTH 88 DEGREES 57 MINUTES EAST, 1548.47 FEET FROM THE NORTH 1/4 CORNER OF SECTION 6 AND PROCEEDING THENCE SOUTH 88 DEGREES 57 MINUTES EAST ALONG SAID SOUTH LINE 390.68 FEET TO THE WESTERLY LINE OF ELECTRIC AVENUE; THENCE SOUTH 15 DEGREES 27 MINUTES WEST ALONG SAID WESTERLY LINE, 140.09 FEET; THENCE NORTH 88 DEGREES 57 MINUTES WEST, 338.99 FEET; THENCE NORTH 14 DEGREES 44 MINUTES EAST, 138.12 FEET TO THE POINT OF BEGINNING.

Tax Parcel Nc. 51 010 99 0005 000

PARCEL D:

PART OF THE SOUTHEAST 1/4 OF FRACTIONAL SECTION 32, TOWN 3 SOUTH, PNGE 11 EAST, BEGINNING AT THE INTERSECTION OF THE SOUTHEASTERLY LINE OF BIDDLE AVENUE, 120 FEET 'DE, WITH THE SOUTHERLY LINE OF WE STREET, 66 FEET WIDE; THENCE SOUTH 54 DEGREES 49 MINUTES EAST, 1176.81 FEET; THENCE SOUTH 31 DEGREES 25 MINUTES WEST, 503.6 FEET; THENCE SOUTH 69 DEGREES 43 MINUTES WEST, 335.69 FEET; THENCE NORTH 56 DEGREES 42 MINUTES 45 SECONDS WEST, 209 FEET; THENCE NORTH 33 DEGREES 14 MINUTES 15 SECONDS EAST, 52.42 FEET; THENCE NORTH 56 DEGREES 47 MINUTES 45 SECONDS WEST, 78.2 FEET; THENCE NORTH 33 DEGREES 14 MINUTES 15 SECONDS EAST, 129.52 FEET; THENCE NORTH 56 DEGREES 47 MINUTES 45 SECONDS WEST, 52.36 FEEt; THENCE SOUTH 33 DEGREES 12 MINUTES 15 SECONDS WEST, 63.46 FEET; THENCE NORTH 56 DEGREES 25 MINUTES 30 SECONDS WEST, 27.89 FEET; THENCE SOUTH 33 DEGREES 17 MINUTES 30 SECONDS WEST, 357.52 FEET; THENCE SOUTH 89 DEGREES 43 MINUTES WEST, 646.43 FEET; THENCE NORTH 30 DEGREES 30 MINUTES 10 SECONDS EAST, 317.3 FEET; THENCE NORTH 34 DEGREES 07 MINUTES EAST, 1000.09 FEET TO THE POINT OF BEGINNING.

Tax Parcel Nc.: 57 023 99 0002 000

PART OF THE SOUTHEAST FFCTIONAL 1/4 CF SECTION 32, *TOWN* 3 SOUTH, RANGE 11 EAST, BEGINNING NORTH 89 DEGREES 43 MINUTES EAST, 546.48 FEET FROM THE INTERSECTION OF THE SOUTHEASTERLY LINE OF BIDOLE AVENUE, 120 FEET WiDE, 1/11TH THE CENTERLINE OF PENNSYLVANIA AVENUE, 56 FEET WiDE, EXTENDED: THENCE NORTH 89 b'zz 43 MINUTES EAST, 433,3 FEET: THENCE NORTH 56 DEOF.EES 42 MINUTES 4.5 SECONDS 'iVEST, 209 *FEET,;*

THENCE NORTH 33 DEGREES 14 MINUTES 15 SECONDS EAST, 52.42 FEET; THENCE NORTH 55 DEGREES 47 MINUTES 45 SECONDS WEST, 78.2 FEET; THENCE WEST 33 DEGREES 14 MINUTES 15 SECONDS EAST, 12962 FEET; THENCE NORTH 56 DEGREES 47 MINUTES 45 SECONDS WEST, 52.86 FEET; THENCE SOUTH 33 DEGREES 12 MINUTES 15 SECONDS WEST; 53.46 FEET; THENCE NORTH 56 DEGREES 26 MINUTES 30 SECONDS WEST, 27.89 FEET; THENCE SOUTH 33 DEGREES 17 MINUTES 30 SECONDS WEST, 357.52 FEET TO THE POINT OF BEGINNING.

Tax Parcel Nc.: 57 023 99 000 3000

L3OMFLQ 1577- 42149

EXHIBIT B

GENERIC INDUSTRIAL LAND USE CATEGORY

A generic industrial site will include sites with the following characteristics:

1. The primary activity at the prope/ is and will continue to be industrial in nature (e.g., manufacturing, utilities, industrial research and development, petroleum bulk storage) and access is and will continue to be reliably restricted consistent with its use (e.g., by fences, security personnel, or both). Inactive or abandoned properties can be included in this category if the use was and/or will be industrial, as described above and access is controlled as necessary to assure unacceptable exposures do not occur. The industrial category does not include farms, gasoline stations, or other commercial establishments where children may commonly be present.

0. The current zoning of the property is industrial, the zoning is anticipated to be industrial or the current industrial use is a legal nan-conforming use. This may include different zoning designations, depending on the community, such as "light industrial" or "heavy industrial.

GENERIC COMMERCIAL LAND USE CATEGORY

generic commercial site would include sites with the following characteristics:

The primary activity at the property is and will continue to be commercial in nature (e.g., retail, warehouse, office/business space). This could include abandoned or inactive commercial properties as long as they fit both the definition of a commercial land use and one of the subcategory definitions described *below*.

2. The current zoning of the propej is commercial, future zoning is anticipated to be commercial, or the current commercial use is a legal nonconforming use. This may include different zoning designations, depending on the community, such as "community commercial," "regional commercial," "retail," or "office-business."

Subcategory, II: This commercial land use subcategory is characterized by the following features. Access to the public is reliably restricted, consistent with its use, by fences, security, or both. Affected surficial soils are located in unpaved or landscaped areas that are frequently contacted by worker populations such as groundskeepers, maintenance workers, or other employees whose primacy duties are performed outdoors. If groundwater is relied an for drinking water, it is assumed that worker populations receive half of their total daily drinking water exposure from the facility.

This subcategory could include, but is not limited to, the following uses:

- large-scale commercial warehouse operations
- wholesale lumber yards
- building supply warehouses

The degree of exposure for such employees under subcategory Il property is assumed to be equivalent to the exposures used to model outdoor activities in the development of the generic industrial criteria. As a result, a unique set of generic criteria has not been defined for this subcategory of commercial land use. Properties that fall into this subcategory should be addressed through the application of the generic industrial criteria or through a ability-specific risk assessment

NOTICE REGARDING STATUTORY OBLIGATIONS APPLICABLE TO THE PROPERTY

THIS Notice Regarding Statutory Obligations Applicable to the Property ("Notice") is executed and recorded by ATOFINA Chemicals, Inc. ("ATOFINA"), a Delaware corporation, with principal offices located at 2000 Market Street, Philadelphia, Pennsylvania. ATOFINA is the owner of real property located in Riverview, Wayne County, Michigan, and Wyandotte, Wayne County, Michigan, which property is more particularly described in Exhibit A attached hereto (the "Property").

Notice is hereby given in accordance with Michigan Administrative Code Rule 299.9525, promulgated pursuant to Part 111, Hazardous Waste Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended ("NREPA"), that the Property has been used to manage hazardous waste and that it is subject to the corrective action requirements of Part 111 of NREPA and the Resource Conservation and Recovery Act, 42 USCA 4251 *et seq.* ("RCRA"), as amended by the 1984 hazardous and solid waste amendments.

The undersigned person executing this Notice represents and certifies that he or she is duly authorized and has been empowered to execute and deliver this Notice.

Signed in the presence of:

)me:kVi CAJL E. _____ ,)c,/L)44

/ _____

Nam it-l. 7-i>1.1oj/

ATOFINA Chemicals, Inc., a Delaware corporation

By: _____
Name: A Ac..

Its: _____ ICit,

STATE OF rn

ACKNOWLEDGMENT

)SS.

COUNTY OF _____

The foregoing instrument was acknowledged before me this1 _____ day of.j4' 200, by ,. 4(1 , the YYuF ATOFINA Che fais, In a Delaware corporation, on behalf of the corporation.

Not Public, 19n4.71. T County
Staof '7fl _____
My commission eires: _____ --O?)

Prepared by and when recorded return to:
Suzanne T. Croissant
Dickinson Wright PLLC
38525 Woodward Avenue, Suite 2000
Bloomfield Hills, Michigan 48304

JANI0 . LEONA0
Nctaiy Pub Wayne Ccunri, Ml
My Cmmaacq Expe Aug. 25, 2004

EXHIBIT A

Legal Descriptions of The Property

PARCEL A:

THAT PART OF THE NORTHWEST 1/4 OF FRACTIONAL SECTION 5, DESCRIBED AS: BEGINNING AT THE INTERSECTION OF THE NORTH SECTION LINE AND THE WESTERLY LINE OF WEST JEFFERSON AVENUE, 106 FEET WIDE, AND PROCEEDING THENCE NORTH 89 DEGREES 45 MINUTES WEST ALONG THE NORTH SECTION LINE, 1614.71 FEET; THENCE SOUTH 14 DEGREES 30 MINUTES WEST ALONG THE EASTERLY LINE OF THE DT AND I RAILROAD RIGHT-OF-WAY, 1651.08 FEET; THENCE NORTH 66 DEGREES 58 MINUTES 45 SECONDS EAST, 244.79 FEET; THENCE SOUTH 89 DEGREES 43 MINUTE EAST, 937.15 FEET; THENCE ALONG THE WESTERLY LINE OF WEST JEFFERSON AVENUE NORTH 29 DEGREES 07 MINUTES EAST, 838.16 FEET AND NORTH 31 DEGREES 01 MINUTE EAST, 893.98 FEET TO THE PLACE OF BEGINNING, EXCEPTING THEREFROM 0.78 ACRES LYiNG WITHIN THE RIGHT-OF-WAY, 24 FEET W1DE, OWNED BY THE \1WANDOTTE SOUTHERN RAILROAD COMPANY, AS NOW LOCATED.

Tax Parcel No 51 007 990003 000

PARCEL B:

THAT PART OF FRACTIONAL SECTION 5, DESCRIBED AS: BEGINNING AT THE INTERSECTION OF THE EASTERLY LINE OF WEST JEFFERSON AVENUE, 106 FEET 'MDE, AND THE NORTH SECTION LINE AND PROCEEDING THENCE SOUTH 89 DEGREES 43 MINUTES EAST ALONG SAID NORTH LINE, 646.48; THENCE SOUTH 33 DEGREES 17 MINUTES 30 SECONDS WEST, 170.38 FEET; THENCE SOUTH 56 DEGREES 42 MINUTES 30 SECONDS EAST, 149.55 FEET; THENCE SOUTH 33 DEGREES 02 MINUTES 30 SECONDS WEST, 275.14 FEET; THENCE SOUTH 56 DEGREES 49 MINUTES 30 SECONDS EAST, 27.16 FEET; THENCE NORTH 33 DEGREES 10 MINUTES 30 SECONDS EAST, 163.98 FEET; THENCE SOUTH 56 DEGREES 46 MINUTES 30 SECONDS EAST, 154.34 FEET; THENCE NORTH 33 DEGREES 13 MINUTES 30 SECONDS EAST, 62.41 FEET; THENCE SOUTH 56 DEGREES 46 MINUTES 30 SECONDS EAST, 62.05 FEET; THENCE SOUTH 33 DEGREES 04 MINUTES 30 SECONDS WEST, 164.49 FEET; THENCE SOUTH 56 DEGREES 55 MINUTES 30 SECONDS EAST, 139.98 FEET; THENCE NORTH 33 DEGREES 04 MINUTES 30 SECONDS EAST, 300 FEET; THENCE NORTH 56 DEGREES 55 MINUTES 30 SECONDS WEST, 62.55 FEET; THENCE NORTH 33 DEGREES 04 MINUTES 30 SECONDS EASE, 100.66 FEET; THENCE SOUTH 56 DEGREES 46 MINUTES 30 SECONDS EAST, 85.59 FEET; THENCE NORTH 33 DEGREES 22 MINUTES 30 SECONDS EAST, 14.63 FEET; THENCE NORTH 17 DEGREES 32 MINUTES 45 SECONDS EAST, 77.65 FEET; THENCE NORTH 56 DEGREES 42 MINUTES 45 SECONDS WEST, 165.10 FEET; THENCE SOUTH 89 DEGREES 43 MINUTES EAST ALONG THE NORTH SECTION LINE, 371.20 FEET; THENCE SOUTH 31 DEGREES 41 MINUTES 30.4 SECONDS WEST ALONG THE U.S. HARBOR LINE, 1760.64 FEET; THENCE SOUTH 89 DEGREES 43 MINUTES WEST, 1402.36 FEET; THENCE ALONG THE EASTERLY LINE OF JEFFERSON AVENUE NORTH 29 DEGREES 07 MINUTES EAST, 778.04 FEET AND NORTH 31 DEGREES 01 MINUTES EAST, 955.24 FEET TO THE PLACE OF BEGINNING. EXCEPTING 7.49 ACRES THEREFROM LYING WITHIN THE 24 FOOT RIGHT-OF-WAY OWNED BY THE WYANDOflE SOUTHERN RAILROAD COMPANY, AS NOW LOCATED.

Tax Parcel Nc. 51 007 99 0001 000

THAT PART OF THE NORTHEAST 1/4 OF FRACTIONAL SECTION 5, DESCRIBED AS: BEGINNING AT A POINT ON THE NORTH SECTION LINE DISTANT SOUTH 89 DEGREES 43 MINUTE EAST, 646.48 FEET FROM THE INTERSECTION OF SAID LINE AND THE EASTERLY LINE OF WEST JEFFERSON AVENUE, 106 FEET WIDE, AND PROCEEDING THENCE SOUTH 89 DEGREES 43 MINUTES EAST ALONG SAID NORTH LINE, 438.00 FEET; THENCE SOUTH 56 DEGREES 42 MINUTES 45 SECONDS EAST, 165.10 FEET; THENCE SOUTH 17 DEGREES 32 MINUTES 45 SECONDS WEST, 77.65 FEET; THENCE SOUTH 33 DEGREES 22 MINUTES 30 SECONDS WEST, 146.63 FEET; THENCE NORTH 56 DEGREES 46 MINUTES 30 SECONDS WEST, 85.59 FEET; THENCE SOUTH 33 DEGREES 04 MINUTES 30 SECONDS WEST, 100.66 FEET; THENCE SOUTH 56 DEGREES 55 MINUTES 30 SECONDS EAST, 62.55 FEET; THENCE SOUTH 33 DEGREES 04 MINUTES 30 SECONDS WEST, 300 FEET; THENCE NORTH 56 DEGREES 55 MINUTES 30 SECONDS WEST, 139.98 FEET; THENCE NORTH 33 DEGREES 04 MINUTES 30 SECONDS EAST, 164.49 FEET; THENCE NORTH 56 DEGREES 46 MINUTES 30 SECONDS WEST, 62.05 FEET; THENCE SOUTH 33 DEGREES 13 MINUTES 30 SECONDS WEST, 62.41 FEET; THENCE NORTH 56 DEGREES 46 MINUTES 30 SECONDS WEST, 154.4 FEET; THENCE SOUTH 33 DEGREES 10 MINUTES WEST, 163.98 FEET; THENCE NORTH 56 DEGREES 49 MINUTES 30 SECONDS WEST, 27.16 FEET; THENCE NORTH 33 DEGREES 32 MINUTES 30 SECONDS EAST, 275.14 FEET; THENCE NORTH 56 DEGREES 42 MINUTES 30 SECONDS WEST, 149.55 FEET; THENCE NORTH 33 DEGREES 17 MINUTES 30 SECONDS EAST, 170.38 FEET TO THE PLACE OF BEGINNING.

Tax Parcel No. 51 007 99 0002 000

* 4 *

THAT PART OF FRACTIONAL SECTION 5, DESCRIBED AS BEGINNING AT A POINT ON THE U.S. HARBOR LINE DISTANT SOUTH 31 DEGREES 41 MINUTES 30.4 SECONDS WEST, 1760.64 FEET FROM THE INTERSECTION OF SAID LINE WITH THE NORTH LINE OF FRACTIONAL SECTION 5 AND PROCEEDING THENCE SOUTH 31 DEGREES 41 MINUTES 30.4 SECONDS WEST ALONG THE U.S. HARBOR LINE, 433.23 FEET; THENCE NORTH 89 DEGREES 43 MINUTES 00 SECONDS WEST, 703.23 FEET; THENCE NORTH 71 DEGREES 58 MINUTES 56 SECONDS WEST, 604.93 FEET TO THE EASTERLY LINE OF RIVER ROAD; THENCE NORTH 28 DEGREES 55 MINUTES 40 SECONDS EAST ALONG SAID LINE, 213.03 FEET; THENCE SOUTH 89 DEGREES 43 MINUTES EAST, 1402.36 FEET TO THE POINT OF BEGINNING.

Tax Parcel No. 51 007 99 0005 000

4 * *

PARCEL C:

THAT PART OF SECTION 5 AND 6 DESCRIBED AS BEGINNING AT A POINT ON THE SOUTH LINE OF PENNSYLVANIA ROAD, DISTANT SOUTH 88 DEGREES 57 MINUTES EAST ALONG THE NORTH SECTION LINE, 693 FEET AND SOUTH 0 DEGREES 18 MINUTES WEST, 60 FEET FROM THE NORTH 1/4 CORNER OF SECTION 6 AND PROCEEDING THENCE SOUTH 88 DEGREES 57 MINUTES EAST ALONG SAID SOUTH LINE, 1832.17 FEET; THENCE SOUTH 0 DEGREES 18 MINUTES WEST, 103 FEET; THENCE NORTH 88 DEGREES 57 MINUTES WEST, 46.79 FEET; THENCE SOUTH 0 DEGREES 18 MINUTES WEST, 735.04 FEET; THENCE SOUTH 88 DEGREES 57 MINUTES EAST, 402.41 FEET; THENCE SOUTH 15 DEGREES 27 MINUTES WEST ALONG THE WESTERLY LINE OF ELECTRIC AVENUE, 1004.91 FEET; THENCE NORTH 88 DEGREES 57 MINUTES WEST ALONG THE NORTH LINE OF COLVIN AVENUE, 1925.32 FEET; THENCE NORTH 0 DEGREES 18 MINUTES EAST ALONG THE EAST LINE OF CLARK AVENUE, 181147 FEET TO THE POINT OF BEGINNING.

Tax Parcel No. 51 010 99 0002 000

THAT PART OF THE NORTHEAST 1/4 OF SECTION 6, DESCRIBED AS BEGINNING AT A POINT ON THE SOUTH LINE OF COLVIN AVENUE, DISTANT SOUTH 88 DEGREES 57 MINUTES EAST, 663 FEET AND SOUTH 0 DEGREES 18 MINUTES WEST, 1931.47 FEET AND SOUTH 88 DEGREES 57 MINUTES EAST, 692.17 FEET FROM THE NORTH 1/4 CORNER OF SECTION 6 AND PROCEEDING THENCE SOUTH 88 DEGREES 57 MINUTES EAST ALONG SAID SOUTH LINE, 794.55 FEET; THENCE SOUTH 14 DEGREES 44 MINUTES WEST, 138.12 FEET; THENCE NORTH 86 DEGREES 57 MINUTES WEST, 760.21 FEET; THENCE NORTH 0 DEGREES 18 MINUTES EAST ALONG THE EAST LINE OF KRAUSE AVENUE, 134.20 FEET TO THE POINT OF BEGINNING.

Tax Parcel No. 51 010 99 0004 000

THAT PART OF THE NORTHEAST 1/4 OF SECTION 6, DESCRIBED AS BEGINNING AT A POINT ON THE SOUTH LINE OF COLVIN AVENUE, DISTANT SOUTH 88 DEGREES 57 MINUTES EAST, 663.0 FEET AND SOUTH 0 DEGREES 18 MINUTES WEST, 1931.47 FEET AND SOUTH 88 DEGREES 57 MINUTES EAST, 1548.47 FEET FROM THE NORTH 1/4 CORNER OF SECTION 6 AND PROCEEDING THENCE SOUTH 88 DEGREES 57 MINUTES EAST ALONG SAID SOUTH LINE 390.68 FEET TO THE WESTERLY LINE OF ELECTRIC AVENUE; THENCE SOUTH 15 DEGREES 27 MINUTES WEST ALONG SAID WESTERLY LINE, 140.09 FEET; THENCE NORTH 88 DEGREES 57 MINUTES WEST, 388.99 FEET; THENCE NORTH 14 DEGREES 44 MINUTES EAST, 138.12 FEET TO THE POINT OF BEGINNING.

Tax Parcel No. 51 010 99 0005 000

PARCEL D:

PART OF THE SOUTHEAST 1/ OF FRACTIONAL SECTION 32, TOWN 3 SOUTH, RANGE 11 EAST, BEGINNING AT THE INTERSECTION OF THE SOUTHEASTERLY LINE OF BIDDLE AVENUE, 120 FEET WIDE, WITH THE SOUTHERLY LINE OF iWE STREET, 66 FEET WIDE; THENCE SOUTH 54 DEGREES 49 MINUTES EAST, 1176.81 FEET; THENCE SOUTH 31 DEGREES 25. MINUTES WEST, 503.6 FEET; THENCE SOUTH 89 DEGREES 43 MINUTES WEST, 335.69 FEET; THENCE NORTH 56 DEGREES 42 MINUTES 45 SECONDS WEST, 209 FEET; THENCE NORTH 33 DEGREES 14 MINUTES 15 SECONDS EAST, 52.42 FEET; THENCE NORTH 56 DEGREES 47 MINUTES 45 SECONDS WEST, 78.2 FEET; THENCE NORTH 33 DEGREES 14 MINUTES 15 SECONDS. EAST, 129.62 FEET; THENCE NORTH 56 DEGREES 47 MINUTES 45 SECONDS WEST, 52.86 FEET; THENCE SOUTH 33 DEGREES 12 MINUTES 15 SECONDS WEST, 63.46 FEET; THENCE NORTH 56 DEGREES 26 MINUTES 30 SECONDS WEST, 27.89 FEET; THENCE SOUTH 33 DEGREES 17 MINUTES 30 SECONDS WEST, 357.52 FEET; THENCE SOUTH 89 DEGREES 43 MINUTES WEST, 646.48 FEET; THENCE NORTH 30 DEGREES 30 MINUTES 10 SECONDS EAST, 317.3 FEET; THENCE NORTH 34 DEGREES 07 MINUTES EAST, 1000.09 FEET TO THE POINT OF BEGINNING.

Tax Parcel Na.: 57 023 99 0002 000

PART OF THE SOUTHEAST FRACTIONAL 1/4 OF SECTiON 32, TOWN 3 SOUTH, RANGE 11 EAST, BEGINNING NORTH 89 DEGREES 43 MINUTES EAST, 646,48 FEET FROM THE INTERSECTION OF THE SOUTHEASTERLY LINE OF BIDDLE AVENUE, 120 FEET WIDE, WITH THE CENTERLINE OF PENNSYLVANIA AVENUE, 66 FEET WiDE, EXTENDED; THENCE NORTH 69 DEGREES 43 MINUTES EAST, 438.8 FEET; THENCE NORTH 56 DEGREES 42 MINUTES 45 SECONDS WEST, 209 FEET;

THENCE NORTH 33 DEGREES 14 MINUTES 15 SECONDS EAST, 52.42 FEET; THENCE NORTH 56 DEGREES 47 MINUTES 45 SECONDS WEST, 78.2 FEET; THENCE WEST 33 DEGREES 14 MINUTES 15 SECONDS EAST, 129.62 FEET; THENCE NORTH 56 DEGREES 47 MINUTES 45 SECONDS WEST, 52.86 FEET; THENCE SOUTH 33 DEGREES 12 MINUTES 15 SECONDS WEST; 53.46 FEET; THENCE NORTH 56 DEGREES 26 MINUTES 30 SECONDS WEST, 27.89 FEET; THENCE SOUTH 33 DEGREES 17 MINUTES 30 SECONDS WEST, 357.52 FEET TO THE POINT OF BEGINNING.

Tax Parcel Nc.: 57 023 99 000 3000

BLOOMFIELD 1737-37 .4€742

Figure 1
Conceptual Model of Vapor Migration Into An Office Building
ATOFINA Chemicals, West Brine Field, Riverview, MI

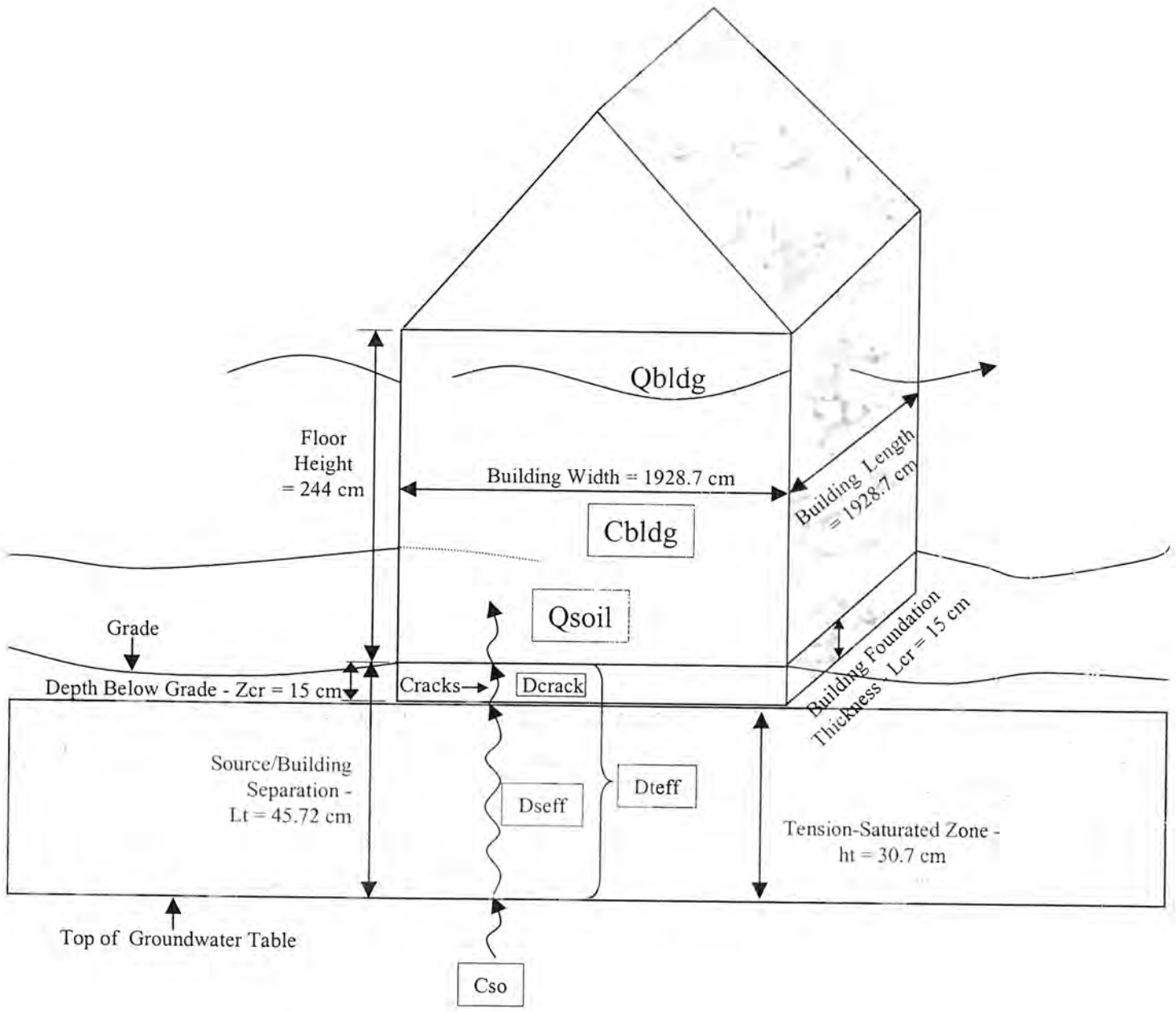


Figure 2
Comparision of Vapor Concentration Prediction Models (Johnson et al., 1990)
ATOFINA Chemicals, West Brine Field, Riverview, MI

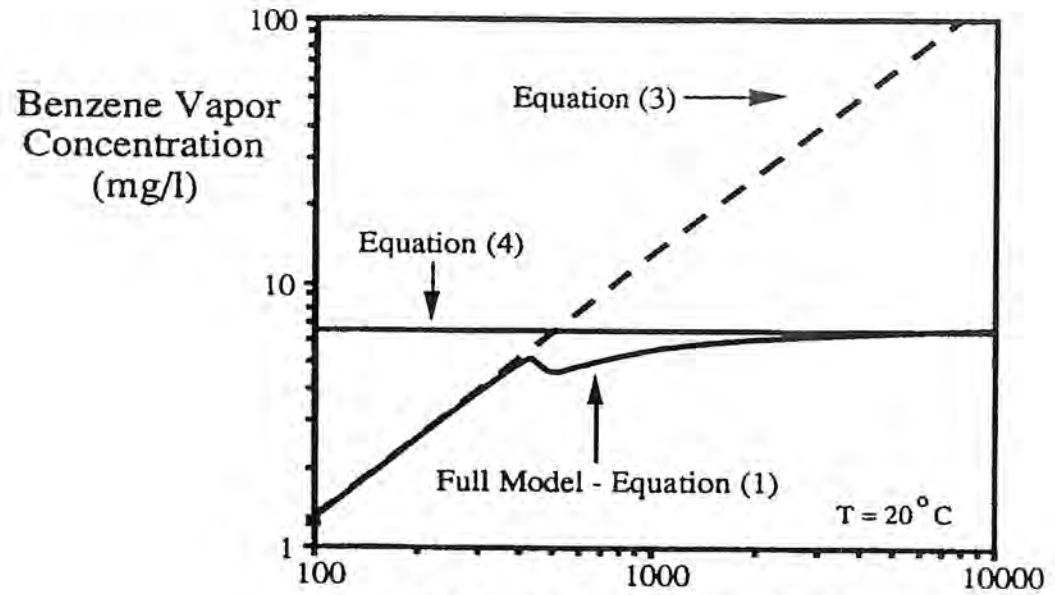
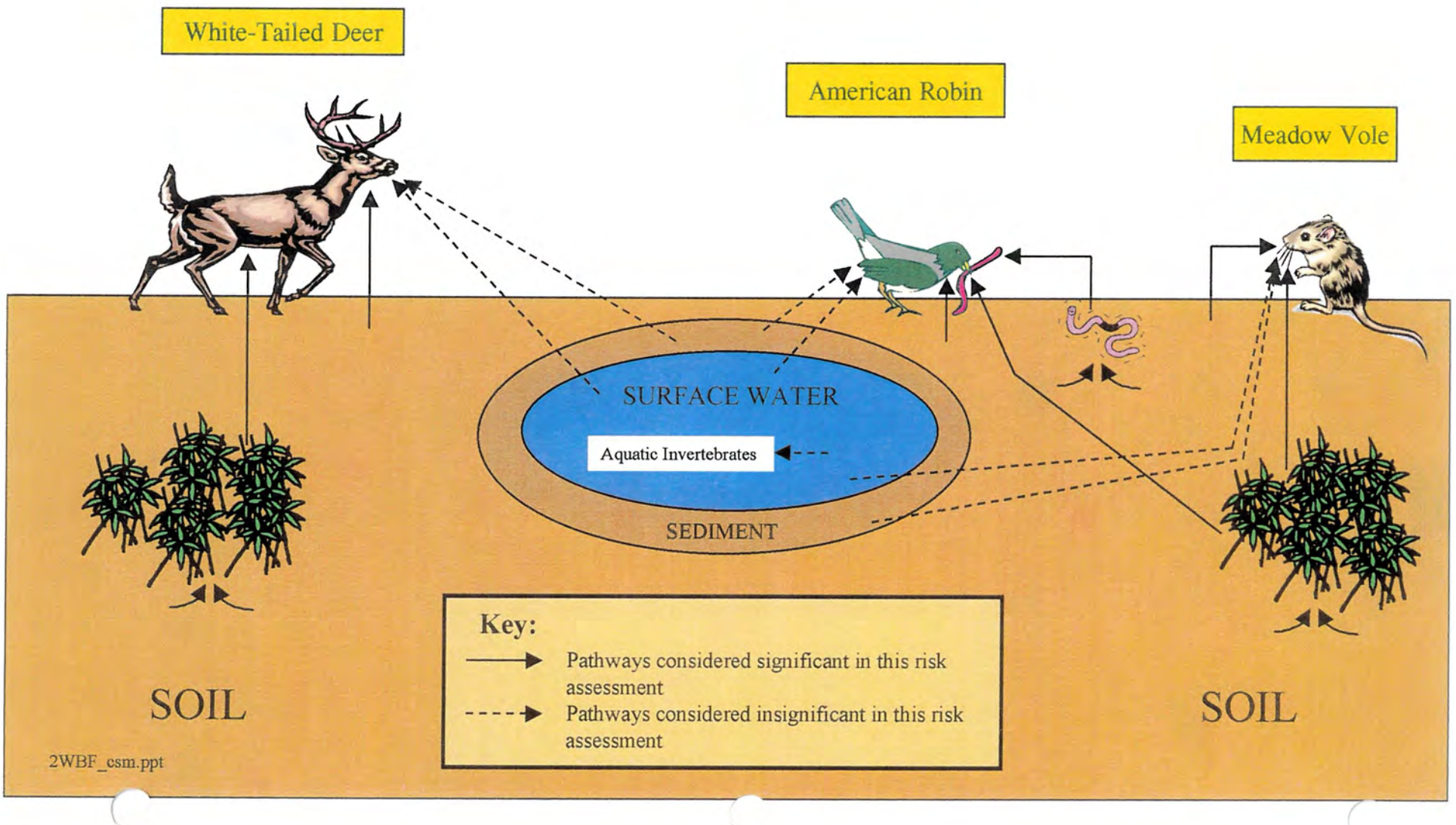
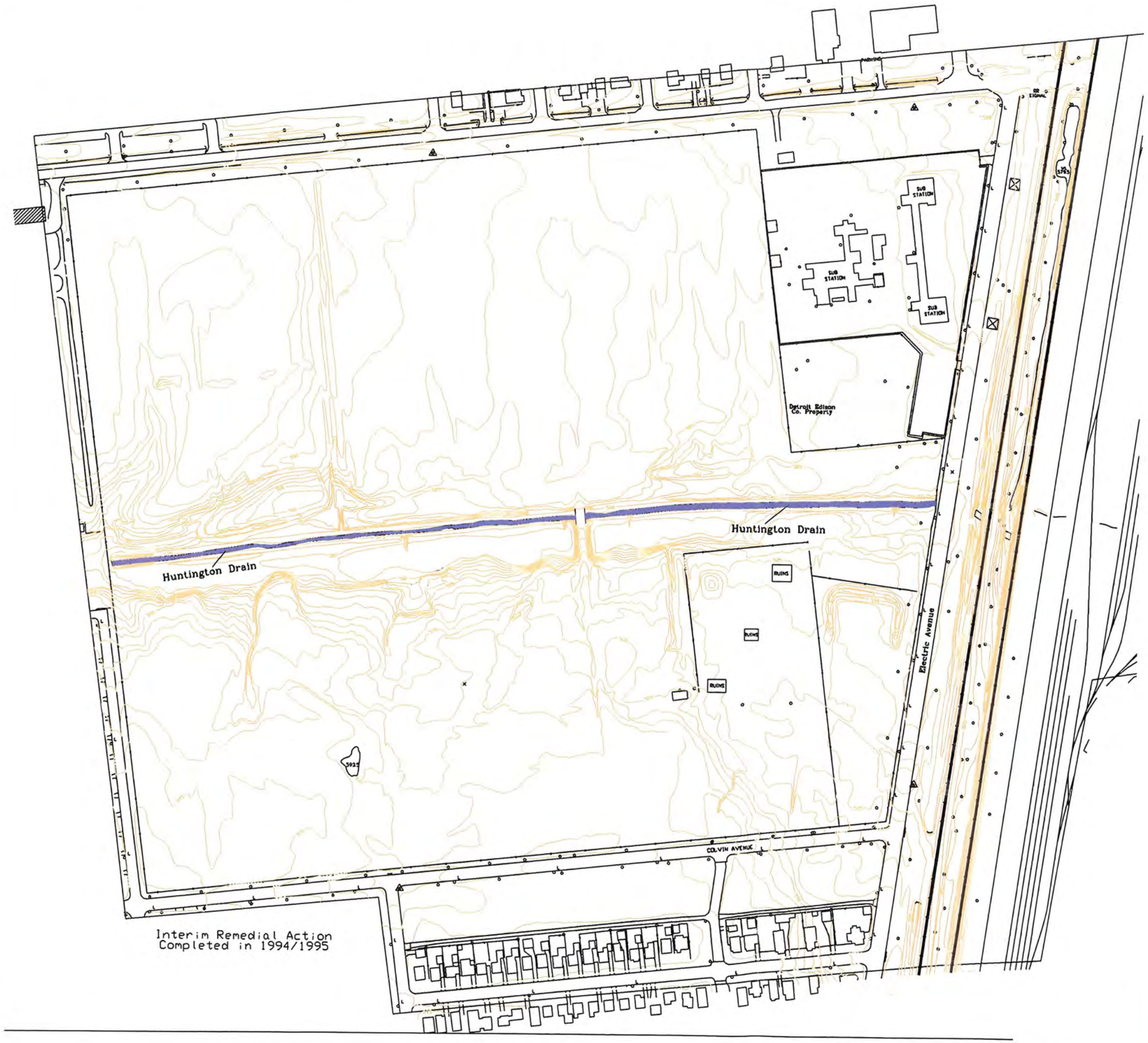
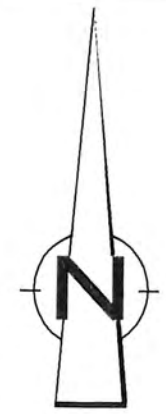


FIGURE 3: ECOLOGICAL CONCEPTUAL SITE MODEL

ATOFINA WEST BRINE FIELD SITE
RIVERVIEW, MI







LEGEND

- Fence Line
- Existing Structure
- Railroad Tracks
- Roadway
- 570 Ground Surface Elevation Contour (ft/msl)
- F Building Foundation
- Huntington Drain

0 200 400ft

Based on a site map provided by Atofina Chemicals

Figure 4

ATOFINA West Brine Field
Site Map

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