CDM Camp Dresser & McKee

Report

Indiana Department of Environmental Management

Continental Steel Superfund Site Remedial Investigation

Volume I
Text

October 15, 1996

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Project Number: 2673

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October 15, 1996

Mr. Arthur C. Garceau, Project Manager
Superfund Section
Office of Environmental Response
Indiana Department of Environmental Management
100 North Senate Avenue
Indianapolis, Indiana 46204

Subject: Draft Final Remedial Investigation Report
Continental Steel Superfund Site

Dear Mr. Garceau:

Camp Dresser & McKee Inc. is pleased to submit herewith three copies of the Draft Final Remedial Investigation Report for the Continental Steel Superfund Site in Kokomo, Indiana.

Please review the report and provide us with your comments as soon as possible, but no later than 30 days from receipt.

We look forward to the receipt of any comments you may have so that we can complete the final RI report as soon as possible.

Sincerely,

CAMP DRESSER & McKEE INC.

Mark A. Burgess, P.E., DEE
Principal Engineer

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List of Abbreviations and Acronyms

Abbreviation/ Acronym	
1,1,1-TCA	1,1,1-trichloroethane
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
4,4'-DDE	4,4'-dichloro-diphenyl-dichloroethene
4,4'-DDT	4,4'-dichloro-diphenyl-trichloroethane
ABB-ES	ABB Environmental Services, Inc.
Ag	silver
Al	aluminum
ARAR	applicable or relevant and appropriate requirement
As	arsenic
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
AWQC	ambient water quality criteria
AWQC	Federal Ambient Water Quality Criteria
Ba	barium
B(a)P	benzo(a)pyrene
BEHP	bis(2-ethylhexyl)phthalate
BGS	below ground surface
BOD	biochemical oxygen demand
BTEX	benzene, toluene, ethylbenzene, xylenes
C	degrees centigrade
Ca	calcium
$CaCO_3$	calcium carbonate
CAMU	corrective action management unit
Cd	cadmium
CDM	Camp Dresser and McKee Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfd	cubic feet per day
cfs	cubic feet per second
CLP	EPA's Contract Laboratory Program
CN	cyanide
Co	cobalt

COC	chemical/contaminant of concern
COD	chemical oxygen demand
COND	conductivity
Cr	chromium
CRL	Central Regional Laboratory
CRQL	contract required quantitation limit
CSO	combined sewer overflow
CSSS	Continental Steel Superfund Site
Cu	copper
DDD	dichloro-diphenyl-dichloroethane
DDE	dichloro-diphenyl-dichloroethene
DDT	dichloro-diphenyl-trichloroethane
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DQO	Data Quality Objective
EM	electro-magnetic
EPA	Environmental Protection Agency
ERA	ecological risk assessment
ESS	Environmental Sampling Supply
F	degrees Fahrenheit
FASP	EPA's Field Analytical Services Program
Fe	iron
FINDS	Facility Index System
FS	feasibility study
FSP	field sampling plan
ft	feet
g	gram
GC/MS	gas chromatography/mass spectroscopy
gpm	gallons per minute
ha	hectare
Hg	mercury
HI	hazard index
HNu	HNu photoionization detector
HQ	hazard quotient
hrs	hours
IDEM	Indiana Department of Environmental Management
in	inch
IRIS	EPA's Integrated Risk Information System
KEMRON	Kemron Environmental Services

kg	kilogram
L	liter
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDL	method detection limit
mg	milligram
Mg	magnesium
mm	millimeter
mo	month
mph	miles per hour
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level
MW	monitoring well
NA	not applicable
NCP	National Contingency Plan
Ni	nickel
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTU	nephelometric turbidity units
OVA	organic vapor analyzer
OVM	organic vapor monitor
PAH	polynuclear aromatic hydrocarbons
Pb	lead
PCB	polychlorinated biphenyls
pH	hydrogen ion concentration
POTW	publicly owned treatment works
ppb	parts per billion ≈ μg/kg or μg/L
ppm	parts per million ≈ mg/kg or mg/L
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RA	risk assessment
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
SARA	Superfund Amendments and Reauthorization Act
Sb	antimony

SB	soil boring
SD	sediment
SDWA	Safe Drinking Water Act
Se	selenium
SG	soil gas
SS	surficial soil
STP	sewage treatment plant
SU	standard units
SVOC	semi-volatile organic compound
SW	surface water
SWF	solid waste facility
T	transmissivity
TAL	Target Analyte List
TCE	trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TEMP	temperature
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TSS	total suspended solids
TURB	turbidity
U.S. EPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
USGS	United States Geological Services
UST	underground storage tank
VC	vinyl chloride
VOC	volatile organic compound
wk	week
wt	weight
WWTP	wastewater treatment plant
yr	year
Zn	zinc
μg	microgram

Section One

Section 1
Introduction

1.1 Background

The Continental Steel Superfund Site (CSSS) is an uncontrolled hazardous waste site located in Kokomo, Indiana. The Indiana Department of Environmental Management (IDEM) is the lead agency responsible for conducting this Remedial Investigation and Feasibility Study (RI/FS) at the site under a cooperative agreement with the United States Environmental Protection Agency (U.S. EPA) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), commonly known as Superfund. On February 20, 1995 CDM entered into a contract with the IDEM to perform an RI/FS of the Continental Steel Superfund Site.

The CSSS is located on West Markland Avenue in the city of Kokomo, in Howard County, in north central Indiana in a residential and industrial area. Residential properties lie mostly to the east and southeast. Mixed residential and industrial areas lie to the north and west. Industrial properties lie to the south. The total site covers about 183 acres and is composed of an abandoned steel-manufacturing facility (the Main Plant), Lagoon Area, Slag Processing Area and the Markland Avenue Quarry. Detailed information on the site background and setting is provided in Section 2 of the Focused RI/FS Work Plan (CDM 1995a).

1.1.1 Operational History

Built in 1896 as the Kokomo Fence Machine Company, the plant continued to expand and merged with The Superior Sheet Steel Company, Canton, Ohio, and Chapman Price Steel Company, Indianapolis to form Continental Steel Corporation in 1927. In 1947, Continental Steel bought the Markland Avenue Quarry. The City of Kokomo signed a lease with Continental Steel in 1972 and the company agreed to build and operate a neutralization plant and lagoon system; the plant was built in 1973.

Also in 1973, Continental Steel Corporation merged with Penn Dixie Steel Corporation, an adjacent steel-manufacturing facility, to become Dixie Continental Interim Corporation. It became Penn Dixie Steel Corporation in 1974 and operated as such until filing for Chapter 11 bankruptcy in 1982. The company reorganized and operated as Continental Steel until filing for Chapter 11 bankruptcy in November of 1985. The plant closed in February of 1986 when Continental Steel filed for Chapter 7 bankruptcy.

Throughout its history, the plant produced nails, wire and wire fence from scrap metal. Operations included reheating, casting, rolling, drawing, pickling, annealing, hot-dip galvanizing, tinning and oil tempering.

1.1.2 Waste Handling and Disposal Areas

The steel manufacturing operations at the plant included the use, handling, storage and disposal of hazardous materials. This section describes these materials and the components of the CSSS called operable units (OUs). The six OUs include:

- OU1 Groundwater;
- OU2 Lagoon Area;
- OU3 Kokomo and Wildcat Creeks;
- OU4 Markland Avenue Quarry;
- OU5 Main Plant; and
- OU6 Slag Processing Area.

The following section outlines the work performed by IDEM and the U.S. EPA at the OUs prior to this Remedial Investigation/Feasibility Study.

Main Plant
The plant consists of three tracts of land comprising approximately 100 acres. These three areas include the Main Plant building area (94 acres), the equipment storage area located at the southwest corner of Markland Avenue and Park Avenue (0.8 acres), and the former engineering building located north of Markland Avenue between Park Avenue and Syndicate Sales (5 acres). The Superfund designated area of the Main Plant consists of 94 acres bordered by West Markland Avenue to the north, Defenbaugh Road and private property to the south, Leeds Street to the east and Wildcat Creek to the west. The Main Plant includes more than 50 abandoned buildings, many with basements, underground sewers, and utility lines. Some process equipment has been removed. The Fence plant to the north of West Markland Avenue is not part of the Superfund site.

Early investigations found more than 700 oil- and solvent-filled drums, 55 aboveground and underground storage tanks, and 33 vats. The tanks and vats held mostly oil and some chlorinated solvents and acids. Twenty-four electrical transformers, 200 capacitors, electric arc furnace dust (baghouse dust), and exposed asbestos were found in the plant.

Markland Avenue Quarry
This 23-acre area was formerly a limestone quarry. It is bordered by Harrison Street to the north, West Markland Avenue to the south, Courtland Avenue to the east, and Brandon Street to the west. Continental Steel disposed of waste materials such as drums, slag, refractory brick, pig iron, and tanks of oil and solvents at the quarry.

Lagoon Area
The Lagoon Area lies one-third of a mile west of the Main Plant. The area is composed of 10 lagoons covering a 56-acre area. In 1980, the Lagoon Area achieved interim Resource Conservation and Recovery Act (RCRA) status. Spent pickle liquor (inorganic acid used to remove impurities from metal surfaces) was transferred from the Main Plant to two hazardous waste storage lagoons. The stored liquid was then pumped to a neutralization and treatment system. The neutralized pickle liquor and sludge generated during treatment were deposited in one of five polishing lagoons. The treated liquid was then discharged to Wildcat Creek, and the sludge was placed into three drying beds.

Slag Processing Area
Slag material generated from operations at the plant was processed and disposed in an area along West Markland Avenue just west of the Lagoon Area known as the Slag Processing Area. The Slag Processing Area consists of approximately 9 acres and is bordered on the north by West Markland Avenue, on the south and west by Wildcat Creek, and on the east by the Lagoon Area. Slag processing apparently involved the reclamation of metals from the waste material. The eastern half of the area is flat, graded slag. The northwest quarter of the area is a 45-foot high mound of slag, and the southwest quarter is a depressional area of slag.

Slag, prevalent throughout various areas of the CSSS, primarily consists of calcium and iron oxides with smaller amounts of aluminum, chromium, lead, manganese, magnesium, and zinc oxides. Slag processing was conducted to reclaim certain metals. The slag may locally be contaminated with oil and solvents depending on location at the CSSS.

Kokomo and Wildcat Creeks
These two creeks run along the borders of the Main Plant and the Lagoon Area. The creeks have received water from the plant's wastewater recycling and filtration system, neutralized pickle liquor from the Lagoon Area, discharge from site outfalls and storm water runoff from the site in general.

Groundwater
Most Kokomo residents rely on public water supplies, although there are private wells in the area. Groundwater appears to have also received contaminants from the Main Plant, the Markland Avenue Quarry, the Lagoon Area and/or other areas related to the site.

1.1.3 Work at the CSSS to Date

The first phase of the 1993 Remedial Investigation addressed three of the operable units (groundwater, Kokomo and Wildcat Creeks, and the Lagoon Area) and was conducted by ABB Environmental Services, Inc. (ABB-ES), a previous IDEM Contractor. In addition, IDEM and the U.S. EPA have completed several emergency response actions to remove hazardous substances that potentially posed an immediate threat to human health and the environment.

The first phase of the 1993 Remedial Investigation generated a significant amount of information about the nature and extent of contamination at the site. In addition, data is available from testing

conducted during emergency response actions and other miscellaneous sources. Details of the prior studies and activities at the site can be found in CDM's Focused RI/FS Work Plan (CDM 1995a).

1.2 Purpose

The purpose of the Remedial Investigation (RI) Report is to provide a single document that contains the information presented in the Draft Technical Memorandums previously submitted to IDEM and U.S. EPA and to incorporate data collected previously during removal actions and the first phase of the RI into the data presentation and discussion. The Technical Memorandums were prepared as described in CDM's Focused RI/FS Work Plan (CDM 1995a) to present the results of field activities and provide input to the feasibility study and risk assessment that were prepared concurrent to the RI Report. RI Technical Memorandums were prepared for each operable unit at the site, for the characterization of the adjacent industrial properties, to describe the procedures and results of the background study conducted at the site and to provide the methodology and initial results for the groundwater modeling task. All the Technical Memorandums described above will be included in this RI Report with the exception of the background study. The information obtained by the background study was used for the human health and ecological risk assessment and will be an appendix to the risk assessment report.

This report describes the site characteristics (either in text or by reference), the source area characteristics and the nature and extent of contamination. The site conceptual models developed in the Focused RI/FS Work Plan are refined in this report. The risk assessment report will present an evaluation of the potential threat to human health and the environment in the absence of any remedial actions and will define site-specific cleanup goals for contaminated media at the site. The feasibility study report will use the groundwater model described in the RI to analyze the fate and transport of the contaminants. This information will then be used in conjunction with the cleanup goals to develop and screen feasible remedial alternatives for contaminated media.

1.3 Organization of Report

The Remedial Investigation report is organized into five sections. This section provides a brief introduction to the site that includes site background information, the RI/FS purpose and report organization. Section 2 provides an overview of the site background and characterizes the setting of the CSSS. Adjacent industrial properties are evaluated in Section 3. Section 4 discusses data useability, contains an overview of CDM's approach to the RI, and provides the data derived from the first and second phases of the field investigation for each operable unit (i.e. Main Plant, Markland Avenue Quarry, Lagoon Area, Slag Processing Area, Kokomo and Wildcat Creeks and site-wide groundwater). Section 5 is a summary of the investigation results for each operable unit.

1.4 References

Camp Dresser & McKee Inc. (CDM). 1995a. *Continental Steel Superfund Site Focused Remedial Investigation/Feasibility Study Work Plan.*

Section Two

Section 2
Site Background and Setting

This section provides an overview of the CSSS, its operational history and the physical setting. More detail is provided on each area in and adjacent to the CSSS in the corresponding sections of this report and in Section 2 of the Work Plan (CDM 1995a). Where appropriate, this section provides greater detail where the understanding of site characteristics has changed or been enhanced by this phase of the Remedial Investigation.

The CSSS is located in the City of Kokomo, Township 23 North, Range 3 East, Sections 1 and 2, and Township 24 North, Range 3 East, Sections 35 and 36 in Howard County, Indiana. The site comprises about 183 acres and is composed of an abandoned steel manufacturing facility (Main Plant), pickling liquor treatment lagoons (Lagoon Area), a former waste disposal area (Markland Avenue Quarry), and a former waste disposal and slag processing area (Slag Processing Area). The components of the site are shown on **Figure 2-1**.

The site is located in a mixed residential, commercial, and industrial area and is zoned for general use. The Main Plant is zoned for industrial use only. Generally, residential properties are located to the east, a mix of residential and industrial properties exist to the north and west, and industrial properties are located to the south. A detailed description of industrial properties located adjacent to the site is provided in Section 3.

2.1 Facility Description and Operational History

The CSSS was founded as the Kokomo Fence Machine Company in 1896. It was operated by Continental Steel Corporation and its predecessors from approximately 1927 to 1986, when the company entered into bankruptcy. The plant produced nails, wire, and wire fence from scrap steel at this location. Operations included reheating, casting, rolling, drawing, pickling, annealing, hot-dip galvanizing, tinning, and oil tempering. An overview of the operational history of each of the four source areas at the CSSS (i.e., the Main Plant, Markland Avenue Quarry, Lagoon Area and the Slag Processing Area) is provided in Section 2 of the Work Plan (CDM 1995a) and in the corresponding sections of this report.

2.1.1 Main Plant

The plant formerly consisted of three tracts of land comprising approximately 100 acres. However, the Main Plant area under the Superfund designation consists of only 94 acres. The Main Plant is bordered by West Markland Avenue to the north, Leeds Street to the east, and Park Avenue to the west (**Figure 2-1**). The Main Plant extends west of Park Avenue to Wildcat Creek. An abandoned filter plant for pretreatment of water discharged to the creek is located on a narrow strip of land between Park Avenue and Wildcat Creek. The Main Plant area also extends south of Kokomo Creek.

Currently, more than 50 abandoned buildings exist at the Main Plant with sizes ranging from 10,000 square feet to 400,000 square feet. The buildings contain many basements, some of which are flooded with water, and a network of underground sanitary sewers, storm sewers, and utility lines. Some process equipment has been removed from the buildings; however, much equipment still remains.

Previous investigations have identified more than 700 oil and solvent-filled drums scattered throughout the Main Plant. More than 50 aboveground and underground storage tanks (ASTs/USTs) and more than 30 vats were noted at the Main Plant. The tanks and vats contained primarily oils, but chlorinated solvents and acids were also identified. Electrical transformers and capacitors were noted throughout the facility, and small quantities of some 200 different chemicals were noted in a laboratory room. Improperly contained electric arc-furnace dust, or baghouse dust, and slag piles were observed throughout the plant. Asbestos was also noted within piping insulation. Removal of the drums, some tank contents, transformers, capacitors was completed during a U.S. EPA removal action during 1990 and 1991. Gross decontamination of many buildings was accomplished by the U.S. EPA during the Fall of 1993, and tank contents of four large ASTs were removed during the Fall of 1994. Details of these actions are presented in Section 3.1 of CDM's Work Plan (CDM 1995a).

2.1.2 Markland Avenue Quarry

The Markland Avenue Quarry was a former limestone quarry purchased in 1947 and used until the early 1980s by Continental Steel for the disposal of waste materials from the steel processing operations. The quarry, which is approximately 23 acres in size, is bordered to the north by Harrison Street, to the south by West Markland Avenue, to the east by Courtland Avenue, and to the west by Brandon Street. At the southeast corner of the former quarry, commercial establishments exist, including Moore Drugs (formerly a Marsh Grocery Store) and a Village Pantry convenience store.

Some waste materials generated during steel processing at Continental Steel were disposed of in the Markland Avenue Quarry. Apparently, near-empty drums were taken to the quarry and the remaining contents dumped onto the ground. A large portion of the quarry has been backfilled

with slag, refractory brick, pig iron, baghouse dust, and, possibly, drums. Previous investigations identified more than 400 drums, several tanks and other waste materials scattered across the property. These drums contained mostly oils, solvents and refuse. It was estimated that more than 1,000 drums were disposed of in the quarry pond.

From a review of aerial photographs, it was determined that the Markland Avenue Quarry, consisting of the entire block between Courtland Street and Brandon Street, was a large pond almost completely filled with water in August of 1938. The exception was the southwest corner and southern border of the area which did not appear to be excavated. As of June 1957, only the southwest corner remained unexcavated and slightly more than half of the quarry had been filled-in. The area that was filled-in appears to be evenly graded with an additional bank constructed along the southern edge of the area. The northwest corner remained filled with water and a building had been erected in the southeast corner of the quarry area. By July 1964, the quarry had been filled-in even further with debris suspected to be from the Main Plant, with a smaller portion of the northwest corner remaining as open water. A railroad spur from the Main Plant had been laid on the portion of the quarry that had been filled-in. It was determined during this phase of the Remedial Investigation that railroad spurs were progressively laid across the filled quarry as the quarry was filled. Slag was transported to the quarry on these rails. From the June 1972 photo, the Markland Avenue Quarry does not appear to have been filled-in any further. There were, however, some new structures that were erected in the southeast corner of the quarry area, on top of the area that had been filled-in earlier.

During 1990, the U.S. EPA removed surface drums and an area of PCB-contaminated soil. More than 1,100 submerged drums and several tanks were removed from the quarry pond by the U.S. EPA during the summer of 1991. Details are presented in Sections 3 of the Work Plan (CDM 1995a).

2.1.3 Lagoon Area

The Lagoon Area is located approximately 0.3 miles west of the Main Plant along the south side of West Markland Avenue (**Figure 2-1**). The area covers approximately 56 acres and includes five polishing lagoons, two acid (hazardous waste storage) lagoons, and three sludge-drying beds. The area is bordered on the south and west by Wildcat Creek and on the east by the City of Kokomo wastewater treatment plant. Immediately to the west of Wildcat Creek lies the Haynes International Inc. facility and its RCRA closed landfill.

While in operation, spent pickle liquor generated at the Main Plant was transferred via a direct pipeline to two hazardous waste storage lagoons. The spent pickle liquor was then pumped to a neutralization and treatment system, and neutralized pickle liquor and sludge (generated by the treatment) were deposited in one of five polishing lagoons. The treated liquid was then discharged to Wildcat Creek and the sludge was placed into three drying beds.

During 1980, Continental Steel achieved interim status for the facility as a hazardous waste treatment, storage and disposal facility under RCRA. The required RCRA groundwater monitoring of the Lagoon Area indicated that groundwater within the limestone aquifer underlying the lagoons was contaminated with metals and trace concentrations of organic compounds. In addition, sampling indicated that surface water, sediment, and fish in Wildcat Creek had been impacted. During RCRA inspections, drums and waste piles of slag were observed in the Lagoon Area. The Lagoon Area was placed on the National Priorities List (NPL) in March of 1989 due to the existence of pickle liquor in the lagoons and the inherent risks to the environment. Shortly thereafter, the Main Plant and Markland Avenue Quarry (discussed previously) were aggregated into the CSSS because all areas were owned and operated by Continental Steel and contained similar contaminants that originated from the same manufacturing processes and threatened the same resources.

Information on historical investigation and removal activities that occurred at the Lagoon Area are provided in Section 3 of the Work Plan (CDM 1995a).

2.1.4 Slag Processing Area

Slag material generated from Continental Steel operations was processed in an area along West Markland Avenue approximately 0.2 miles west of the Lagoon Area **(Figure 2-1)**. The area, which consists of approximately nine acres, is bounded to the north by West Markland Avenue, to the south and west by Wildcat Creek, and to the east by the Lagoon Area.

Slag processing apparently involved the reclamation of metals from the slag. An undetermined amount of slag was placed in this area. The slag consisted primarily of calcium and iron oxides with lesser amounts of aluminum, chromium, lead, manganese, magnesium and zinc oxides. Slag materials may also have been contaminated with oils and solvents.

A portion of the Slag Processing Area was formerly known as the Chaffin Quarry. A review of historical aerial photographs indicates that the quarry encompassed the southwest quarter of the Slag Processing Area. The Chaffin Quarry may also have been used to dispose of waste materials (i.e., drums) from the Main Plant. Aerial photographs also showed that in August 1938, the Chaffin Quarry was completely surrounded by trees and filled with water.

2.2 Site Setting

Details of the site setting including demography, meteorology, site hydrology, stream hydrology, regional geology and regional hydrogeology are provided in Section 2 of the Work Plan (CDM 1995a).

2.2.1 Regional Physiography, Geology and Hydrogeology

CSSS is located in Howard County, in the Upper Wabash River basin. The Indiana Department of Natural Resources (IDNR) divided the Wabash River basin into three subbasins: an upper basin, a middle basin, and a lower basin (Fenelon *et al.* 1994). The Upper Wabash River basin extends in area from the northeast portion of the state, westward along the Wabash River, to the city of Lafayette in Tippecanoe County.

Kokomo and Wildcat Creeks flow westward through the site to the Wabash River. The confluence of Wildcat Creek and Kokomo Creeks is located southwest of the Main Plant. Wildcat Creek is the last tributary of the Wabash River in the Upper Wabash River basin.

Most physiographic features in the Upper Wabash River basin were formed by glaciers. Howard county is located on the Tipton Till Plain, a nearly flat glacial till plain that covers much of central Indiana. The till plain surface slopes gently to the west at a slope of less than one percent. Till, a mixture of unsorted and unstratified clay, silt, sand, and gravel deposits, is the predominant deposit. According to the "Hydrogeologic Atlas of Aquifers in Indiana" (Fenelon *et al.* 1994), the surface of the till plain is undulating and poorly drained. Incised valleys along Wildcat Creek and Kokomo Creek provide the most prominent topographic features in the vicinity of the site.

The till plain is underlain by ground moraine and ablation tills deposited during several glacial advances during the Pleistocene Epoch (1 million to 10,000 years ago). The plain is covered by surficial drift deposits from melting ice, streams, and ice-dammed lakes. Buried deposits of sand and gravel interspersed within the till plain are thicker and more extensive than valley-train and alluvial deposits near the ground surface.

Glacial drift deposits in the vicinity of the site range in thickness from zero feet in quarries along Wildcat Creek to more than 200 feet in buried valleys that were eroded in the underlying bedrock. Glacial drift deposits underlying the site are generally less than 20 feet in thickness.

Paleozoic bedrock underlies the glacial drift deposits. Bedrock structure is dominated by the Cincinnati Arch in this area of the state (**Figure 8**, Hydrogeologic Atlas of Aquifers in Indiana, Fenelon *et al.* 1994). The axis of the Cincinnati Arch plunges to the northwest, at a slope of 4 to 13 feet per mile. According to the "Hydrogeologic Atlas of Aquifers in Indiana" (Fenelon *et al.* 1994), the Cincinnati Arch, during the Paleozoic Era (225 to 570 million years ago), separated open seas to the northeast and southwest and supported coral reef communities that are now carbonate deposits. The site is located near the axis of the Cincinnati Arch, although bedrock units in the vicinity of the site dip slightly southwest from the axis of the arch.

According to "Water Resources of Wildcat Creek and Deer Creek Basins, Howard and Parts of Adjacent Counties, Indiana, 1979-82" (Smith *et al.* 1985), the predominant feature of the bedrock surface is a valley system cut by streams flowing from east to west. **Figure 3** in "Water Resources of Wildcat Creek and Deer Creek Basins, Howard and Parts of Adjacent Counties, Indiana, 1979-82" (Smith *et al.* 1985) is drawn at a scale of three miles per inch and appears to indicate the presence of a ancient river channel located to the southwest of the site. The presence of an ancient river channel located southwest of the site was also suggested during construction of the groundwater model for

the site from residential well logs. Lithologic logs for residential wells located southwest of the site indicate that the top of the bedrock is at depths up to 140 feet, which is significantly deeper than bedrock encountered at the site during the field investigation.

According to references (Smith *et al.* 1985 and Fenelon *et al.* 1994), groundwater flow is primarily through semi-confined sand and gravel deposits within the glacial drift, where these deposits are present, and through open fractures, joints, bedding planes, and solutional channels within the bedrock. Although the principle sources of groundwater are glacial drift aquifers in the Upper Wabash River basin, these aquifers are not present at the site. The Silurian-Devonian carbonate aquifer is the primary bedrock source of groundwater in the site vicinity.

According to "Water Resources of Wildcat Creek and Deer Creek Basins, Howard and Parts of Adjacent Counties, Indiana, 1979-82" (Smith *et al.* 1985), the USGS collected water level measurements from approximated 150 domestic and commercial wells during 1980 and from two continuous-record observation wells from 1966 to 1981 during the study of the Wildcat and Deer Creek basins. According to this study, groundwater flow within the bedrock is generally toward streams; however, reaches of Wildcat Creek near Kokomo are affected by the diversion of surface water, large-quantity groundwater withdrawals, treated wastewater discharges, and the regulation of reservoirs.

2.2.2 Site Geology

Bedrock at the site is overlain by up to 20 feet of silty clay or fill. A detailed description of the unconsolidated deposits at the site is provided in Section 2 of the Work Plan (CDM 1995a).

Bedrock at the site is described in detail in Section 2 of the Work Plan (CDM 1995a). The bedrock at the site according to Shaver *et al.* (1986) from top down consists of Silurian limestone and dolostone of the Kokomo Limestone Member (Kokomo Limestone) and the Liston Creek Limestone Member (Liston Creek Limestone) of the Wabash Formation in the Salina Group (**Figure 2-2**). Below the Liston Creek is the Mississinewa Shale Member (Mississinewa Shale) of the Wabash and Pleasant Mills Formations of the Salina Group.

The Kokomo Limestone generally consists of up to 50 feet alternating layers of massive and thinly laminated, tan to gray dolostone. The laminated dolostone is spottily petroliferous, pitted with occasional chert nodules.

The Kokomo Limestone is underlain by the Liston Creek Limestone. The Liston Creek Limestone has two distinct lithologies. The upper 30 to 35 feet of the unit consists of yellowish gray to bluish white, fossiliferous dolostone. Some fossils are pyritized. The dolostone has thin indistinct, contorted laminae and occasional horizontal and vertical fractures. The lower 30 to 45 feet of the unit consists of light gray to olive gray limestone. The limestone has contorted and irregular laminae and a few mineralized fossils.

The Mississinewa Shale is a light gray to olive gray silty dolostone. The dolostone is very fine-grained and argillaceous. The unit has few fossils and voids. Where present, the fossils and voids are typically altered to or filled with sulfides (CDM 1995a).

The Kokomo Limestone, Liston Creek Limestone and Mississinewa Shale contain horizontal bedding plane fractures as well as numerous vertical fractures with dominant orientation of N79E with dips ranging from approximately 80° SE to 80° NW. A second fracture orientation of N25W dipping approximately 80° NE is present and has calcite cementation present. A parting (small fracture) is present with an orientation of N65W with a dip near vertical. These fracture orientations are present in the Liston Creek Limestone and extend less frequently into the upper portions of the Mississinewa Shale. Generally fractures are present less frequently with increasing depth. This is true with the exception of the Liston Creek Limestone/Mississinewa Shale contact where groundwater migrating along the contact has weathered and enhanced fractures along the contorted bedding planes in the rock resulting in increased permeability.

2.2.3 Site Hydrogeology

A detailed discussion of site hydrogeology is provided in Section 4 for each area investigated. Water-bearing zones, based on field observations and for the purposes of evaluation and discussion, were divided into three zones - the shallow, intermediate and lower water-bearing zones. The upper water-bearing zone extends from approximately 800 feet above mean sea level (MSL) to approximately 760 feet MSL and the intermediate water-bearing zone extends from 760 feet MSL to 700 feet MSL. The lower water-bearing zone extends from 700 feet MSL to 660 feet MSL.

Shallow Water-Bearing Zone
The shallow water-bearing zone across the majority of the site consists of 5 to 20 feet of variable fill material and/or native silty clay overlying up to 40 feet of highly fractured and weathered Kokomo Limestone. Groundwater flow in the upper-water bearing zone is toward the creeks and the water table generally follows surface topographic features. The shallow water-bearing zone wells tend to be the most prolific groundwater producers of the three zones with estimated discharge rates up to over 20 gallons per minute (gpm). Although high hydraulic conductivities are observed in the shallow water-bearing zone, hydraulic conductivities vary significantly with location. The variability in hydraulic conductivities observed in monitoring wells screened within a single water-bearing zone is dependent on factors including: 1) whether wells intersect a water-bearing fracture, 2) whether wells intersect water-bearing bedding plane fractures, and 3) how well the intersected fracture system is developed.

Intermediate Water-Bearing Zone
The intermediate water-bearing zone consists of up to 60 feet of fine grained argillaceous (contains clay minerals) limestone. The intermediate water-bearing zone consists of the lower 10 feet of the Kokomo Limestone and the Liston Creek Limestone below. Wells completed in this water-bearing zone tend to produce less water than those completed in the shallow and lower water-bearing zones.

Flow is dependent on open connected fractures. As a result, a combination of the fine grained nature of the limestone and paucity of open fractures result in lower yielding wells. Significant fractures are widely spaced (greater than 100 feet between fractures) and tend to be narrow with little or no evidence of dissolution along fractures. Bedding plane fractures tend to be more widely spaced (.75 to 3 feet) and tighter than observed in the overlying Kokomo Limestone. Communication between the shallow and intermediate zones likely varies with location. Water level

fluctuations in monitoring wells may be an indication that secondary porosity is well developed in the bedrock along the creeks and that secondary porosity development may extend into the intermediate water-bearing zone.

Lower Water-bearing Zone

The lower water-bearing zone consists of the lower 10 to 20 feet of the Liston Creek Limestone. The lower water-bearing zone also includes the upper 5 to 20 feet of the Mississinewa Shale. This water-bearing zone consists of well-developed bedding plane fractures which have been "weathered" by groundwater flow along the top of the Mississinewa Shale - the lower less permeable unit. Wells completed in this zone generally produce more water than the intermediate water-bearing zone and less than the shallow water-bearing zone. The thickness and development of this zone varies with location. Poorly completed private or industrial wells may be a possible contaminant migration pathway to this zone.

Vertical hydraulic gradients have been qualitatively measured at nested well site locations across the site. Due to the heterogeneous nature of the water-bearing units and the variable hydraulic conductivities with depth, quantitative gradients could not be calculated. Vertical gradients vary both in direction and magnitude with location and depth and can not be applied across the site for great distances. Vertical gradients, therefore are discussed in Section 4 by area due to these local variances.

2.3 References

Camp Dresser & McKee Inc. (CDM), 1995a. *Continental Steel Superfund Site Focused RI/FS Work Plan.*

Fenelon, J. M., K. Bobay, and others. 1994. *Hydrogeologic Atlas of Aquifers in Indiana.* U.S. Geological Survey, Water-Resources Investigations Report 92-4142. Indianapolis, IN.

Shaver, Robert H. 1961. *Stratigraphy of the Silurian Rocks of Northern Indiana,* Geological Survey, Indiana Department of Conservation, Bloomington, Indiana.

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Section Three

Section 3
Characterization of Adjacent Industrial Properties

The objective of this section is to identify areas surrounding the Continental Steel Superfund Site (CSSS) which may have a current or historical impact on environmental media in and around the CSSS. Evaluation and identification of potential sources is important to understanding contaminant distributions and ultimately for remediation or control of source areas. Without the identification of all potential sources of environmental impact, remediation goals based solely on known sources of contamination from the CSSS may not be achievable. It is not within the scope of this Remedial Investigation (RI) to fully characterize the nature and extent of potential contamination identified at other industrial areas near the CSSS. The other industrial areas of interest include the former Continental Steel Fence Plant (currently Syndicate Sales, Inc.); the former Continental Steel Engineering Building (currently Ellis Cartwright Auctioneers); Haynes International, Inc. Park Avenue Operations (formerly Cabot Corporation); Haynes International, Inc. Defenbaugh Street Operations; the City of Kokomo's wastewater treatment plant; a PSIEnergy substation (formerly Public Service Indiana); and the Dixon Road quarry currently owned by Mohr Construction. These areas of interest were originally identified in Section 2.2 of the Continental Steel Superfund Site Focused RI/FS Work Plan (CDM 1995a). Environmental impact within the area of concern resulting from other potential sources outside the immediate study area have also been reviewed and are discussed in this section. **Figure 3-1** illustrates the locations and approximate boundaries of the areas of interest discussed in this section. Included as **Appendix A** is an ERIIS Property Record Report for the Continental Steel Property (EDR 1996). This report includes information concerning facilities around Continental Steel not discussed within the text of this memorandum.

3.1 Activities

For each of the industrial facilities identified in Section 3.1, a records search was performed to support or refute the possibility that the facility impacted environmental media in the area of the CSSS. The following items and files were reviewed for information and records:

- Sanborn Maps
- Historical Aerial Photographs
- State Spills - IDEM
- UST/LUST - IDEM
- RCRA - IDEM
- NPDES - IDEM
- SARA Title III - IDEM
- TSCA - IDEM
- Indiana State Board of Health
- Indiana Department of Natural Resources - Division of Fisheries

- Howard County Local Emergency Planning Committee
- Kokomo Fire Department
- Howard County Health Department

3.1.1 Former Continental Steel Fence Plant

The former Fence Plant is located north of West Markland Avenue between Lindsay and Brandon Streets and comprises approximately 11 acres (**Figure 3-2**). The former Fence Plant consists of four buildings which were used by Continental Steel for the production of weaved wire fence, barbed wire and bale ties. This building was sold and is currently a distribution warehouse for Syndicate Sales Inc. Soil sampling and analysis for the former Fence Plant area were contracted by IDEM in July 1992. The results of this study indicated that fill materials and soils at the former Fence Plant were contaminated with volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and metals. Upon review of the report, IDEM ordered further sampling to determine if the current owner of the property, Just-D Limited Partnership (Just-D) should be permitted to build on the site. The results of IDEM's sampling led to the conclusion that Just-D should be informed of the potential for a soil investigation and possibly soil remediation, and that any construction performed would be at their own risk.

3.1.1.1 Sanborn Maps

The former Fence Plant property was drawn on 1927, 1948, and 1965 Sanborn Maps among those reviewed dated 1889 through 1965. Only a portion of the former Fence Plant property was shown in 1965 bordered by South Lindsay Street, South Leeds Street, West Markland Avenue, and West Harrison Street. Within this area, a potential source of VOCs was identified as the Fence Plant Machine Shop located in the south central end of the building.

3.1.1.2 Historical Aerial Photographs

The historical aerial photographs reviewed displayed the progressive growth of the former Fence Plant. In a 1938 photograph, the former Fence Plant consisted of a single building (Bldg. 65) bordered by South Lindsay Street, South Leeds Street, West Markland Avenue, and Fowler Street. A 1951 photograph reveals an addition onto the original structure's east side extending beyond Fowler Street to the north. An addition was added to the north end of Building 65 by 1964. By 1972, the four buildings comprising the former Fence Plant were complete. Little change is visible between 1972 and 1989.

3.1.1.3 Regulatory Records

Regulatory records maintained by various local and state agencies were reviewed to identify facility chemical inventories as well as minor to significant industrial spills, leaks and releases.

3.1.1.3.1 State Spill Records

State of Indiana Spill Records were reviewed at IDEM. Continental Steel was the responsible party for numerous pollutant spills and releases as documented by the state. However, there is no indication that any spill or release originated from the former Fence Plant while in operation and while under the ownership of Continental Steel or its known predecessors.

Under the ownership of Just-D Limited Partnership, there are no records of spills at the former Fence Plant. Records reviewed include those maintained under the names of Just-D Ltd., Just-A-Wee Corporation and Syndicate Sales, Incorporated.

3.1.1.3.2 Underground Storage Tank/Leaking Underground Storage Tank (UST/LUST)

No State of Indiana UST/LUST records are available at IDEM for the former Fence Plant under the names of Continental Steel, Just-D Ltd., Just-A-Wee Corp., or Syndicate Sales, Inc..

In a Phase I Assessment performed by SJLudlow Consulting Engineers, Inc. (1992a) for Fortune Management, a discussion of UST/LUST locations on properties surrounding the former Continental Steel Engineering Building identified the existence of three USTs at Syndicate Sales, Inc. (former Fence Plant). This information may be erroneous in that the USTs identified were most likely located at the Syndicate Sales, Inc. facility on 2025 North Wabash Street, more than 2 miles north of the former Fence Plant. A UST System Closure Report (July 21, 1995) for the Syndicate Sales - North Wabash Street facility identified the existence and ultimate removal of three USTs. Attempts to contact Syndicate Sales, Inc. management to confirm the absence of USTs at the former Fence Plant location were unsuccessful.

3.1.1.3.3 Resource Conservation and Recovery Act (RCRA)

No RCRA hazardous waste generator permits or records of action taken against Continental Steel specific to the Fence Plant (including closures and post closure monitoring) were found at IDEM. No RCRA information pertaining to the former Fence Plant was found under the names of Just-D Ltd., Just-A-Wee Corp., or Syndicate Sales, Inc.

3.1.1.3.4 National Pollutant Discharge and Elimination System (NPDES)

No records of NPDES permits and permit violations were found specific to the former Fence Plant under the names of Continental Steel, Just-D Ltd., Just-A-Wee Corp., or Syndicate Sales, Inc..

3.1.1.3.5 Superfund Amendments and Reauthorization Act (SARA) Title III

Review of the Syndicate Sales, Inc. 1995 Tier Two Emergency and Hazardous Chemical Inventory revealed formaldehyde, hexane, pentane, phenol, sulfuric acid, and phenolsulfonic acid in reportable quantities at the former Fence Plant. No records were found under the names of Continental Steel, Just-D Ltd., or Just-A-Wee Corp.

3.1.1.3.6 Toxic Substances Control Act (TSCA)

A Low-level Polychlorinated biphenyl (PCB) Waste Disposal Approval notice was found at IDEM for Just-D Limited Partnership regarding the off-site disposal of 500 tons of wood block flooring containing less than 50 parts per million (ppm) PCBs. The wood blocks were a part of the original flooring for the Continental Steel Fence Plant. The blocks were approximately ten inches long by three inches wide by two inches thick and were coated with creosote as a precaution against fire. The original source of the PCB contamination was not identified. Test results for wood block sampling at the former Fence Plant indicated PCB contamination of 13 milligrams per kilogram (mg/kg) for Aroclor-1248. For Aroclor-1242 contamination was detected at 14 mg/kg. The toxicity characteristic leaching procedure (TCLP) extraction revealed lead contamination at 1.2 milligrams per liter (mg/l). There was no record of other areas sampled for PCB content including walls, drains and sumps.

3.1.1.3.7 Indiana State Board of Health

According to the Indiana State Board of Heath, no records of chemical spills or releases are maintained at this office. All past records were kept with IDEM after its creation and separation from the State Board of Health.

3.1.1.3.8 Indiana Department of Natural Resources (IDNR) - Division of Fisheries

According to the IDNR - Division of Fisheries, any IDNR record documenting fish kills would also be documented by IDEM - Emergency Response Branch. Both departments typically investigate water related incidents concurrently.

3.1.1.3.9 Howard County Local Emergency Planning Committee

According to Mr. Larry Smith, Chairman, Local Emergency Planning Committee, no records are maintained for spills or releases of environmental contaminants.

3.1.1.3.10 Kokomo Fire Department

According to Mr. Dave Duncan, Assistant Fire Chief, Kokomo Fire Department, no specific records are kept documenting spills or releases of environmental contaminants.

3.1.1.3.11 Howard County Health Department

According to the Howard County Health Department, no records are maintained for spills or releases of environmental contaminants.

3.1.1.4 Potential Environmental Impacts by the Former Fence Plant

Potential environmental impacts may be difficult to differentiate from those impacts contributed by Markland Avenue Quarry and the Continental Steel Main Plant. Environmental media impacted around the site may include surface and subsurface soils as well as groundwater. Results of a 1990

ERM-Midwest, Inc. (ERM) subsurface soil investigation performed at the former Fence Plant for Just-A-Wee Corporation indicate elevated detectable levels of chromium (range 26 to 571 ppm) and lead (32 to 130 ppm) in the fill beneath Building 65. Elevated levels of a variety of PAHs were detected; however, no VOCs or PCBs were detected.

Results from the ERM study of the east parking lot of the former Fence Plant indicate areas of localized contaminants including: methylene chloride [9 parts per billion (ppb) (4.0 to 4.2 ft.)]; toluene [6 ppb (6.0 to 6.7 ft.)]; trichloroethene [10 ppb (4.0 to 4.2 ft.)]; trichloroethene [27 ppb (30.0 to 32.0 ft.)]; phenanthrene [580 ppb (4.0 to 6.0 ft.)]; chromium [718 ppb (0.0 to 2.0 ft. depth)]; chromium [1,200 ppm (4.0 to 4.2 ft.)]; and lead [310 ppm (0.0 to 2.0 ft.)]. No PCBs were detected in soil samples (ERM 1990).

ERM performed additional soil and air sampling in 1992 for Just-D Limited Partnership at the former Fence Plant. The sampling results are consistent with those obtained during the 1990 ERM investigation. No PCBs were detected in the soil samples.

The former Fence Plant is a known source of PCBs as identified after testing and disposal of it's wood block flooring. The actual PCB source may have been heavy lubricating oils for machinery in the plant. The PCB contaminated oils do not appear to have migrated into the soils beneath and surrounding the former Fence Plant. PCBs generally have limited mobility through soil. There is no mention of sampling being performed in any existing sewers, sumps, or catch basins near or under the PCB contaminated wood block floor before or after its removal. The former Fence Plant may also have been a source of other contaminants such as VOCs, PAHs and metals. VOCs, although not detected beneath the former Fence Plant, are expected to have been present in solvents used in the machine shop. With the extensive use of oils expected for machine upkeep, a detectable quantity of PAH contamination would also be anticipated. This is supported by the findings of the ERM-Midwest, Inc. (1990, 1992) studies. The levels of chromium detected under the parking lot and former Fence Plant are consistent with those found around buildings of the Main Plant. Due to the nature of the processing at the Main Plant, it may be the most likely source of the chromium at the former Fence Plant.

3.1.2 Former Continental Steel Engineering Building

The former Engineering Building is located north of West Markland Avenue between South Park Avenue and the former South Phillips Street (**Figure 3-2**). The former Engineering Building consists of one building which was used by Continental Steel for office space, document storage and potentially for storage of various industrial process materials. Previous owners of the building include Indiana Railway and Light Company (transfer date - 1922), Northern Indiana Power Company (transfer date - 1941), and Public Service Company of Indiana, Incorporated (transfer date - 1958). Use of the building by these owners may have included trolley motor maintenance, electrical transformer maintenance and material storage (Kauble 1996). Mr. Matthew Gentry purchased the former Engineering Building at the Continental Steel bankruptcy auction. Mr. Gentry transferred ownership of the property to Ellis Cartwright Auctioneers in 1992. The building is currently used as an office and auction house.

3.1.2.1 Sanborn Maps

The former Engineering Building property was drawn on 1916, 1927, 1948, 1965 and Sanborn Maps among those reviewed dated 1889 through 1965. The 1916 and 1927 maps depict the former Engineering Building as two separate structures. There is no evidence of environmental impact on these maps.

3.1.2.2 Historical Aerial Photographs

The earliest historical aerial photograph reviewed taken in 1938 showed the former Engineering Building as a single structure with an addition onto the east half of the building. Little change to the former Engineering Building is visible between 1951 and 1989 although the immediate property surrounding the building has undergone extensive development.

3.1.2.3 Regulatory Records

Regulatory records maintained by various local and state agencies were reviewed to identify facility chemical inventories as well as minor to significant industrial spills, leaks, and releases.

3.1.2.3.1 State Spill Records

State of Indiana Spill Records were reviewed at IDEM. Continental Steel was the responsible party for numerous pollutant spills and releases as documented by the state. However, there is no indication that spills or releases originated from the former Engineering Building while under the ownership of Continental Steel or other current, recent, or past owners.

3.1.2.3.2 Underground Storage Tank/Leaking Underground Storage Tank (UST/LUST)

No State of Indiana UST/LUST records are available at IDEM for the former Engineering Building under the names of Continental Steel, Indiana Railway and Light Company, Northern Indiana Power Company, Public Service Company of Indiana, Incorporated, Mr. Matthew Gentry or Ellis Cartwright Auctioneers. A Phase I Environmental Site Assessment (ESA) performed by SJLudlow Consulting Engineers, Inc. (SJLudlow) for Mr. Gentry in 1992 stated the former Engineering Building contained three 1,000 gallon USTs for boiler fuel oil (1992a). While under ownership of Public Service of Indiana, the former Engineering Building may have been used to service electrical transformers. One or more of the USTs may have been used to store PCB oil for the transformers (Kauble 1996). According to the SJLudlow Phase I ESA, the USTs were removed prior to 1974 (1992a). During a follow-up Phase II ESA, a sample collected from fill at the approximate base of the former USTs by SJLudlow was analyzed for total petroleum hydrocarbons (TPH). Analytical test results and photoionization detector (PID) readings (during drilling) did not indicate the presence of petroleum hydrocarbon contamination in the vicinity of the former USTs (SJLudlow 1992b).

3.1.2.3.3 Resource Conservation and Recovery Act (RCRA)

No RCRA hazardous waste generator permits or records of action taken against Continental Steel specific to the former Engineering Building (including closures and post closure monitoring) were

found at IDEM. No RCRA information pertaining to the former Engineering Building was found under the names of Indiana Railway and Light Company, Northern Indiana Power Company, Public Service Company of Indiana, Incorporated, Mr. Matthew Gentry, or Ellis Cartwright Auctioneers.

3.1.2.3.4 National Pollutant Discharge and Elimination System (NPDES)

No records of NPDES permits and permit violations were found specific to the former Engineering Building under the names of Continental Steel, Indiana Railway and Light Company, Northern Indiana Power Company, Public Service Company of Indiana, Incorporated, Mr. Matthew Gentry, or Ellis Cartwright Auctioneers.

3.1.2.3.5 Superfund Amendments and Reauthorization Act (SARA) Title III

No information under SARA Title III was found specific to the former Engineering Building for Continental Steel, Indiana Railway and Light Company, Northern Indiana Power Company, Public Service Company of Indiana, Incorporated, Mr. Matthew Gentry or Ellis Cartwright Auctioneers.

3.1.2.3.6 Toxic Substances Control Act (TSCA)

No information under TSCA was found specific to the former Engineering Building for Continental Steel, Indiana Railway and Light Company, Northern Indiana Power Company, Public Service Company of Indiana, Incorporated, Mr. Matthew Gentry, or Ellis Cartwright Auctioneers. While under the ownership of Public Service of Indiana, the former Engineering Building may have been used for servicing PCB-containing transformers and for storage of PCB oil (Kauble 1996).

3.1.2.3.7 Indiana State Board of Health

According to the Indiana State Board of Heath, no records of chemical spills or releases are maintained at this office. All past records were kept with IDEM after its creation and separation from the State Board of Health.

3.1.2.3.8 Indiana Department of Natural Resources (IDNR) - Division of Fisheries

According to the IDNR - Division of Fisheries, any IDNR record documenting fish kills would also be documented by IDEM - Emergency Response Branch. Both departments typically investigate water related incidents concurrently.

3.1.2.3.9 Howard County Local Emergency Planning Committee

According to Mr. Larry Smith, Chairman, Local Emergency Planning Committee, no records are maintained for spills or releases of environmental contaminants.

3.1.2.3.10 Kokomo Fire Department

According to Mr. Dave Duncan, Assistant Fire Chief, Kokomo Fire Department, no specific records are kept documenting spills or releases of environmental contaminants.

3.1.2.3.11 Howard County Health Department

According to the Howard County Health Department, no records are maintained for spills or releases of environmental contaminants.

3.1.2.4 Potential Environmental Impacts by the Former Engineering Building

Potential environmental impacts may be difficult to differentiate from those impacts contributed by the Continental Steel Main Plant and other industrial facilities surrounding the former Engineering Building. The environmental media potentially impacted around the site would include subsurface soils and groundwater. The integrity of the USTs removed from the building is not known. If it is assumed that spills or leaks of fuel oil occurred, then the contaminant expected would be elevated levels of a variety of semivolatile organic compounds (SVOCs). The SJLudlow Phase II ESA field VOC screening and sample analyses for TPH confirmed the absence of detectable VOCs and TPHs in the fill material at the approximate base of the former fuel oil USTs (1992b). The only elevated soil contaminant detected during TCLP extraction was barium at a level said to be significantly less than the 100 ppm maximum contaminant level (MCL) (SJLudlow 1992b).

The Phase II ESA performed by SJLudlow also included an abbreviated groundwater study. A monitoring well was installed at the southeast corner of the former Engineering Building from which groundwater samples were collected. Results of the analytical tests indicated elevated levels of the following constituents: chloroform (5.1 micrograms per liter (µg/l); 1,1,1-trichloroethane (2.6 µg/l); trichloroethene (39 µg/l); and barium (0.06 mg/l) (SJLudlow 1992b). The contaminants can most likely be attributed to environmental impacts from facilities other than the former Engineering Building.

3.1.3 Haynes International, Inc. Park Avenue Operations

The Haynes International Park Avenue Operations (formerly owned and operated separately by Cabot Corporation, Union Carbide and Carbon Corporation) was encompassed by West Markland Avenue, South Park Avenue, and Phillips Street (**Figure 3-2**). The majority of the buildings were demolished, but several buildings remain near the intersection of West Markland Avenue and Lindsay Street. The Park Avenue Operations manufactured metal alloys. It is not clear when ownership of the original Haynes Satellite operation (Union Carbide and Carbon Corp.) was transferred to Cabot Corporation. Ownership of this plant was transferred to Haynes International Inc. from Cabot Corp. in the early 1970's and was closed by the mid 1970's. The area around the former foundry is no longer used for manufacturing operations. The Cabot Corporation High Technology Materials Division was listed on Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) as requiring no further remedial action until February 1995 when it was delisted along with approximately 25,000 sites nationwide as part

of the U.S. EPA's Brownfields Redevelopment Program. The exact Cabot property formerly listed on CERCLIS is unclear in the documentation reviewed.

The Haynes International Park Avenue Operations also included the Haynes Technology Group located on the north side of Park Avenue between Phillips Street and the Haynes International Corporate Headquarters (**Figure 3-2**). The Technology Group continues to construct and operate pilot scale operations for all processes prior to production at the Defenbaugh Street Operations according to Haynes management.

3.1.3.1 Sanborn Maps

The Park Avenue property was drawn on 1896, 1902, 1909, 1927, 1948 and 1965 Sanborn Maps among those reviewed dated 1889 through 1965. Various areas of the plant property were shown individually bordered by South Lindsay Street, South Park Avenue, West Markland Avenue, or old Phillips Street. Within these areas, the foundry (labeled as the Haynes Stellite Co.) was in existence between 1927 and 1965. The 1896 map displays the north half of the property as being utilized by the Gennebeck and Son Canning Company in 1896. The canning facility was described as the Howard County Canning Company in 1902 and as the Kokomo Canning Company in 1909.

No information is available for the canning companies once located on the Park Avenue Operations property to identify them as potential sources of contamination.

Areas of the Park Avenue Operation foundry which may have contributed to environmental impacts include the machine shop, maintenance shop, truck garage, print shop, transformer room, and foundry as depicted on the 1965 Sanborn map.

3.1.3.2 Historical Aerial Photographs

The historical aerial photographs reviewed display the progressive growth of the Park Avenue Operations. In a 1938 photograph, the Park Avenue Operations occupies the northern half of the property between Markland Avenue and Park Avenue. A 1951 photograph first reveals the development of the entire property. An area immediately north of the former Engineering Building appears to have been used as open storage for mounds of unidentifiable loose material and debris. Little difference is noted between the photographs taken between 1951 and 1987 (**Figure 3-3**). A 1989 photograph shows the beginning of structural demolition on the north half of the property.

3.1.3.3 Regulatory Records

Regulatory records maintained by various local and state agencies were reviewed to identify facility chemical inventories as well as minor to significant industrial spills, leaks and releases.

3.1.3.3.1 State Spill Records

State of Indiana Spill Records were reviewed at IDEM. Haynes International and the former Cabot Corporation were named as the responsible party for a number of spills and releases having an impact on the environment. Despite the address on some reports specifying incidents occurring at

the Park Avenue Operations, it has been determined that the address is erroneous and that all the incidents noted occurred at the Defenbaugh Street Operations. Documented follow-up communications with Haynes International management in addition to descriptions in the reports of spill sources, near-by facility buildings, affected outfalls, and creek tributaries support this conclusion.

3.1.3.3.2 Underground Storage Tank/Leaking Underground Storage Tank (UST/LUST)

State of Indiana UST/LUST records were reviewed at IDEM for the Park Avenue Operations. A 1986 Notification for USTs was found documenting two out of service tanks. The tanks were installed in approximately 1961, the first being a 1,000 gallon capacity gasoline tank and the other a 2,000 gallon capacity diesel fuel tank. Both tanks were closed and filled in place in 1974. No verification sampling results were available. In a letter from Haynes International to IDEM dated November 28, 1990, Haynes notified the state that it no longer owns or operates USTs in Kokomo, Indiana.

3.1.3.3.3 Resource Conservation and Recovery Act (RCRA)

Prior to the mid-1980's, Haynes International (Cabot Corporation) maintained a single EPA facility identification number as a large quantity generator for both the Park Avenue Operations and the Defenbaugh Street Operations. As a result, one RCRA permit covered both facilities causing difficulty in identifying the origin of generated hazardous wastes. The following wastes may have been generated at either location.

According to a 1980 RCRA Hazardous Waste Permit Application filed by Cabot Corporation, the estimated waste to be generated includes by listing number: 900 pounds K054 (no description available); 400 pounds D002 (corrosive waste); 100 pounds D001 (ignitable waste); 5 tons D002 (salt tank sludge); 225 tons D007 (chromium contaminated wastewater treatment plant (WWTP) sludge); 5,850 tons D007 (chromium contaminated slag); 360 tons D007 (chromium contaminated dust collector fines); 80,000 tons D007 (chromium contaminated wastewater); 156 tons D007 (chromium contaminated waste acid); 715 tons D007 (chromium contaminated misc. grindings); 180 tons F001 (1,1,1-trichloroethane); and 4 tons F002 (1,1,1-trichloroethane sludge). A 1981 RCRA form was modified to combine like wastes and to delete wastes covered under other permits.

In a State of Indiana 1987 Facility Annual Report, hazardous wastes sent to other facilities included the following approximated amounts: 349 tons D007 (chromium contaminated alloy pickling wastewater treatment sludge); 143 tons D007 (chromium contaminated bag house dust); 9 tons D001 (ignitable waste petroleum naphtha); 24 tons D002/D007 (corrosive, chromium contaminated spent pickle liquor); 19 tons F001 (waste 1,1,1-trichloroethane); 207 pounds F002 (petroleum distillates, 30% perchloroethylene); 8 tons D001/F001 (ignitable automotive oils, 10% 1,1,1-trichloroethane); 946 pounds P030 (waste printers conversion solution); and 600 pounds F001 (waste methylene chloride). Within a U.S. EPA inspection summary the following statement was made, "Cabot [Defenbaugh Street Operations] receives spent solvent from their Lindsay Street operation approximately twice per year. The solvent is placed in their 'Less than 90-day Accumulation Area' and stored for less than 10 days."

There is no documentation of RCRA violations specific to the Haynes International Park Avenue Operations.

3.1.3.3.4 National Pollutant Discharge and Elimination System (NPDES)

No records of NPDES permits or permit violations were found in IDEM NPDES files specific to the Haynes International Park Avenue Operations. Haynes did utilize two outfalls from the Park Avenue Operations facilities into Wildcat Creek until 1984.

3.1.3.3.5 Superfund Amendments and Reauthorization Act (SARA) Title III

Review of the Haynes International 1994 Tier Two Emergency and Hazardous Chemical Inventory revealed cobalt, nickel, chromium, hydrofluoric acid, nitric acid, sulfuric acid, argon, hydrogen and oxygen in reportable quantities. The location given on the inventory was specific to the Defenbaugh Street Operations; however since the Technology Group operates a pilot scale process for each process at the DSO, it can be assumed that lesser quantities of these materials exist(ed) at the Park Avenue Operations Technology Group facility.

3.1.3.3.6 Toxic Substances Control Act (TSCA)

A Complaint and Notice of Opportunity for Hearing, dated 1988, was sent to Haynes International by the U.S. EPA. Six separate violations involving PCBs were alleged to have occurred at the Park Avenue Operations Technology Group facility. Count I. involved inadequate record keeping for PCB containers, transformers and large capacitors. Count II. described the existence of a 62-foot long utility trench, three feet wide and three feet deep containing six inches of water and a half-inch layer of PCB laden oil. The PCB concentration in the oil was 4,400 ppm. Count III. pertained to Haynes International's failure to register its PCB transformers with the local fire department. Count IV. described PCBs used in a system not totally enclosed as required by law. Counts V. and VI. pertained to Haynes International's failure to meet the storage and labeling requirements for PCB oil, PCB contaminated debris and transformers.

A Consent Agreement and Final Order from the U.S. EPA dated March 1989 lists the activities performed by Haynes International to mitigate the allegations of each complaint. The utility trench is reported to have been cleaned-up and encapsulated. Verification sampling is reported to have been below 100 $\mu g/100\ cm^2$. No actual sampling results or remedial methods were provided.

3.1.3.3.7 Indiana State Board of Health

According to the Indiana State Board of Heath, no records of chemical spills or releases are maintained at this office. All past records were kept with IDEM after its creation and separation from the State Board of Health.

3.1.3.3.8 Indiana Department of Natural Resources (IDNR) - Division of Fisheries

According to the IDNR - Division of Fisheries, any IDNR record documenting fish kills would also be documented by IDEM - Emergency Response Branch. Both departments typically investigate water related incidents concurrently.

3.1.3.3.9 Howard County Local Emergency Planning Committee

According to Mr. Larry Smith, Chairman, Local Emergency Planning Committee, no records are maintained for spills or releases of environmental contaminants.

3.1.3.3.10 Kokomo Fire Department

According to Mr. Dave Duncan, Assistant Fire Chief, Kokomo Fire Department, no specific records are kept documenting spills or releases of environmental contaminants.

3.1.3.3.11 Howard County Health Department

According to the Howard County Health Department, no records are maintained for spills or releases of environmental contaminants.

3.1.3.4 Potential Environmental Impacts by the Haynes International, Inc. Park Avenue Operations

The Park Avenue Operations including all property north of West Markland Avenue has had in the past and presently continues to have the potential to impact the environment around Continental Steel. Environmental media impacted may include surface soils, subsurface soils, groundwater, and Wildcat Creek. Specific potential sources of contaminants include the machine shop at the former Cabot foundry where solvents would be expected. PCBs were known to have been present at the Technology Group facility where contaminated oils were in direct contact with subsurface soil. The area around the transformer room at the former Cabot foundry identified on the Sanborn Maps is a potential source of PCBs as well. Since all processes at the Defenbaugh Street Operations were performed at pilot scale at the Technology Group facility, VOCs and metals would be expected. The foundry would have been a source for VOCs and metals as well. All of these contaminants may have appeared in stormwater exiting outfalls into Wildcat Creek potentially impacting that environment as well.

3.1.4 Haynes International, Inc. Defenbaugh Street Operations

Haynes International, Inc. Defenbaugh Street Operations (DSO) manufactures billet, sheet, plate and wire made of high performance nickel and cobalt-based alloys. Haynes International, Inc. DSO is located on two properties, one north and one south of Defenbaugh Street southwest of the Lagoon Area (**Figure 3-1**). Two landfills are located at the DSO. The landfill located on the south side of the plant contains waste sludge from the Haynes wastewater treatment plant (WWTP). This landfill achieved RCRA closure status in 1989. The landfill design includes a clay cap and a leachate collection system within drainage layer constructed on natural clay till. The second landfill is

located on the north side of the plant along Wildcat Creek. This landfill was used primarily for the disposal of slag, foundry sand, construction debris, refractures and abrasives and metal-bearing lime sludge. RCRA corrective actions have consisted of mining the landfill for recyclable materials, stockpiling the residual material on the unmined portion of the landfill installation of a bottom clay liner and leachate collection system, refilling and contouring the landfill and closing the landfill with a clay cap. Haynes International reportedly now disposes of their hazardous waste off-site.

3.1.4.1 Sanborn Maps

The Defenbaugh Street Operations property was not drawn on any Sanborn Maps among those reviewed dated 1889 through 1965.

3.1.4.2 Historical Aerial Photographs

The historical aerial photographs reviewed display the progressive growth of the Defenbaugh Street Operations. In a 1938 photograph, the property located where the current DSO-North landfill currently resides shows quarries owned by Continental Steel. The property was purchased from Continental Steel (no date) according to a historical property description by Haynes International in a 1988 RCRA Closure document (document # 10.4/88.04344). The DSO first appears in a 1951 photograph. The quarry at the north end of the property is water-filled. A 1957 photograph shows several new structures. A dramatic increase in structures and land use around the current DSO-North landfill is shown in a 1964 photograph. Between 1974 and 1978, photographs show the quarry is filled in as are the lagoon beds. By 1987, the DSO-North landfill has grown significantly in height since the previous photograph. No photographs reveal the development of the DSO-South landfill.

3.1.4.3 Regulatory Records

Regulatory records maintained by various local and state agencies were reviewed to identify facility chemical inventories as well as minor to significant industrial spills, leaks, and releases.

3.1.4.3.1 State Spill Records

State of Indiana Spill Records were reviewed at IDEM. Haynes International and the former Cabot Corporation were named as the responsible party for a number of spills and releases having an impact on the environment. A spill of PCB contaminated oil from a transformer occurred in 1982. The release was contained and cleaned-up. Its impact to the environment was minimal yet the incident served as documentation of PCB use at the facility. In 1983, an undisclosed amount of pickling rinse water was released to an outfall emptying into Wildcat Creek. The rinse water contained 12.5 ppm hexavalent chromium. A release of an unknown quantity of 3% water soluble oil occurred in 1984. The oil was mixed with stormwater and discharged into Kitty Run which in turn empties into Wildcat Creek. A similar incident occurred that same year releasing 1,500 gallons of 3% water soluble oil. Five hundred gallons of the oil was thought to have entered Wildcat Creek before cleanup. Other minor incidents were documented.

3.1.4.3.2 Underground Storage Tank/Leaking Underground Storage Tank (UST/LUST)

State of Indiana UST/LUST records were reviewed at IDEM for the Defenbaugh Street Operations. A 1986 Notification for USTs was found documenting four tanks in service. The oldest tank was installed around 1971 with a 2,000 gallon capacity for used oil. An 8,000 gallon tank was installed around 1981 for hydraulic oil storage. Two other tanks were installed around 1983 with 1,000 and 2,000 gallon capacities for gasoline storage. After removal of the 2,000 gallon used oil tank in 1989, laboratory results from samples collected from the tank location indicated a maximum hydrocarbon contamination of 22,100 mg/kg. Twenty-five cubic yards of contaminated soil were removed as a result of the LUST. In 1990 the remainder of the USTs were removed from the ground at the DSO. In a letter from Haynes to IDEM dated November 28, 1990, Haynes notified the state that it no longer owns or operates USTs in Kokomo, Indiana.

3.1.4.3.3 Resource Conservation and Recovery Act (RCRA)

See Section 3.1.3.3.3 for waste generated by Haynes International.

Two landfills were operated at the Defenbaugh Street Operations and fell under the jurisdiction of RCRA after the promulgation of RCRA Interim Status Regulations. Both landfills received hazardous wastes described below and have undergone RCRA closure and post-closure monitoring.

DSO-North Landfill
The DSO-North landfill was placed into service around 1948. It consists of property purchased from Continental Steel. Approximately 3 acres of the site had been backfilled with slag to a depth of 5 to 20 feet by Continental Steel. The original landfill began as several pickling waste treatment ponds with solid waste disposal activities run concurrently between ponds. The ponds were used for solid waste disposal after the construction of the plant's wastewater treatment facility in 1972. The majority of the waste was non-hazardous with the exception of small amounts of hazardous Air Melt Shop flue dusts disposed of between 1963 and 1985. Hazardous and non-hazardous flue dusts were buried separately after 1982. Separated hazardous flue dust was exhumed and recycled in 1985.

Content of the DSO-North landfill has been determined to include several hazardous constituents. The original pond bottoms were found to contain nickel, trivalent chromium, and hexavalent chromium bearing sludge (D007 waste). The Air Melt Shop flue dusts are dispersed throughout the landfill. Molten salt descaling tank sludge from the pickling process is also in the landfill. The landfill was operated as a single cell and therefore has no organized pattern of waste disposal. There is no documentation of an original clay liner; however, the landfill was maintaining a water level approximately ten feet above existing groundwater before closure activities.

Closure of the DSO-North landfill included the recovery of recyclable scrap metal through crushing and screening of waste materials. After scrap recovery was performed, the residual material was stockpiled on an unexcavated portion of the landfill. Excavated sections of the landfill were lined with a bottom clay liner and leachate collection system, refilled with residual waste material, recontoured to design grade, capped with clay, and seeded for erosion prevention.

As part of a post-RCRA closure agreement, Haynes International installed a mix of 14 monitoring wells and piezometers around the DSO-North landfill to monitor the migrational direction of potential contaminants from the landfill. Well construction data can be found in **Table 3-1**. Shallow groundwater flow around the landfill varies by season, yet trends to the north-northwest (**Figures 3-4A** and **3-4B**). Deeper groundwater flow direction is to the southwest (**Figures 3-5A** and **3-5B**).

Upgradient groundwater samples were collected in 1992 and 1993 from MW-4 (well depth at 32 feet) at the southeast corner of the DSO-North landfill. The following detected groundwater contaminants and their respective maximum concentrations include: 1,1-dichloroethane (4.0 ppb); tetrachloroethene (570 ppb); trichloroethene (162 ppb); fluoride (7,000 ppb); iron (1,370 ppb); manganese (140 ppb); nickel (160 ppb); sodium (529,000 ppb); and sulfate (258,000 ppb).

Downgradient groundwater samples were collected in 1992 and 1993 from monitoring wells located northeast and west of the DSO-North landfill. Well depths range from 16 feet to 84 feet. The following detected groundwater contaminants and their respective maximum concentrations include: 1,1,1-trichloroethane (610 ppb); 1,1-dichloroethane (149 ppb); 1,1-dichloroethene (40 ppb); tetrachloroethene (53,100 ppb); trichloroethene (13,940 ppb); chloroform (39 ppb); hexavalent chromium (139,000 ppb); fluoride (20,000 ppb); iron (5,200 ppb); manganese (1,340 ppb); nickel (1,230 ppb); and sulfate (1,250,000 ppb). Typically, the highest contaminants were found at the wells on the northwest corner of the landfill. Results from 1994 sampling events were similar to those described above.

DSO-South Landfill
The DSO-South landfill was constructed in 1973 to store sludge from the Haynes WWTP. The sludge consists of metallic-hydroxides, carbonates, and sulfates and is characterized as hazardous based on total chromium content. The landfill design includes an unlined excavation into natural silty clay soil filled with two to three feet of gravel and perforated plastic pipe. The pipe led to a central leachate collection system. The DSO-South landfill accepted approximately 365 cubic yards of waste per year until its closure in 1988. Closure included filling in areas to grade specifications, addition of a clay cap and seeding the enclosed unit.

There are 20 monitoring wells and piezometers around the general area of the DSO-South landfill to monitor the potential migration of contaminants from the landfill. Partial well construction data can be found in **Table 3-2**. According to 1994 groundwater directional flow maps submitted by Haynes International in compliance with RCRA Post Closure Permit conditions, shallow groundwater in the clayey till around the landfill trends to the northeast (**Figures 3-6A** and **3-6B**). Deeper groundwater flow direction is to the east (no figures available).

Upgradient groundwater samples were collected in 1992 and 1993 from SB-3, SP-4, and SP-8B along the west side of the DSO-South landfill. The following detected groundwater contaminants and their respective maximum concentrations include: barium (4.0 ppb); iron (300 ppb); manganese (270 ppb); and nickel (260 ppb).

Downgradient groundwater samples were collected in 1992 and 1993 from monitoring wells located on the northeast corner and east side of the DSO-South landfill. The following detected

groundwater contaminants and their respective maximum concentrations include: 1,1,1-trichloroethane (21,580 ppb); 1,1-dichloroethane (420 ppb); 1,1-dichloroethene (5,760 ppb); tetrachloroethene (55 ppb); trichloroethene (72 ppb); barium (1,750 ppb); chloroform (174 ppb); iron (8,400 ppb); manganese (470 ppb); nickel (150 ppb); and sulfate (1,117,000 ppb). Typically, the highest contaminants were found at the wells on the northeast corner of the landfill. Results from 1994 sampling events were similar to those previously described. No record was found documenting remedial actions for the groundwater contaminant exceedances.

The DSO-South landfill is not believed to be the source of the high levels of chlorinated solvents detected at its northeast corner according to a Geraghty & Miller, Inc. report submitted April 23, 1992. The area in question consists of a gravel pad formerly used as a storage area for drums of 1,1,1-trichloroethane (TCA). Geraghty & Miller, Inc. reported spills of TCA were not uncommon (1992). Previous studies defined the vertical extent of contamination as being within surficial clay groundwater. The horizontal extent of contamination was characterized by Geraghty & Miller, Inc. in 1992 using Geoprobe soil gas and groundwater analyses. According to the report, the contaminant plume was found not to have advanced beyond 150 feet down gradient of the source due to low horizontal and vertical permeabilities and shallow hydraulic gradients (**Figure 3-7**) (Geraghty & Miller 1992).

3.1.4.3.4 National Pollutant Discharge and Elimination System (NPDES)

In a 1984 NPDES permit for the Haynes International WWTP, the following daily maximum effluent discharge limitations into Wildcat Creek were recorded: 531 pounds total suspended solids, 7.6 pounds total chromium, 1.5 pounds hexavalent chromium, and 15.9 pounds total nickel. In a later permit, the effluent limitations were lowered to the following daily maximum levels: 23.6 pounds total suspended solids, 1.37 pounds oil and grease, 0.034 pounds cobalt, 0.372 pounds iron, 0.034 pounds total chromium, 0.034 pounds total copper, and 0.17 pounds total nickel. No NPDES violations were found. However, during a 1985 U.S. EPA Potential Hazardous Waste Site Preliminary Assessment performed by the Indiana State Board of Health, it was noted that effluent water samples collected on June 14, 1984, indicated high concentrations of nickel entering Wildcat Creek from Outfall #4 north of the DSO-North landfill. Trichloroethylene, PCE, chloroform, and 1,1-TCA were detected in elevated concentrations in effluent exiting Outfall #3 east of the DSO-North landfill during the same sampling event.

3.1.4.3.5 Superfund Amendments and Reauthorization Act (SARA) Title III

Review of the Haynes International 1994 Tier Two Emergency and Hazardous Chemical Inventory revealed cobalt, nickel, chromium, hydrofluoric acid, nitric acid, sulfuric acid, argon, hydrogen and oxygen in reportable quantities. The location given on the inventory was specific to the Defenbaugh Street Operations.

3.1.4.3.6 Toxic Substances Control Act (TSCA)

IDEM TSCA files were reviewed. No documentation specific to the Defenbaugh Street Operations was found. A State Board of Health report located in the state spill files documented the use of

PCBs in transformers at the DSO. PCB use was also documented in 1988 at the Park Avenue Operations when free PCB contaminated oil was found in a utility trench at the facility. According to the Environmental Risk Information & Imaging Services Property Record Report (ERIIS) prepared for CDM on January 11, 1996 by Environmental Data Resources, Inc. (EDR) (**Appendix A**), the DSO is currently listed on the PCB Activity Database System (PADS) as being a PCB generator, storer, transporter, or permitted disposer (EDR 1996).

3.1.4.3.7 Indiana State Board of Health

According to the Indiana State Board of Heath, no records of chemical spills or releases are maintained at this office. All past records were kept with IDEM after its creation and separation from the State Board of Health.

3.1.4.3.8 Indiana Department of Natural Resources (IDNR) - Division of Fisheries

According to the IDNR - Division of Fisheries, any IDNR record documenting fish kills would also be documented by IDEM - Emergency Response Branch. Both departments typically investigate water related incidents concurrently.

3.1.4.3.9 Howard County Local Emergency Planning Committee

According to Mr. Larry Smith, Chairman, Local Emergency Planning Committee, no records are maintained for spills or releases of environmental contaminants.

3.1.4.3.10 Kokomo Fire Department

According to Mr. Dave Duncan, Assistant Fire Chief, Kokomo Fire Department, no specific records are kept documenting spills or releases of environmental contaminants.

3.1.4.3.11 Howard County Health Department

According to the Howard County Health Department, no records are maintained for spills or releases of environmental contaminants.

3.1.4.4 Potential Environmental Impacts by the Haynes International Defenbaugh Street Operations

The two primary areas of concern at Haynes International Defenbaugh Street Operations revolve around the RCRA landfills located to the north and south of Defenbaugh Street. The DSO-North landfill has been shown to contribute a significant amount of chlorinated hydrocarbons and metals to groundwater contamination. Shallow groundwater flow at the DSO-North Landfill trends north (**Figure 3-4A**) to northwest (**Figure 3-4B**). Thus, shallow groundwater may contribute potential contaminants to Wildcat Creek. Note that analytical results from surface water and sediment samples collected from Wildcat Creek in the DSO-North landfill area are available as described in Section 4.4.5 (Kokomo and Wildcat Creeks). Deep bedrock groundwater flow trends to the southwest (**Figure 3-5A** and **3-5B**).

At the northeast corner of the DSO-South landfill, a source of chlorinated solvent and smaller amounts of metal contamination in groundwater has been identified as well. In both areas, the contamination is at levels that suggest the potential for Dense Non-Aqueous Phase Liquids (DNAPLs) to exist in the general areas.

Other areas of concern revolve around the process areas where chlorinated solvents and other potential contaminants have been frequently used and stored. Storage areas, degreasing processes and machine shops may be small sources of constituents contributing to an overall environmental impact by the Defenbaugh Street Operations facilities.

3.1.5 City of Kokomo Wastewater Treatment Plant

The City of Kokomo's wastewater treatment plant (WWTP) and sanitation utility is located just south of West Markland Avenue with the Lagoon Area bordering it to the west and Wildcat Creek to the east (**Figure 3-1**). The treatment plant recently has been expanded to a capacity of 23 to 24 million gallons per day (mgd), but is currently operating at 16 to 18 mgd. Currently, the city is revising its pretreatment standards, which now date back to the 1970's. The treatment plant is limited, however, by the fact that the City's sewers are combined storm and sanitary sewers. The combined sewer system greatly increases the potential for untreated wastewater to be discharged directly to Kokomo and Wildcat Creeks.

3.1.5.1 Sanborn Maps

The City of Kokomo's WWTP property was not drawn on any of the reviewed Sanborn Maps dated 1889 through 1965.

3.1.5.2 Historical Aerial Photographs

The historical aerial photographs reviewed displayed the progressive growth of the WWTP. A 1938 photograph is the first visual documentation of the facility. At that time, the facility consisted of four large tanks and three smaller tanks. By 1951, two lagoons were added south of the four large tanks. By 1957, two additional tanks were added to the northwest of the original four large tanks. A 1964 photograph revealed two more tanks added around the existing tanks. By 1972, the WWTP had increased to a total of 13 tanks and a series of five lagoons to the south of the tanks. A 1974 photograph revealed the addition of two lagoons and the backfilling of one existing lagoon. By 1978, in-ground aeration beds were added and several of the lagoons consolidated. In 1987 and 1989 photographs, the backfilling of all the lagoons and additional facility development are revealed. The original contents of the presently backfilled lagoons are unknown. If hazardous components existed in the lagoon sludge, the potential exists for groundwater impact.

3.1.5.3 Regulatory Records

Regulatory records maintained by various local and state agencies were reviewed to identify facility chemical inventories as well as minor to significant industrial spills, leaks, and releases.

3.1.5.3.1 State Spill Records

State of Indiana Spill Records were reviewed at IDEM. Three separate incidents were documented as occurring near the Wildcat Creek outfall of the Kokomo WWTP. The facility was only identified as being a potential spill source. A 1970 Indiana State Board of Health report described a fish kill resulting from effluent discharging from the treatment plant and Continental Steel into Wildcat Creek. An investigation yielded chemical results of : iron (0.03 ppm); copper $^{2+}$ (0.21 ppm); cyanide (0.0 ppm); pH of 7.9 above the WWTP outfall; and pH of 7.1 below the WWTP outfall. An estimated 10,000 gizzard shad were killed as a result of the effluent release.

A 1972 Indiana Department of Natural Resources, Enforcement Division report documented a fish kill in Wildcat Creek bordering the WWTP. There was no description of the contaminants. An estimated 348 shad were killed.

A spill in Wildcat Creek near the WWTP was documented by IDEM in 1987. The release was a milky green solution from an unidentified source. There were no noted environmental impacts. Upstream sample analyses reported the following results: ammonia-N (0.7 mg/l); biochemical oxygen demand (BOD) (5.6 mg/l); chlorides (8.0 mg/l); NO_2 +NO_3-N (1.0 mg/l); oil and grease (3.0 mg/l); phosphorus-P (0.08 mg/l); and total kjeldahl nitrogen (TKN) (1.2 mg/l). Sample analyses from the impacted area reported the following results: ammonia-N (1.6 mg/l); BOD (7.6 mg/l); chlorides (43.0 mg/l); NO_2 +NO_3-N (1.4 mg/l); oil and grease (2.0 mg/l); phosphorus-P (0.24 mg/l); and TKN (2.9 mg/l).

3.1.5.3.2 Underground Storage Tank/Leaking Underground Storage Tank (UST/LUST)

No State of Indiana UST/LUST records were available at IDEM for the Kokomo WWTP. According to the ERIIS Report (**Appendix A**), the City of Kokomo Sanitation Utilities removed an 11,750 gallon diesel storage tank on July 18, 1994 (EDR 1996).

3.1.5.3.3 Resource Conservation and Recovery Act (RCRA)

No hazardous waste generator permits or records of action taken against the Kokomo WWTP under RCRA (including closures and post closure monitoring) were found at IDEM.

3.1.5.3.4 National Pollutant Discharge and Elimination System (NPDES)

Records of NPDES permits and permit violations were found for the Kokomo WWTP at IDEM. A 1987 NPDES permit authorized the facility to discharge the following pollutants at the specified daily maximum levels: cadmium (0.02 mg/l); hexavalent chromium (0.01 mg/l); cyanide (0.03 mg/l); lead (0.05 mg/l); and zinc (1.0 mg/l). Effluent limitations were adjusted effective 1990. The adjustments authorized the facility to discharge the following pollutants at the specified daily maximum levels: cadmium (0.004 mg/l); hexavalent chromium (0.03 mg/l); cyanide (0.009 mg/l); lead (0.02 mg/l); and zinc (0.19 mg/l).

One U.S. EPA NPDES Compliance Inspection Report and three Indiana State Board of Health - Water Pollution Control Division inspection reports were reviewed and found to contain documentation of NPDES permit violations. During a February 1992 U.S. EPA inspection, numerous violations of metals limits were noted. A September 1992 state inspection noted violations of dissolved oxygen, cyanide, and lead resulting in an "out of NPDES compliance" designation. A 1993 state inspection noted that raw sewage from overflows may be entering Wildcat Creek. The report listed the plant as "out of compliance". During 1994, a state inspection found violations of metals in plant effluent and designated the plant as being "out of NPDES compliance."

3.1.5.3.5 Superfund Amendments and Reauthorization Act (SARA) Title III

Review of the Kokomo WWTP's 1994 Tier Two Emergency and Hazardous Chemical Inventory revealed solid and liquid chlorine, nitric acid, and liquid sulfur dioxide.

3.1.5.3.6 Toxic Substances Control Act (TSCA)

A Low-level PCB Waste Disposal Approval notice (1990) was found at IDEM for disposal of 16,000 tons of Kokomo wastewater treatment sludge containing less than 50 parts per million PCBs. Test results for filter cake sampling at the Kokomo WWTP indicated PCB contamination ranging between 4.8 ppm and 6.1 ppm for Aroclor-1248. For Aroclor-1254, contamination was detected between 2.1 ppm and 2.5 ppm.

3.1.5.3.7 Indiana State Board of Health

According to the Indiana State Board of Heath, no records of chemical spills or releases are maintained at this office. All past records were kept with IDEM after its creation and separation from the State Board of Health.

3.1.5.3.8 Indiana Department of Natural Resources (IDNR) - Division of Fisheries

According to the IDNR - Division of Fisheries, any IDNR record documenting fish kills would also be documented by IDEM - Emergency Response Branch. Both departments typically investigate water related incidents concurrently.

3.1.5.3.9 Howard County Local Emergency Planning Committee

According to Mr. Larry Smith, Chairman, Local Emergency Planning Committee, no records are maintained for spills or releases of environmental contaminants.

3.1.5.3.10 Kokomo Fire Department

According to Mr. Dave Duncan, Assistant Fire Chief, Kokomo Fire Department, no specific records are kept documenting spills or releases of environmental contaminants.

3.1.5.3.11 Howard County Health Department

According to the Howard County Health Department, no records are maintained for spills or releases of environmental contaminants.

3.1.5.4 Potential Environmental Impacts by the Kokomo Wastewater Treatment Plant

The Kokomo WWTP has undoubtedly impacted Wildcat Creek to some extent primarily through effluent disposition. Metals introduced into the creek would be expected to accumulate in areas of sediment deposition. Loss of raw sewage into the creek would release biological as well as chemical contaminants directly into the environment. Metals, PCBs and oils and grease have been documented in plant influent. Therefore, it is possible that these materials may have been introduced into Wildcat Creek from the WWTP.

Groundwater in the vicinity of the CSSS may have been impacted by the Kokomo WWTP lagoons in existence between 1951 and 1978. The contaminants and extent of accessibility to groundwater would be determined by the content of the lagoon influent.

3.1.6 PSIEnergy/Public Service Indiana (PSI)

PSIEnergy is a provider of electric power in Indiana and operates a substation south of Defenbaugh Street and west of Park Road (**Figure 3-1**). As a power substation, PSIEnergy/PSI may have used transformers with PCB-containing oils in the past.

3.1.6.1 Sanborn Maps

The PSIEnergy property was not drawn on any of the reviewed Sanborn Maps dated 1889 through 1965.

3.1.6.2 Historical Aerial Photographs

The historical aerial photographs reviewed did not indicate any environmental impacts occurred as a result of PSIEnergy or former occupants of this site. The substation portion of the property was first documented in a 1938 photograph and was visibly similar in 1951. The substation was expanded to the west by 1957. By 1964, the building on Defenbaugh Street was erected. Photographs from 1972, 1978, 1987 and 1989 were all structurally similar to that taken in 1964.

3.1.6.3 Regulatory Records

Regulatory records maintained by various local and state agencies were reviewed to identify facility chemical inventories as well as minor to significant industrial spills, leaks, and releases.

3.1.6.3.1 State Spill Records

State of Indiana Spill Records were reviewed at IDEM. The only spills documented involved a transformer leak in 1985 and a 10,000 gallon underground storage tank leaking unleaded gasoline in

1989 and 1990. The transformer lost an estimated one gallon of transformer oil. It was not stated whether the oil contained PCBs. There was no estimate of gasoline lost from the leaking 10,000 gallon UST.

3.1.6.3.2 Underground Storage Tank/Leaking Underground Storage Tank (UST/LUST)

State of Indiana UST/LUST records were reviewed at IDEM. As of 1994, PSIEnergy and the previous Public Service Indiana (PSI) reported a total of six USTs operated at the West Defenbaugh Street site. Two 10,000 gallon tanks were installed in 1959 containing gasoline and diesel fuel respectively. A third tank with a 500 gallon capacity was installed in 1983 and was used for spent oil storage. In 1990, all three tanks were closed, removed, and replaced with USTs of equal capacity with the exception of the 500 gallon tank which was upgraded to a 550 gallon capacity.

In 1989, a leak from the 10,000 gallon gasoline storage tank was reported to the Emergency Response Branch of IDEM after being discovered during a pressure test. The leak was located in the fill line at an estimated rated of 0.237 gallons/hour. No estimates were given with respect to the quantity of gasoline lost in the incident. A total of 1.5 barrels of potentially contaminated soil were removed as a result of the incident. Soil sample analysis indicated contaminants below detection limits. There are no records of a groundwater investigation performed as a result of this incident.

In 1990, a second leak from the 10,000 gallon gasoline storage tank was reported to IDEM. The leak was again in a pipeline connected to the UST. The leak rate was determined to be 11 gallon/hour. No information was found pertaining to the quantity of gasoline lost in the incident or remedial efforts performed.

3.1.6.3.3 Resource Conservation and Recovery Act (RCRA)

No hazardous waste generator permits or records of action taken against PSIEnergy under RCRA (including closures and post closure monitoring) were found at IDEM.

3.1.6.3.4 National Pollutant Discharge and Elimination System (NPDES)

No record of NPDES permits or permit violations were found for PSIEnergy/PSI at IDEM.

3.1.6.3.5 Superfund Amendment and Reauthorization Act (SARA) Title III

Review of PSIEnergy's 1995 Tier Two Emergency and Hazardous Chemical Inventory revealed gasoline and diesel fuel stored in two 10,000 gallon USTs.

3.1.6.3.6 Toxic Substances Control Act (TSCA)

No record of TSCA reports were found for PSIEnergy/PSI at IDEM. Although PSIEnergy reported no PCBs at its facility, there is documentation of PCB contaminated oil spilled from numerous transformers maintained by PSIEnergy in Kokomo and Howard County. In the Howard County spill file, a report from the PSIEnergy Executive Director, Environmental Programs listed numerous

releases of transformer oil between March 12, and March 13, 1991. Of the 16 spills reported, 14 had PCB levels between less than one part per million and 500 parts per million.

3.1.6.3.7 Indiana State Board of Health

According to the Indiana State Board of Heath, no records of chemical spills or releases are maintained at this office. All past records were kept with IDEM after its creation and separation from the State Board of Health.

3.1.6.3.8 Indiana Department of Natural Resources - Division of Fisheries

According to the IDNR - Division of Fisheries, any IDNR record documenting fish kills would also be documented by IDEM - Emergency Response Branch. Both departments typically investigate water related incidents concurrently.

3.1.6.3.9 Howard County Local Emergency Planning Committee

According to Mr. Larry Smith, Chairman, Local Emergency Planning Committee, no records are maintained for spills or releases of environmental contaminants.

3.1.6.3.10 Kokomo Fire Department

According to Mr. Dave Duncan, Assistant Fire Chief, Kokomo Fire Department, no specific records are kept documenting spills or releases of environmental contaminants.

3.1.6.3.11 Howard County Health Department

According to the Howard County Health Department, no records are maintained for spills or releases of environmental contaminants.

3.1.6.4 Potential Environmental Impacts by PSIEnergy/PSI

The potential for soil and groundwater contamination exists from the known releases of gasoline reported to the IDEM, Emergency Response Branch. Although the 1989 release was below detectable limits, the 1990 release can not be ruled out as a source of VOCs in area groundwater as well as a source of localized soil contamination. Although it is likely that the transformers at the PSIEnergy substation contained PCBs, there is no documentation or reference to such materials in any files reviewed prior to writing this section.

3.1.7 Mohr Construction/Dixon Road Quarry

The Dixon Road quarry is located on the west side of Howard County Road 200 West (Dixon Road) approximately 0.1 mile south of West Markland Avenue (**Figure 3-1**). The former limestone quarry comprises approximately 15 acres. The quarry is bounded to the north by Wildcat Creek, to the south by a concrete plant (Mohr Construction), to the east by Dixon Road and to the west by the Martin Marietta quarry. The quarry was used by Continental Steel as a waste disposal site for

stabilized pickle liquor, coal ash, and demolition/construction debris. One-quarter of the quarry has effectively been filled by the waste. As a result of the environmental implications of this waste, the current owner of the quarry, Mohr Construction, has enrolled in the Indiana Voluntary Remediation Program (VRP) and will remediate the area to the clean-up goals negotiated by Mohr Construction and IDEM. A Phase II Investigation was completed for Mohr Construction by Capital Environmental Enterprises, Inc. (CEE) in 1995 to determine what contaminants exceeded the cleanup goals.

3.1.7.1 Potential Environmental Impacts by Mohr Construction/Dixon Road Quarry

Due to past waste disposal in the quarry at or below the bedrock surface, the potential for surface soil or subsurface soil contamination outside the excavated quarry is somewhat limited. The two primary environmental impact areas of concern are groundwater and Wildcat Creek. Deep bedrock groundwater flow at the quarry is to the southwest towards the Martin Marietta quarry groundwater pumping facility and away from the creek. This reduces the potential for the creek acting as a contaminant migration pathway. For further groundwater discussion, see Section 4.4.6 (Groundwater).

According to CEE, the waste material in the quarry may potentially impact groundwater although it is not presently thought to be due to the effects of groundwater pumping at the Martin Marietta quarry (1995). Results from the CEE Phase II Investigation sampling indicate the waste contains high levels of lead and zinc (1995). Reported values for lead and zinc are 6,000 mg/kg and 39,000 mg/kg. Maximum detected levels for other metals include chromium (440 mg/kg); cobalt (13 mg/kg); nickel (170 mg/kg); and vanadium (43 mg/kg). PCBs were detected below 0.3 ppm. VOCs and SVOCs were also detected. Detected VOCs included methylene chloride (75 ppb), trans-1,2-dichloroethene (58 ppb); and 1,1-dichloroethane (6.2 ppb). Detected SVOCs included benzo(a)anthracene (0.76 ppm) and anthracene (0.55 ppm). Zinc is the only soil contaminant that exceeded Mohr Construction's Voluntary Cleanup Goals (CEE 1995).

Currently, the groundwater beneath the Dixon Road Quarry does not appear to have been impacted by the waste materials located in the quarry (CEE 1995). According to the CEE 1995 Phase II Investigation, minor levels of VOCs detected include cis-1,2, dichloroethane (89 µg/l); acetone (27 µg/l); 1,1-dichloroethane (4 µg/l); and 1,1-dichloroethene (3.8 µg/l). Minor levels of PAHs were- detected including 55 µg/l of phenol and 22 µg/l of bis(2-ethylexyl)phthalate. Dissolved metals just above detection limits include barium (51.1 µg/l); chromium (12.8 µg/l); nickel (23.8 µg/l); silver (5.3 µg/l); and zinc (36.5 µg/l). None of the detected contaminants are above Mohr Construction's VRP Cleanup Goals. It is suspected that the potential sources of the contaminants detected are the Haynes DSO North RCRA landfill and the Continental Steel Lagoon Area (CEE 1995).

3.1.8 Additional Facilities Impacting Kokomo and Wildcat Creeks

Sources of contaminants impacting the Kokomo and Wildcat Creeks are known to exist outside the immediate area surrounding Continental Steel. Evidence documenting this impact was found during record searches of the State Spill file at IDEM.

3.1.8.1 Chrysler Corporation

The Chrysler Corporation is located approximately 2.5 miles southeast of the CSSS (**Figure 3-1**). A 1971 spill incident was reported in Kokomo Creek originating from a storm sewer interceptor pit on the north side of the Chrysler plant. The spill consisted of an undetermined amount of waste oil. The spill was identified immediately upstream of Highland Park and resulted in a minor fish kill. A similar incident occurred in 1974 when a large oil spill occurred affecting the same area of Kokomo Creek. An investigation was conducted and the source was never confirmed. It was noted that the Chrysler Corporation outfalls into the creek were less than one-half mile upstream. Several ducks in Highland Park were covered with the oil.

A 1976 spill report was the most significant record of a release by Chrysler Corporation into Kokomo Creek directly affecting the Continental Steel area. At the time of the spill, the creek was at or above flood stage. Chrysler estimated that an approximate 7,500 gallons of number two oil was spilled and 7,000 gallons recovered. The major area of containment and clean-up was along the south side of the Main Plant at the old Park Avenue bridge as well as the new Park Avenue bridge located immediately before the confluence of Kokomo and Wildcat Creeks. The location of the oil containment efforts allowed significant quantities of oil to accumulate around Continental Steel's southern perimeter. Oil residue was visible on upper stream banks, trees, tall grass, and in flooded lowland areas from the Kokomo and Wildcat confluence upstream to the Chrysler outfall. Other less severe spill incidents resulting from Chrysler Corporation are documented in IDEM files.

3.1.8.2 Delco Electronics

Delco Electronics is located approximately 2.75 miles southeast of the CSSS (**Figure 3-1**). A large number of spills into Kokomo Creek have been documented in IDEM spill files naming Delco Electronics as the responsible party. Many of the contaminants released by Delco are also contaminants of concern at the Continental Steel site. In 1976, a release occurred into Kokomo Creek involving an uncertain amount of trichloroethene sludge. A release of 10,000 gallons of wastewater containing 45 mg/l of copper cyanide into a storm sewer leading to Kokomo Creek occurred in 1980. Approximately 50 to 200 gallons of fuel oil was released into the Creek in 1987. A reported 200 gallons of mineral oil was released into Kokomo Creek in 1993. Much of the mineral oil was contained at the Delco outfall, however 22 water fowl in Highland Park were apparently coated with the oil and required immediate attention. In 1993, 130 gallons of F006 listed contaminated wastewater from electroplating was released into a catch basin ultimately draining into Kokomo Creek. Finally, a potential lead release occurred in 1994 from Delco Electronics. The quantity of lead released was not reported. The effect of the release on Kokomo Creek was a noticeable discoloration. Groundwater may also have been affected.

3.1.8.3 Gladieux Refinery, Inc.

In 1977, a spill of approximately 400 gallons of number six fuel oil occurred at Cuneo Press Company as a result of operator error on behalf of Gladieux Refinery, Inc. The release was located between Ohio Street, Crystal Street, Vaile Avenue and Wildcat Creek (**Figure 3-1**). An estimated 100 gallons of the oil entered a storm sewer and was released directly into Wildcat Creek. Recovery

booms were placed immediately upstream of the Phillips Street bridge and a secondary boom upstream of the West Markland Avenue bridge at the northwest corner of the Main Plant. The extent of environmental damage was not indicated.

3.1.8.4 Potential Impact of Additional Facilities

As has been described, the releases of contaminants by Chrysler Corporation, Delco Electronics, and Gladieux Refinery, Incorporated into the Kokomo and Wildcat Creeks have directly impacted property within the Continental Steel area. The contaminants released range from VOCs to metals. The detection of elevated PAHs along the Kokomo Creek is to be expected due to the number of oil spills. The impacts caused by such contaminants must be considered when determining the contaminant source areas.

3.2 Field Activities

3.2.1 Soil Gas Survey

CDM conducted a soil gas survey around the former Engineering Building and current Syndicate Sales buildings as described in the Field Sampling Plan (FSP) (CDM 1995b). The soil gas survey using a Geoprobe and transportable gas chromatograph detected hits of tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE); 1,1,1-trichloroethane (1,1,1-TCA), and vinyl chloride (VC). Trans-1,2-dichloroethene and 1,1-dichloroethene were not detected in the surveys. The sample analyses were performed using the modified SW-846 Method 8260. The results of the soil gas survey are summarized in **Table 3-3**. See **Figure 3-8** for sample locations and **Figures 3-9A, B, C, D** and **E** for detectable contaminants and contours. Most areas of higher contamination exist at locations previously occupied by structures identified as potential sources. Soil gas sampling point FPSG-88 is located where the machine shop used to be at the Haynes Park Avenue Operations (**Figure 3-3**). Sampling point FPSG-71 is located within the area of the former truck garage. The type of contaminants detected correspond to the solvents expected to have been used at such facilities. The elevated level of contaminants at these particular locations support the identification of the original facilities as potential contributing sources of contamination.

Soil gas sampling point FPSG-53, located approximately 100 feet north of the former Continental Steel Engineering Building, revealed an elevated level of PCE as compared to other sample points. No previous structures or facilities appeared at this exact location. The general area appears to have been used as open storage for unidentified loose materials and debris as shown in historical aerial photographs dating back to 1951 (**Figure 3-3**). Sample point FPSG-08 contained detectable concentrations of cis-1,2-DCE, PCE and VC. Due to the proximity of the location to the Main Plant and the former Haynes/Cabot facility, the source of the constituents cannot accurately be determined without additional study.

3.2.2 Groundwater Sampling

Previous groundwater sampling events conducted by ABB-ES have shown groundwater contamination with cis-1,2-DCE, PCE, 1,1,1-TCA and TCE in wells surrounding the former Fence Plant and Haynes Park Avenue Operations. As part of the field activities, CDM sampled groundwater from monitoring wells around these facilities. Analytical results indicated groundwater contamination with 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, TCE and VC. An apparent plume of PCE has been identified through combined soil gas and groundwater analyses by CDM as a band extending northeast and southwest across the Park Avenue Operations. Complete analytical results from samples collected during CDM field activities are given in the 1996 RI Volume IV Groundwater Tables and discussed in Section 4.4.6 (Groundwater). Recent groundwater sample analyses support the identification of the machine shop, maintenance shop, truck garage and print shop as potential contributing sources of chemical contaminants.

Haynes International Defenbaugh Street Operations is a potential source of metals and VOCs contamination in groundwater. Sampling events performed for Haynes have confirmed the presence of elevated contaminants in groundwater at the Haynes DSO and especially around the DSO-North landfill. Results from analyses performed on groundwater samples collected by CDM during field activities continue to confirm the presence of metals and VOCs around the DSO. Complete analytical results for groundwater samples collected by CDM at and nearby the DSO are presented in the 1996 RI Volume IV Groundwater Tables and discussed in Section 4.4.6 (Groundwater).

3.3 Discussion

Table 3-4 summarizes the potential and known contaminants present by industrial facility, contaminant type, and impacted environmental media.

The immediate Continental Steel Superfund Site and surrounding environmental media may have been and may continue to be impacted by nearby industrial facilities. The former Fence Plant may be a source of VOCs, SVOCs and metals as all have been detected within the property boundaries of the former facility. The full extent of contaminant contribution may be difficult to determine if Markland Avenue Quarry, located up gradient of the former Fence Plant, is contributing contaminants as well. Chemical constituents detected at the former Haynes Park Avenue Operations south of Park Avenue and west of the former Fence Plant may have originated from industrial activities performed at the former Haynes/Cabot foundry. Specifically, support facilities such as the machine shop and truck maintenance garage were located where elevated levels of VOCs have recently been detected through soil gas analysis. These chemicals were commonly used in similar activities throughout general industry.

The source and extent of an apparent plume of PCE has been identified through soil gas and groundwater analyses as a band extending from the northeast (PCE identified in samples collected from monitoring well UA-28) to the southwest (PCE identified in groundwater samples collected from monitoring LA-03A and E) across the Park Avenue Operations (see **Figure 2-1** for well

locations). The source of the plume does not appear to be associated with or resulting from historical activities performed by Continental Steel. The soil gas and groundwater results from the samples collected between Park Avenue and Brandon Street do not depict, however, the full extent of expected soil and groundwater contamination in that area. The northern and southern-most contoured areas of VOC detection on the soil gas maps are open-ended and therefore do not allow for accurate source area determination.

The extent to which the Haynes International DSO and the Mohr Construction/Dixon Road quarry are contributing chemical constituents to groundwater and subsurface soil west of the CSSS has not been completely identified. Groundwater contaminants have been detected in samples collected up and down gradient from the DSO as well as beneath Dixon Road quarry (Section 4.4.6 Groundwater). This difficulty in source identification results from multiple facilities containing similar or identical potential contaminants. The groundwater contaminants detected beneath Dixon Road quarry may have originated from the Continental Steel Lagoon Area, Haynes DSO-North landfill, waste piles contained in Dixon Road quarry itself, or a combination of all of the above. All of the facilities have been identified as having the potential to impact the CSSS. A more thorough delineation of the extent of contamination from each of these other industrial sources would be necessary to provide a more accurate source (facility) identification.

3.4 Conclusions

Contaminants are expected to have been released, and in certain instances known to have been released, at every industrial facility reviewed in this section. At most facilities, the current condition and use of the property differs to some extent from its historical use. As a result, it is extremely important to accurately identify past and present owners and uses of the properties. Based upon the results of this historical review, no further historical evaluation is recommended at this time. However, if further off-site source evaluation is deemed necessary, a complete title search should be conducted for each property including Continental Steel to clarify land usage by current and previous owners. This title search should be completed prior to any attempts to further delineate the extent of contamination from other industrial facilities.

Examination of industrial properties adjacent to the CSSS is necessary for understanding potential contaminant source areas and distribution. Ultimately, this information is necessary for the delineation and remediation of these potential source areas.

3.5 References

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Section Four

Section 4
Characterization of Continental Steel Superfund Site

4.1 Investigation Approach

CDM's Focused RI/FS Work Plan (CDM 1995a), Field Sampling Plan (CDM 1995b) and Quality Assurance Project Plan (QAPP) (CDM 1995c) provide a detailed description of the approach to the investigation conducted by CDM. This approach was based on a thorough review of existing site data generated by previous U.S. EPA response actions and by the first phase of the RI field investigation conducted by ABB-ES. CDM developed site conceptual models for each of the source areas of the CSSS and identified data gaps based on the existing information. A preliminary risk analysis and preliminary feasibility study were prepared using the existing site data.

These models and preliminary studies are presented in the work plan and were used to focus the field investigation to collect only data necessary to support the baseline risk assessment and feasibility study for each operable unit. This focused approach differs from the traditional linear approach in that the availability of extensive existing data allowed these preliminary evaluations and models to be developed and used early in the RI/FS process, thus minimizing the collection of unnecessary data. Additionally, for this project, the data collection activities detailed in the Field Sampling Plan and QAPP were initially documented in technical memorandum format so that data could be used in conjunction with existing data to prepare the risk assessment and feasibility study reports concurrent with the RI report.

The text of this report includes the site characteristics and the nature and extent of contamination. The information and data supporting the text are provided in appendices to this report. **Appendix A** contains the property record report for properties adjacent to the CSSS site. **Appendix B** contains the Data Useability Technical Memorandum that discusses quality control measures and useability of the data collected by CDM. The results of the air impact analysis for the Main Plant are included in **Appendix C**. Main Plant soil boring logs and a detailed inspection log for the Main Plant buildings comprise **Appendix D**. The Markland Avenue Quarry air impact analysis is included in **Appendix E**. **Appendix F** contains CDM and ABB-ES monitoring well construction logs. Aquifer testing analysis and results are included in **Appendix G**. The groundwater flow model for the CSSS developed by CDM is included in **Appendix H**. **Appendix I** contains relevant data collected by ABB-ES during the first phase of the investigation.

4.2 Conceptual Site Models

A goal of the RI was to confirm and/or refine the conceptual site model for each operable unit. The site conceptual model for each operable unit is presented in Section 6 of CDM's Focused RI/FS Work Plan (CDM 1995a). Based on the data collected, confirmation of the conceptual site model was achieved for each operable unit. Additionally, the following minor refinements to the site conceptual models were determined:

Main Plant
Based on sampling results, the site conceptual model is refined to indicate that surface soil lead contamination is localized around buildings. Additionally, sewers and basements are less contaminated than originally believed and represent less of a source for subsurface contamination. Radiological sampling conducted by IDEM and the Indiana State Department of Health during the Phase II RI indicates "no evidence of gross radiological contamination" in the former laboratory area and as a result is no longer considered a concern for this area.

Markland Avenue Quarry
Review of a boring log for a failed well installation indicates the depth of fill in the quarry is greater than 72 feet. As a result, it is believed that 20 plus feet of fill is present beneath the quarry pond bottom and sediments. The excavated quarry, therefore, extends 30 or more feet into the Liston Creek Limestone rather than 10 feet as previously shown in the conceptual model.

Lagoon Area
The conceptual site model for the Lagoon Area was confirmed by the second phase of investigation and requires no refinement at this time.

Slag Processing Area
The conceptual site model for the Slag Processing Area was confirmed by the second phase of investigation. Leaching is not a great concern since TCLP results do not exceed the maximum concentration TCLP Regulatory levels.

Groundwater
Based on evaluation of new and existing data, the site conceptual model is refined to include a moderately permeable water-bearing zone beneath the "Less Fractured Bedrock" of the Liston Creek Limestone at the contact of the Liston Creek Limestone and Mississinewa Shale. Additionally, the "Highly Fractured Limestone" characteristic of the upper water-bearing zone extends deeper in the vicinity of the Lagoon Area. Also, based on groundwater modeling, groundwater flow across the site is governed by the pumping affects of Martin Marietta Quarry.

Kokomo and Wildcat Creeks
The site conceptual model for Kokomo and Wildcat Creeks was confirmed by the second phase of investigation. Surface water contaminant levels detected were low and as a result is not a concern.

4.3 Data Useability

CDM's Focused RI/FS Work Plan (CDM 1995a) provides a detailed discussion in Section 3.3 of the useability of existing data generated by U.S. EPA during removal actions and by ABB-ES during the first phase of the RI. The existing data was determined to be 98 percent useable and all data was entered or converted to CDMs Environmental Data Manager database for subsequent use. Data gaps were identified from the useability review and were taken into consideration during development of the field sampling plan for the Phase II field activities. Analytical methods and laboratories used for CDM's field program were chosen to be consistent with those used by ABB-ES during the first investigation phase to the extent possible.

The Phase II QAPP (CDM 1995c) details the QA/QC measures deemed necessary to produce useable data from field screening and analysis as well as laboratory analysis. The data Useability Technical Memorandum presents the detailed evaluation of the laboratory, field screening and field analysis data collected by CDM. The data is evaluated to determine the degree to which the defined QA/QC measures were followed and the data useability is defined for each set of data. The Data Useability Technical Memorandum is included as **Appendix B** and the main findings are summarized below.

The Phase II field sampling program at CSSS used four types of data acquisition methods: field screening, field analysis, field analytical laboratories and external laboratory programs. The QAPP specifies the specific QC requirements, data quality objectives and data uses for each method of acquisition. The field analytical laboratory used by CDM and ABB-ES was the U.S. EPA Field Analytical Services Program (FASP) laboratory. The non-CLP metals analyses were performed by Kemron Environmental Services for CDM and by Coast-to Coast Analytical for ABB-ES. The samples requiring the highest level of quality (Data Quality Objective Level 4) were analyzed by the U.S. EPA Contract Laboratory Program (CLP) and the Central Regional Laboratory (CRL) for CDM and by the CLP for ABB-ES. A discussion of the comparability of the data sets is provided in CDM's Work Plan (CDM 1995a).

The Phase II field sampling program at the CSSS conducted by CDM was successful in collecting the goal of 95 percent useable data as specified in the Phase II QAPP (CDM 1995c). This goal was achieved with no major deviations from either the QAPP or the Phase II Field Sampling Plan (CDM 1995b). All data gaps and unuseable data encountered in the evaluation of the data were minor and represent a loss of only two percent of the data collected during the Phase II field sampling program. Therefore, 98 percent of the data is considered useable.

4.4 Characterization of Operable Units

The following subsections provide a characterization of each operable unit and present a summary of and the results of the field investigation activities for that operable unit. There are six operable units for the CSSS, four of which are considered source areas. The four source areas include the

Main Plant, Markland Avenue Quarry, the Lagoon Area and the Slag Processing Area. The remaining two operable units are Kokomo and Wildcat Creeks and site-wide Groundwater.

To provide a point of reference for the reader, the data presented in the results discussions for each operable unit may be compared to the screening values provided in **Tables 4.4.1-23** and **4.4.1-24.** For groundwater, Safe Drinking Water Act Maximum Contaminant Levels (MCLs) are provided for comparison. For surface and subsurface soils and groundwater constituents with no MCL, IDEM Voluntary Remediation Program (VRP), Tier II Guidance for Residential and Non-Residential Land Use values are provided (**Tables 4.4.1-23** and **4.4.1-24**). The IDEM VRP Tier II Guidance information is provided strictly as a point of reference to the reader. This guidance is not promulgated and may not be appropriate for use under the Superfund Program. Actual site-specific risk numbers and cleanup goals were developed for each contaminant of concern using site data and are presented in the baseline risk assessment.

The data in this report is presented in table and graphical formats. The units of measure are provided for each chemical concentration. Typical units of measure for organic constituents in solid media (soil, sludge and sediment) are µg/kg (microgram per kilogram). The typical units of measure for inorganic constituents in solid media are mg/kg (milligram per kilogram). For aqueous media (groundwater and surface water), units of measure for organic constituents are µg/L (microgram per liter) and for inorganic constituents and general water quality parameters the units of measure are mg/L (milligram per liter). The units µg/L and mg/kg are approximately the same as ppb (part per billion) for the levels of contamination at this site. The units mg/L and mg/kg are approximately the same as ppm (part per million) for the levels of contamination detected at the site.

4.4.1 Main Plant Area

4.4.1.1 Description

This section has been prepared to document the methodologies and results of field activities conducted during CDM's Remedial Investigation of the Continental Steel Superfund Site (CSSS) Main Plant (OU5), Kokomo, Indiana (**Figure 2-1**). The investigation of the Main Plant was conducted to build upon site information collected from previous investigations, to characterize the nature and extent of contamination, and to help determine appropriate remedial action alternatives. Information obtained during Main Plant building inspections served as a reference for the Interim Risk Assessment/Feasibility Study (RA/FS) report (CDM 1996).

The Main Plant formerly consisted of three tracts of land comprising approximately 100 acres. These three areas included the Main Plant building area (94 acres), the equipment storage area located at the southwest corner of Markland Avenue and Park Avenue (0.8 acres), and the engineering building located north of Markland Avenue between Park Avenue and Syndicate Sales Inc. (5 acres) (**Figure 2-1**). The Superfund designated area of the Main Plant consists of 94 acres bordered by West Markland Avenue to the north, Leeds Street to the east, and Wildcat Creek to the west as shown in (**Figure 2-1**). South of Kokomo Creek the Main Plant extends south to Defenbaugh

Road and is bordered on the west by Park Avenue and on the east by "old" Park Avenue and Highland Park. Residential properties lie mostly to the east and southeast. Mixed residential and industrial areas lie to the north and west of the Main Plant. Industrial properties are located to the south.

The Main Plant was the location of nail, wire, and wire fence manufacturing from scrap metal from approximately 1896 through 1986. Operations included reheating, casting, rolling, drawing, pickling, annealing, hot-dip galvanizing, tinning, and oil tempering.

A layout of the Main Plant showing the division of the facility into areas, is presented in **Figure 4.4.1-1**. The site was previously divided into area designations A through H by the U.S. EPA to facilitate sample numbering. Currently, more than 50 abandoned buildings exist at the Main Plant with sizes ranging from 10,000 square feet to 400,000 square feet. The buildings contain many basements, several of which are flooded with water and other fluids. A network of underground sanitary sewers, storm sewers, and utility lines are present throughout the facility. Some process equipment has been removed from the buildings; however, much equipment still remains.

Previous investigations conducted by the U.S. EPA and ABB Environmental Services, Inc. (ABB-ES 1993) identified more than 700 oil and solvent filled drums, 55 aboveground and underground storage tanks, and 33 vats containing oils, chlorinated solvents, and acids. Additional contents of the plant buildings included 24 electrical transformers, 200 capacitors, electric arc furnace dust (baghouse dust), slag piles, small quantities of some 200 chemicals, cylinders, and exposed asbestos within piping insulation.

Removal actions were conducted by the U.S. EPA at the Main Plant in 1990 and 1991. Approximately 24 cylinders containing oxygen, acetylene, and freon, and 34, 55-gallon drums were collected throughout the Main Plant. The cylinders were disposed of off-site. The drums remain stored in Building 123A. Oil from several transformers was pumped into 55-gallon drums and stored in Building 123A. The majority of the contents of the above ground and underground storage tanks which included acids, oils and chlorinated solvents, were removed and disposed of off-site. Four large fuel oil tanks were cleaned by the U.S. EPA as an additional removal action in the fall of 1994.

Gross decontamination and screening investigations of many of the Main Plant buildings were accomplished by the U.S. EPA in the fall of 1993. Decontamination activities included lead dust removal, debris removal, and limited soil removal. Buildings containing the highest concentrations of lead were decontaminated first, utilizing a HEPAVAC to vacuum lead dust into cubic-yard bags. Debris including metal scrap and paper products was separated from the dust and stockpiled. A pile of lead-contaminated soil, two areas of PCB-contaminated soil, and PCB-contaminated woodblock floors from Buildings 14 and 14A were removed, stockpiled, and covered with visqueen. At the conclusion of the removal activities, piles of potentially lead-contaminated dust and debris not placed in cubic yard bags were covered with visqueen and remain in the Main Plant buildings.

Samples from inside and outside the Main Plant buildings were collected including: dust/sediment from floors and beams; liquid samples from tanks, drums, transformers, and flooded basements;

solids from sewers; materials which potentially contained possible asbestos; and soil from stained areas. Waste materials collected during the removal actions were containerized and stored at the Main Plant.

4.4.1.2 Potential Releases and Migration Pathways

A number of contaminant release and migration pathways exist at the Main Plant area. Primary sources of contamination at the Main Plant are the approximately 50 abandoned buildings, many with drums, tanks, vats, transformers, industrial waste, asbestos containing materials and flooded basements present within the buildings. Potential releases of volatiles, semi-volatiles (oils and solvents), PCBs, and metals may occur due to past spillage, dumping, uncontained storage, sewer discharge, or poor housekeeping. The media affected by a release may include soils, creek sediments, groundwater, and air via particulates.

Subsurface pathways exist that may serve as conduits for contaminant release and migration. Possible contaminants within the fill and surface soils may leach laterally and downward into the groundwater. Downward leaching contaminants could migrate into the shallow, intermediate, and possibly lower water-bearing zones. Potentially contaminated shallow aquifer groundwater may discharge to the hydraulically connected nearby creeks (Kokomo and Wildcat). Contaminant migration by this route is dependent not only on groundwater flow gradient and direction but also on the physical and chemical characteristics of the contaminants. Additionally, spills or leached contaminants may preferentially migrate along utilities in the sand or gravel fill in utility trenches. Underground utilities on-site include gas and numerous types of sewers, (e.g., sanitary, rinse [contaminated], acid, and combined storm, rinse and/or cooling water). These sewers not only provide preferential migration pathways but may also have been potential sources of spills through leaking joints and releases in the past and possibly in the present.

Contaminants may also be released to the surrounding area from Main Plant basement flooding. Sewers and drainage basins of the plant have received plant wastes and may be a potential residual source of contamination. These residual contaminants may be released to Kokomo and Wildcat Creeks via wastewater and stormwater discharge through several outfalls and combined sewers. Also, surficial contaminants may be released as runoff to Kokomo and Wildcat creeks.

Lead dust, slag piles, asbestos-containing materials, metal containing wastes, and stained areas have been observed in and outside of the Main Plant buildings. Thus, Main Plant buildings and surrounding surficial soils may contain contaminants which might be released via airborne dispersion and tractive transport of contaminants adsorbed or adhered to soil particles. The potential for off-site migration of contaminated dust increases as the buildings continue to deteriorate.

4.4.1.3 Summary of Investigation

The objectives of the investigation of the Main Plant were to:

- Identify and characterize potential contamination source areas;

- Characterize the nature and extent of surface and subsurface soil contamination;
- Evaluate the impact of source area contamination on subsurface soils and groundwater;
- Evaluate fate and transport mechanisms;
- Collect appropriate data to support the evaluation of risk to the surrounding community and the evaluation of remedial alternatives; and
- Collect sufficient confirmatory data to evaluate the need for expedited remedial measures.

Main Plant investigations included inside and outside building inspections, confirmatory wipe sampling, basement and sewer sampling, subsurface soil sampling, soil gas sampling, groundwater sampling, residential surface soil sampling, and indoor air and high volume air sampling. All field activities and sample collection were conducted according to the RI/FS Work Plan and Phase II Field Sampling Plan (FSP) (CDM 1995a and 1995b).

Building Inspections

In order to assess the current site conditions, detailed site walkover inspections were conducted of each Main Plant building (**Figure 4.4.1-1**). The condition of the building structure, presence of debris piles and staining, and evidence of U.S. EPA clean-up was noted (**Table 4.4.1-1**). During the inspections, visible tanks, vats, equipment, basements, pits and drums were noted (**Table 4.4.1-2**).

Wipe Sampling

Confirmatory wipe samples of internal roofs, I-beams, floors, and walls were collected to evaluate the effectiveness of the U.S. EPA gross decontamination of the buildings in reducing human health risks to trespassers. Per the FSP (CDM 1995b), CDM teams collected wipe samples from five buildings that had been decontaminated by the U.S. EPA (**Figure 4.4.1-2**). Teams of three CDM personnel entered the buildings in Level C safety protection to collect the samples. At each sample location, samples were collected for SVOC, PCB and metal analyses. A separate area was wiped for each sample parameter, but all parameters for a specific sample location were collected adjacent to each other.

Samples WS-01 through WS-04 were collected in Building 112B (**Figure 4.4.1-2**). WS-01 was collected from the floor in the north central portion of the building, WS-02 from an I-beam in the south central part of the building, WS-03 from the west wall at the south end of the building, and WS-04 from the central part of the east wall. Samples WS-05 through WS-08 were collected from Building 12, WS-05 from the south wall of Building 12, WS-06 from an I-beam at the west end of the building, WS-07 from the floor in the north central portion of the building, and WS-08 from the east wall of the building. Samples WS-09 through WS-12 were collected from Building 71B. Sample WS-09 from the side of a vertical exhaust vent located on the west side of the building, WS-10 from a central area of the east wall, WS-11 from the floor at the northeast part of the building, and WS-12 from the floor at the southwest area of the building. Samples WS-13 through WS-16 were collected from Building 112C. WS-13 from the northwest wall, WS-14 from the floor at the northeast area of the building, WS-15 from the south wall on the west side, and WS-16 from the floor at the center of the south end of the building. WS-17 through WS-20 were collected in the combined area of Buildings 8, 10 and 122. WS-17 from the floor at the southeast area of the building,. WS-18 from the side of a piece of floor mounted metal machinery from the southeast area of the building, WS-19

from a steel guard by some piping at the southwest area of the building and WS-20 from a wall dividing the combined building area from Building 11.

Indoor and High Volume Air Sampling
CDM collected indoor air samples with Alpha-1 personal air samplers from Buildings 112B, 11, 42 and 68 (**Figure 4.4.1-2**). Indoor air samples were collected to assess potential inhalation impacts to workers or trespassers in the Main Plant buildings. Additionally, high volume air samples were collected from locations in surrounding residential neighborhoods to assess migration of fugitive dust from the Main Plant. Details of the Main Plant indoor air sampling and the residential high volume air sampling are presented in **Appendix C**, Air Impact Analysis for the Main Plant. To provide an estimate of potential exposure levels, a dispersion modeling analysis of fugitive dust from the plant site to the surrounding residential area was performed and is presented in **Appendix C**.

Basement and Sewer Sampling
Basement and sewer sampling locations were identified during the building inspections (**Figure 4.4.1-3**) and sampled according to FSP (CDM 1995b) procedures. Water samples were collected from basements visually indicating contamination. The data will be used to evaluate disposal options when basement water is pumped out. Solids were collected from sewers and outfalls to characterize residual contamination in potential pathways for contaminant migration.

Basement water and sewer sediment samples were collected throughout the Main Plant area in October and November, 1995. Basement sample locations were chosen based on location (proximity to machinery and transformers) and by visual inspection (sheen on water, evidence of submersed waste, debris, etc.). Basement offices with furniture or other office equipment and locations previously sampled by the U.S. EPA were not sampled. Sample locations included basements accessible by stairs or other openings, machine pits, vats, and trenches. Utility plans were reviewed to determine areas of potential concern for sewer sampling.

Teams of two CDM personnel entered the Main Plant buildings in Level C personal protective equipment to collect basement and sewer samples. Basement water samples were collected according to the procedure in the FSP (CDM 1995b). Samples were collected from the water surface in each location, with the exception of sample BS-03. Sample BS-03 from the bottom of a pit in Building 112 (nail mill) which is adjacent to the location of a 3000 gallon TCE tank and a reported spill. Sewer sediment samples were collected using a hand held dredge or sediment auger depending on the consistency of the sediment, according to the FSP (1995b).

The collection of 20 basement samples was proposed in the Work Plan and FSP (CDM 1995a and 1995b). Nineteen samples and three duplicate samples were collected during the field program and 18 samples and the three duplicates were analyzed in the laboratory. Basement samples were analyzed by the Field Analytical Services Program (FASP) laboratory for volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Samples were submitted to the Kemron Environmental Services laboratory for metals analysis. Two confirmatory samples were analyzed by the Contract Laboratory Program (CLP) laboratory for target organics and metals. Field observation of BS-14 indicated the possible presence

of hydrocarbons. Rather than submittal to FASP lab for organic analysis as proposed in the Work Plan (1995), BS-14 was sent to Kemron for PCB analysis and hydrocarbon fingerprinting.

The collection of ten sewer sediment samples in the Main Plant was proposed. Numerous sewer locations were identified for sample collection, however, lack of sediment or inaccessibility resulted in only six accessible sewers being sampled according to FSP (1995b) procedure at the Main Plant. The six samples and one duplicate sample were submitted to the FASP laboratory for analysis of VOCs, PAHs, and PCBs. Metals analysis was conducted by the Kemron laboratory. One confirmatory sample was analyzed by the CLP lab for target organics and metals.

Subsurface Soil Sampling/Soil Boring Investigation

Past field investigations conducted by the U.S. EPA involved surficial soil sampling of stained areas throughout the Main Plant area. Numerous contaminant sources including oil and solvent-filled drums, underground and aboveground storage tanks, electrical transformers and capacitors, vats, slag piles, and electric arc-furnace and baghouse dust, were responsible for the stained areas. Although these field investigations characterized surficial contamination, the extent of subsurface contamination was not addressed. Using the results of the U.S. EPA surface soil study, a focused subsurface soil boring investigation was implemented by CDM to delineate the vertical extent of impact at these stained locations. The boring program was designed to provide the information necessary to estimate the concentrations and volume of contaminated soil. Twenty-four soil borings were proposed for advancement to bedrock. Additionally, 10 contingency borings were proposed based on site inspection of impacted surface soils. Selected contingency borings were proposed for advancement at an angle to obtain samples beneath building foundations if deemed appropriate.

CDM and subcontractor Imaging Subsurface, Inc. advanced 33 of the 34 proposed Main Plant area geoprobe soil borings and collected samples for VOC, SVOC, PCB, and metal analyses (**Figure 4.4.1-4**). The highly compacted and extremely hard subsurface slag fill prevented the completion of the angled borings. Vertical borings were advanced and samples collected using the methods outlined in the FSP (CDM 1995b).

Geoprobe soil samples were collected by advancing a 4-foot long, 2-inch diameter sampler containing an acetate liner. Soil samples were examined for color, consistency, soil type (Unified Soil Classification System [USCS]) and other physical observations (e.g., oily sludge, ash-like, slag, etc.), and logged on soil boring logs. Main Plant geoprobe soil boring logs are presented in **Appendix D**. Soil samples were screened using a photoionization detector (PID). A composite shallow and composite deep soil sample from each location based upon the worst case field screening results. If field screening detected nothing, randomly selected surface composite and deep composite samples were collected. To collect sufficient volume for laboratory analysis, one to four soil borings were advanced and shallow and deep samples were composited based on screening results. Shallow subsurface impediments (slag fill) inhibited the collection of deep samples at three locations (SB-A1, SB-B, and SB-H3).

Soil Gas Survey

Soil gas sampling was conducted in an area formerly utilized as a waste slag disposal area in the south Main Plant (**Figure 4.4.1-5**). The soil gas survey was conducted to identify potential source areas of VOC contamination in the vadose zone and VOCs in shallow groundwater.

Soil gas sampling was completed using a Geoprobe by subcontractors Matrix Environmental Group, Inc. and Dispersion with CDM oversight. Soil gas samples were analyzed using a portable gas chromatograph (GC) to provide real-time analysis for the following VOCs: trichloroethene; tetrachloroethene; 1,1-dichloroethene; trans-1,2-dichloroethene; cis-1,2-dichloroethene; 1,1,1-trichloroethane; and vinyl chloride.

The sampling interval for the Main Plant soil gas survey was approximately 100 feet.
In accordance with the soil gas sampling procedure (CDM 1995b), the soil probe was driven via Geoprobe to approximately 8 to 10 feet below ground surface or until refusal. A maximum of three attempts were made within a 10-foot radius of each sample point if refusal was encountered in the upper four feet. A soil gas sample on the third attempt if the sampling rod could be driven more than two feet below ground surface. A sampling depth of two feet or greater ensured that ambient air from above the ground surface would not be sampled. If a sampling depth of two feet could not be reached, the crew advanced to the next sampling point. Soil gas sampling depths ranged from two to 9.5 feet below ground surface.

Seventy-five soil gas sample locations at the Main Plant were proposed in the Work Plan and FSP (CDM 1995a and 1995b). Due to the inaccessibility of several of the proposed locations and difficulty in penetrating the slag/fill, a total of 49 soil gas samples were collected at the Main Plant (**Figure 4.4.1-5**).

Groundwater Sampling

A more detailed examination of the procedures implemented and results obtained from groundwater sampling in the vicinity of the Main Plant can be found in Section 4.4.6 (Groundwater).

Groundwater was sampled from ten shallow aquifer monitoring wells located upgradient, downgradient, and within the Main Plant area to evaluate groundwater quality and characterize possible downgradient contaminant migration (**Figure 2-1**). Two monitoring wells, LA-04 and LA-05, were Westbay ™ Multi-Port monitoring wells from which discrete groundwater samples were collected from the intermediate and lower groundwater-bearing zones. Two upgradient monitoring wells located east and northeast of the Main Plant were sampled to aid in the identification of possible upgradient groundwater contamination. Two groundwater monitoring wells within the boundaries of the Main Plant were sampled for VOCs, PAHs, PCBs, and metals contamination. Six downgradient monitoring wells located south and west of the Main Plant along Park Avenue between Markland Avenue and Defenbaugh Road were sampled for VOC, PAH, PCB and metal contamination.

Residential Surface Soil Sampling

Surface soil samples were collected from the residential area located east of the Main Plant and from other areas in the vicinity that may be receptors of airborne contaminants. This work was

performed to assess the risk to the surrounding residential area from windblown dust (**Figure 4.4.1-6**). All samples were collected within a half-mile radius of the site boundary. Surface soil samples were collected at 29 residential locations following the procedures outlined in the FSP (1995b). Soil samples were collected at least 10 to 15 feet from the residences and within the top six inches. Additional soil samples were collected from Highland Park at the following locations: in the sandbox at the playground, from beneath the swing set, and from exposed dirt at second base at the baseball field (**Figure 4.4.1-6**). Samples were analyzed for SVOCs (including PAHs), PCBs, pesticides and metals. Off-site residential surface soil sampling analytical results will be used to confirm the extent of airborne contamination predicted by air dispersion modeling (**Appendix C**) of potential past and present contaminant levels due to past and present activity at the CSSS.

4.4.1.4 Results of Investigation

4.4.1.4.1 Building Surveys

In order to assess the current condition of the Main Plant, CDM surveyed all of the buildings in October and November 1995. More than 50 abandoned buildings occupy the CSSS Main Plant. The buildings, which are identified by non-sequential numbers in this and previous reports, are in varying degrees of disrepair, and many are structurally compromised. As described in the Work Plan (CDM 1995a), the surveys had numerous objectives including:

- Evaluating structure condition and estimating the size of holes and openings in buildings for potential closure or demolition;
- Determining where and to what degree U.S. EPA cleanups had occurred;
- Confirming the locations of remaining potentially hazardous materials and other source areas;
- Identifying locations for subsequent sampling based on the above determinations; and
- Building on ABB-ES's Main Plant Inspection (1993) to further CDM's understanding of the types of operations conducted at the facility, the types of chemicals/materials that were used, and the location of chemicals/materials' former use.

The Main Plant buildings and grounds were surveyed from both exterior and interior perspectives. CDM teams of two or more people conducted surveys outside the buildings, generally in Level D safety protection. However, due to the high lead and other metals concentrations known to be present in the soil at Main Plant subareas G and H, the teams upgraded to Level C if warranted by readings on the dust monitors in those areas. Teams recorded observations in the CSSS field log books about the buildings' outer dimensions and the number and size of holes, gaps, or openings.

The buildings were entered by CDM personnel in teams of two that were equipped with an organic vapor monitor (OVM). In all cases, CDM teams were dressed in Level C safety protection. At the beginning of the field investigation, all buildings were surveyed at random locations with a radiation meter.

For the interior building surveys, CDM developed a Detailed Inspection of Main Plant form. An example of the inspection form is found in **Appendix D**. During each interior building survey, CDM teams completed an inspection form that described observations such as structural details; the

condition of the building; evidence of U.S. EPA cleanup; the presence of tanks (aboveground and underground), basements, sumps, pits, electrical equipment, etc.; and the presence and location of samples collected during prior investigations. Inspectors also made sketches of each building specifically noting stained areas, debris piles, basements, pits, machinery/equipment and drums.

For background information about the Main Plant, CDM reviewed ABB-ES's Technical Memorandum No. 3 Main Plant Inspection (1993), and compiled historical information about the industrial processes and other key observations. This information was assembled with CDM's survey results. The historical information and CDM's survey findings are summarized in **Tables 4.4.1-1** and **4.4.1-2. Table 4.4.1-1** includes information on the use, construction, and condition of each building. **Table 4.4.1-2** contains all other relevant information for each building including evidence of U.S. EPA cleanup, drums, spilled or piled materials, tanks, sumps, pits, basements, electrical equipment and other notable observations.

The following paragraphs provide a concise discussion of major building survey findings. Where possible, similar observations were grouped together to provide a summary of observations of one type - i.e., building condition, electrical equipment, etc.

The general condition of most buildings of the Main Plant is poor. Damage to the walls and roofs, broken windows, rust, and holes are common to a majority of buildings. While approximately 75 percent of the buildings are steel structures with sheet metal walls and roofs, some are constructed of brick and/or wood. The following buildings have partial or completely collapsed wood roofs: 4 (rod cleaning), 14 (fine wire drawing), 30 (office), 123 (milbanks), 27 (plumbing) and 29 (paint shop) (**Figure 4.4.1-1**).

Buildings 40, 42 and 5 possess major damage to interior and exterior walls, floors and roofs. The steel siding along the east side of all three buildings is either heavily damaged or missing in most areas. Numerous pits and trenches exist, many of which are filled with brick and mortar from collapsed interior walls. Large sections of roof are riddled with holes.

Large openings in the buildings, including service doors, broken windows, collapsed walls and other holes created by physical damage, act as a potential pathway for airborne contaminants to migrate from within buildings to outside as well as access points to trespassers. During 1993 and 1994 the U.S. EPA conducted a clean-up of some Main Plant buildings. Evidence suggests that the gross decontamination completed in 1993 included collection of dust, debris, and wood block floors from buildings, then piling or placing the materials in tote bags. Piles of debris covered with plastic were noted in several buildings. Tote bags were observed in buildings 5, 24, 29A, 71B, 112A, 112B and 125. In 1994, the clean-up consisted of building content removal and cleaning of tanks located both inside and outside of buildings. There is evidence that more than 20 buildings were cleaned by the U.S. EPA as shown in **Table 4.4.1-3.** Five buildings containing tanks and three free-standing tanks were cleaned in 1994 (**Table 4.4.1-3**). The tanks cleaned by the U.S. EPA were labeled with the date. An opening and a label were observed on each of the large free standing tanks. In addition to gross decontamination and tank cleaning, the U.S. EPA drained transformers and removed drums. Building 71 is used for storage of drums and overpack drums after removal from Markland Avenue

Quarry. Approximately 220 overpack drums and 400 drums were observed in Building 71. Drums originally stored in Building 69 have been removed.

Numerous Main Plant buildings were found to contain pits, sumps, trenches, basements or some other form of below ground cavity. Standing water or other liquid was noted in 17 buildings. **Table 4.4.1-4** summarizes the buildings found to contain sumps, pits, trenches, or basements where a standing liquid was observed.

Orange/brown stagnant water was the most common liquid observed in the sumps, pits, and basements. Metal, wood, paper and other debris was often found floating in or breaking the surface of the water. Several pits and basements were discovered to contain floating product or an oil sheen on the surface of the water. Four shallow machine pits were present in Building 116 (wire drawing room) which were estimated to contain two to three inches of oil. The basement of Building 113 (construction shop) was partially filled with standing water and an estimated two to three inches of free product. An oil sheen was observed in several pits containing water in Building 19 (rod storage). Oil stains, to varying extents, were routinely seen in machine pits and trenches throughout the Main Plant.

Building 42 (blooming mill) and Building 40 (billet mill) had a significant number of trenches, pits and basements, most of which were partially filed in with brick and concrete debris from demolition. Building 42 was found to have a substantial number of basement and pit areas, including several with two to three feet of standing water.

Although many transformers and capacitors suspected to contain PCBs were reportedly removed or drained during U.S. EPA removal actions of 1990 and 1991, a significant number of these and other potentially hazardous electrical items, including mercury switches and mercury vapor lamps, are present throughout the main plant. Fifteen buildings were found to contain one or more transformers. Of 24 identified transformers, six were determined to be dry type transformers and the remaining number unknown. A leaking transformer suspended approximately 15 feet above the floor was observed in Building 12 (wire galvanizing). When available, transformer type, model number and other labeling was recorded and included in **Table 4.4.1-2.**

Mercury switches were found in six buildings of the Main Plant, although their identification was tentative in certain cases. Overhead mercury vapor lamps were observed in 11 buildings, although identification of these lamps was tentative in most instances, due to inaccessibility for close inspection. **Table 4.4.1-5** summarizes the buildings containing possible mercury switches and mercury vapor lights.

Several buildings were noted for their abundance of electrical equipment which was usually housed in large metal cabinets. While many of these cabinets were gutted and no longer contained any electrical items, some were still intact. Building 4 (motor room) contained a strip of electrical control-cabinets at the southwest end. In addition, four large transformers (3,500 kVA) were located just outside the south entrance to the building. Other buildings with a significant amount of electrical equipment housed within control rooms included: 32 (storage), 40 (billet mill), 68 (continuous caster), 71A (truck dock) and 9A (electrical substation).

Suspected asbestos-containing material (ACM) was observed in 14 buildings. Buildings where ACM was suspected are listed in **Table 4.4.1-6.** Identification of ACM was considered tentative since laboratory confirmation in addition to visual inspection is usually required to verify the presence of asbestos. Although numerous types of suspected ACM's including thermal system insulation, brick, floor tile, transite siding and Cemestos and asbestos coating may be present within the buildings, the building survey objectives did not include a comprehensive asbestos survey. Building 50 contained numerous piles of white, asbestos brick. The tile floor of Building 34 (laboratory and offices) was broken and is suspected to contain asbestos. ACM pipe insulation in poor condition was observed in a pile and throughout Building 1 (boiler house). ACM was confirmed by the U.S. EPA in this building in 1993.

4.4.1.4.2 Wipe Sample Analytical Results

Surface wipe sample results are reported by building. **Table 4.4.1-7** lists the organic and inorganic compounds detected at or above the laboratory quantitation limits for the surface wipe samples collected at the Main Plant. **Table 4.1** defines data qualifiers and terms used in the Summary of Detection Tables. Surface wipe sample locations are shown on **Figure 4.4.1-2**. Samples WS-01 through WS-04 were collected in Building 112B, samples WS-05 through WS-08 in Building 12 samples WS-09 through WS-12 were collected in Building 71B, samples WS-13 through WS-16 in Building 112C, and samples WS-17 through WS-20 in combined Buildings 8, 10 and 122. No SVOCs were detected in the surface wipe samples from Buildings 112B, 12, 112C and 8, 10 and 122. No PCBs were detected in the surface wipe samples from Buildings 112B and 8, 10 and 122.

Table 4.4.1-8 shows the frequency of detection and range of concentrations for parameters detected in wipe sample analyses. The range of concentrations detected for each parameter is as follows (units: $\mu g/ft^2$):

Wipe Samples

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: SVOCs ($\mu g/ft^2$)			
Phenol	1	21	1500 - 1500
bis(2-Ethylhexyl)phthalate	1	21	770 - 770
di-n-Octylphthalate	1	21	710 - 710
Group: PCBs ($\mu g/ft^2$)			
Aroclor-1248	6	21	1.1 - 106
Aroclor-1260	1	21	1.4 - 1.4
Group: Inorganics ($\mu g/ft^2$)			
Arsenic	21	21	16 - 190

Wipe Samples (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (µg/ft^2)			
Barium	21	21	6.7 - 730
Cadmium	21	21	1.1 - 36
Chromium	21	21	4.3 - 1100
Copper	21	21	34 - 4600
Lead	21	21	11 - 100,000
Nickel	21	21	17 - 530
Zinc	21	21	120 - 24,000

4.4.1.4.3 Basement and Sewer Sample Analytical Results

Basements

Table 4.4.1-9 lists the organic and inorganic compounds detected at or above the laboratory quantitation limits for the basement water samples collected at the Main Plant. Main Plant basement water and sewer sediment sampling locations are shown in **Figure 4.4.1-3**. **Table 4.4.1-10** shows the frequency of detection and range of concentrations for parameters detected in basement sample analyses. The range of concentrations detected for each parameter is as follows [units: organics = µg/L (parts per billion) and inorganics = mg/L (parts per million)]:

Basement Samples

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,2-Dichloroethene (total)	1	3	3 - 3
cis-1,2-Dichloroethene	2	19	22 - 370
Trichloroethene	2	22	28 - 31

Note: Volatile organic compounds were analyzed by two different laboratories, CLP and FASP. The CLP laboratory reported total 1,2-dichloroethene and FASP reported the individual 1,2-dichloroethene isomers. Thus, both the total individual isomers were reported in this list.

Group: PAHs (µg/L)			
Acenaphthene	2	24	84 - 390
Acenaphthylene	4	24	34 - 5200
Anthracene	4	24	52 - 330

Basement Samples (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: PAHs (µg/L) (Continued)			
Benzo(a)anthracene	3	24	340 - 390
Benzo(a)pyrene	4	24	80 - 410
Benzo(b&k)fluoranthene	5	21	300 - 41,000
Benzo(g,h,i)perylene	3	24	490 - 3000
Chrysene	2	24	680 - 680
Dibenzo(a,h)anthracene	4	24	460 - 980
Fluoranthene	4	24	83 - 1500
Fluorene	4	24	52 - 260
Indeno(1,2,3-cd)pyrene	2	24	640 - 900
Naphthalene	1	24	420 - 420
Phenanthrene	4	24	53 - 230
Pyrene	4	24	130 - 650
Group: PCBs (µg/L)			
Aroclor-1242	1	23	11 - 11
Group: Inorganics (mg/L)			
Aluminum	1	3	.156 - .156
Arsenic	2	23	.061 - .1
Barium	20	23	.0135 - .11
Cadmium	1	23	.02 - .02
Calcium	3	3	24.3 - 57.5
Chromium	2	23	.028 - .05
Copper	8	23	.0099 - .2
Iron	3	3	1.14 - 2.11
Lead	4	23	.002 - .1
Magnesium	3	3	1.58 - 3.41
Manganese	3	3	.201 - .215
Nickel	9	23	.02 - .22
Potassium	3	3	5.25 - 7.32
Sodium	3	3	4.04 - 8.95
Zinc	23	23	.0063 - 12

Confirmatory Sample Results

Main Plant basement water confirmatory samples analyzed by the U.S. EPA Contract Laboratory Program (CLP) for VOCs, SVOCs, PAHs, PCBs, pesticides and metals are presented in **Table 4.4.1-9**. Confirmatory samples were collected at the Main Plant basement water sample locations BS-03 and BS-13. A duplicate sample, BS-13-D, was also collected at location BS-13. Organic results were compared to U.S. EPA sponsored Field Analytical Service Program (FASP) laboratory analyses and inorganic results to Kemron Environmental Services (Kemron) laboratory analyses to insure accuracy. CLP VOC sample analyses compare well with FASP results except for 1,2-dichloroethene and trichloroethene at BS-03. 1,2-dichloroethene was detected by CLP lab at a concentration of 3 µg/L which is below the FASP lab quantitation limit (QL) of 10 µg/L. FASP reported quantified results only when the concentration was greater than or equal to the QL. Trichloroethene was detected at a concentration of 28 µg/L (BS-03) by CLP lab and reported as a non detection by FASP lab. CLP PAH, PCB and metal analytical results are consistent with FASP (organic) and Kemron (inorganic) results for basement water samples BS-03, BS-13 and BS-13-D.

Basement sample BS-14 was sent to Kemron Environmental Services laboratory for PCB analysis and hydrocarbon fingerprinting because it was suspected to contain product. Although no PCBs were detected, gas chromatographic (GC) hydrocarbon fingerprinting detected hydrocarbon chains C12 through C32. Comparison of GC results (C12-C32) with known GC results for hydrocarbons indicate that sample BS-14 contains a compound similar to hydraulic oil.

Sewers

Table 4.4.1-11 lists the organic and inorganic compounds detected at or above the laboratory quantitation limits for the sewer sediment samples collected at the Main Plant. Sampling locations are shown in **Figure 4.4.1-3**. **Table 4.4.1-12** shows the frequency of detection and range of concentrations for parameters detected in sewer sediment sample analyses. The range of concentrations detected for each parameter is as follows [units: organics = µg/kg (parts per billion) and inorganics = mg/kg (parts per million)]:

Sewer Samples

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/kg)			
2-Butanone	2	2	13 - 43
Acetone	2	2	61 - 200
Chlorobenzene	1	8	280 - 280
Chloroform	1	2	6 - 6
cis-1,2-Dichloroethene	1	6	230 - 230
Ethylbenzene	3	8	5 - 410
o-Xylene	1	6	1000 - 1000

Sewer Samples (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/kg)			
Tetrachloroethene	1	8	17 - 17
Toluene	2	8	2 - 18
Total Xylenes	2	2	30 - 300
Trichloroethene	1	8	2600 - 2600
Group: SVOCs (µg/kg)			
di-n-Butylphthalate	1	2	970 - 970
2-Methylnaphthalene	2	2	6500 - 6700
Group: PAHs (µg/kg)			
Acenaphthene	2	7	2400 - 2900
Acenaphthylene	1	7	1000 - 1000
Anthracene	1	7	2000 - 2000
Benzo(a)anthracene	1	7	13,000 - 13,000
Benzo(a)pyrene	3	7	6000 - 12,000
Benzo(b&k)fluoranthene	3	5	7300 - 62,000
Benzo(g,h,i)perylene	3	7	5400 - 16,000
Chrysene	2	7	21,000 - 29000
Dibenzo(a,h)anthracene	1	7	18,000 - 18,000
Fluoranthene	2	7	2600 - 6300
Fluorene	2	7	640 - 4200
Indeno(123-cd)pyrene	1	7	20,000 - 20,000
Naphthalene	3	7	4200 - 24,000
Phenanthrene	1	7	7700 - 7700
Pyrene	3	7	3000 - 15,000
Group: PCBs (µg/kg)			
Aroclor-1242	2	7	2100 - 25,000
Aroclor-1248	2	7	11,000 - 25,000
Aroclor-1254	1	7	25,000 - 25,000
Aroclor-1260	1	7	25,000 - 25,000

Sewer Samples (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Pesticides (µg/kg)			
4,4'-DDE	2	2	36 - 53
4,4'-DDT	1	2	16 - 16
Aldrin	2	2	20 - 22
alpha-BHC	2	2	21 - 30
Endrin	2	2	49 - 61
Group: Inorganics (mg/kg)			
Aluminum	2	2	6660 - 7520
Antimony	2	2	32.1 - 33.3
Arsenic	9	9	7.3 - 220
Barium	9	9	53 - 800
Beryllium	2	2	.66 - .68
Cadmium	8	9	5 - 53.1
Calcium	2	2	42,900 - 46,500
Chromium	8	9	22 - 704
Cobalt	2	2	12.6 - 14.8
Copper	9	9	55 - 1330
Iron	2	2	123,000 - 129,000
Lead	9	9	6.1 - 8800
Magnesium	2	2	11,700 - 12,700
Manganese	2	2	4250 - 5280
Mercury	2	2	.22 - .33
Nickel	9	9	22 - 480
Potassium	2	2	865 - 916
Selenium	2	2	4.7 - 5.7
Silver	2	2	2.5 - 2.5
Sodium	2	2	383 - 755
Thallium	2	2	6.7 - 7.1
Vanadium	2	2	48.8 - 54
Zinc	9	9	72 - 510,000

Sewer Samples (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Miscellaneous (%)			
Percent Solids	7	7	60 - 82.1

Confirmatory Sample Results

Main Plant sewer confirmatory samples analyzed by the U.S. EPA CLP for VOCs, SVOCs, PAHs, PCBs, pesticides and metals are presented in **Table 4.4.1-11**. Confirmatory samples were collected at the Main Plant basement sewer sample locations SR-03 and SR-03-D (duplicate sample). Organic results were compared to U.S. EPA sponsored FASP laboratory analyses and inorganic results to Kemron laboratory analyses to insure accuracy. CLP VOC sample analyses for SR-03 and SR-03-D confirm FASP lab VOC results except for chlorobenzene, ethylbenzene, tetrachloroethene and toluene. These differences result from three factors. First, the heterogeneous nature of the sewer sediment can cause different result concentrations. Second, two laboratories, CLP and FASP, analyzed the sediment and it is not unusual for results from different laboratories to be dissimilar. Third, CLP analyses are subjected to a higher level of quality assurance/quality control than FASP laboratory analyses.

CLP PAH results compared well with FASP results. However, CLP showed detections for PAHs that FASP analyzed for but did not detect because the FASP lab quantitation limits (QLs) were higher than the CLP detections. PCB detections reported by FASP lab were inconclusive because no identifiable gas chromatographic pattern match could be made. Thus, CLP non detections for PCBs are consistent with FASP laboratory results. CLP metal results for SR-03 and SR-03-D confirm Kemron laboratory metal results except for arsenic and copper. These differences likely result from matrix heterogeneity. Also, CLP copper values for SR-03 and SR-03-D were labeled as estimated by the laboratory.

4.4.1.4.4 Soil Boring Analytical Results

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in the soil boring samples at the Main Plant is presented in **Table 4.4.1-13A** (surface) and **Table 4.4.1-15A** (deep). Toxicity characteristic leaching procedure (TCLP) results are presented in **Tables 4.4.1-13B** (surface) and **4.4.1-15B** (deep), respectively. Sampling locations are shown on **Figure 4.4.1-4.** Soil boring samples were not collected at SB-F1 and SB-F7 due to shallow subsurface impediments. **Table 4.4.1-14** and **Table 4.4.1-16** show the frequency of detection and range of concentrations for parameters detected in surface and deep soil boring sample analyses, respectively. The range of concentrations detected for each parameter is as follows [units: organics = µg/kg (parts per billion) and inorganics = mg/kg (parts per million)]:

Soil Borings (Surface)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/kg)			
1,1-Dichloroethene	1	47	330 - 330
2-Butanone	1	12	8 - 8
Acetone	8	12	7 - 76
Carbon Disulfide	1	12	7 - 7
Ethylbenzene	2	47	3 - 8.1
m&p-Xylene	1	35	16 - 16
Methylene Chloride	18	47	1 - 39
Xylene	3	35	18 - 26
Tetrachloroethene	5	47	4 - 1600
Toluene	8	47	3 - 76
Total Xylenes	1	12	26 - 26
Trichloroethene	3	47	9.6 - 5600
Group: SVOCs (µg/kg)			
bis(2-Ethylhexyl)phthalate	3	9	96 - 180
Butylbenzylphthalate	2	9	20 - 120
di-n-Butylphthalate	4	9	22 - 55
Diethylphthalate	1	9	71 - 71
2,4-Dimethylphenol	1	9	62 - 62
2-Methylnaphthalene	4	9	28 - 260
Group: PAHs (µg/kg)			
Acenaphthene	3	44	28 - 260
Acenaphthylene	1	44	45 - 45
Anthracene	7	44	88 - 2100
Benzo(a)anthracene	10	44	23 - 16,000
Benzo(a)pyrene	12	44	21 - 8800
Benzo(b&k)fluoranthene	4	35	8800 - 15,000
Benzo(b)fluoranthene	9	9	34 - 1600
Benzo(g,h,i)perylene	6	44	38 - 4000
Benzo(k)fluoranthene	6	9	24 - 1100

Soil Borings (Surface) (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: PAHs (µg/kg) (Continued)			
Carbazole	3	9	21 - 130
Chrysene	12	44	27 - 30,000
Dibenzo(a,h)anthracene	5	44	150 - 20,000
Dibenzofuran	3	9	56 - 220
Fluoranthene	12	44	29 - 8000
Fluorene	6	44	35 - 2300
Indeno(123-cd)pyrene	7	44	31 - 21,000
Naphthalene	4	44	21 - 310
Phenanthrene	10	44	21 - 4000
Pyrene	13	44	33 - 16,000
Group: PCBs (µg/kg)			
Aroclor-1242	4	47	600 - 30,000
Aroclor-1248	11	47	110 - 30,000
Aroclor-1254	4	47	49 - 30,000
Aroclor-1260	1	47	300 - 30,000
Group: Pesticides (µg/kg)			
4,4'-DDD	1	12	9.4 - 9.4
4,4'-DDE	4	12	5.5 - 280
4,4'-DDT	2	12	3.8 - 18
Aldrin	2	12	3.9 - 1000
alpha-Chlordane	4	12	3.4 - 320
beta-BHC	2	12	2.4 - 360
Dieldrin	1	12	170 - 170
Endosulfan I	1	12	2 - 2
Endosulfan II	2	12	7.7 - 8
Endosulfan Sulfate	1	12	2.7 - 2.7
Endrin Aldehyde	1	12	7.5 - 7.5
Endrin Ketone	1	12	15 - 15
gamma-BHC (Lindane)	1	12	190 - 190

Soil Borings (Surface) (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Pesticides (µg/kg) (Continued)			
Heptachlor	3	12	8.8 - 280
Methoxychlor	1	12	21 - 21
Group: Inorganics (mg/kg)			
Aluminum	10	10	4880 - 9920
Antimony	5	10	2.6 - 37.1
Arsenic	44	46	5.4 - 89
Barium	46	46	18 - 580
Beryllium	10	10	.34 - 1.8
Cadmium	40	46	.82 - 83
Calcium	10	10	21,700 - 111,000
Chromium	46	46	6.3 - 2800
Cobalt	10	10	4.5 - 12.2
Copper	46	46	15 - 1300
Iron	10	10	19,700 - 78,800
Lead	44	46	42 - 39,000
Magnesium	10	10	8450 - 38,900
Manganese	10	10	484 - 12,800
Mercury	7	10	.06 - .81
Nickel	46	46	14 - 260
Potassium	9	10	191 - 1380
Selenium	9	10	.53 - 2.7
Silver	5	10	.65 - 11
Sodium	9	10	83.2 - 5710
Thallium	5	10	.43 - .68
Vanadium	10	10	19.1 - 113
Zinc	46	46	42 - 92,500
Group: Miscellaneous (%)			
Percent Solids	36	36	79 - 96

Soil Borings (Deep)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/kg)			
1,1-Dichloroethene	2	34	2.1 - 170
2-Butanone	1	4	6 - 6
Acetone	4	4	15 - 46
Ethylbenzene	1	34	7 - 7
m&p-Xylene	1	30	17 - 17
Methylene Chloride	5	34	1 - 19
Xylene	2	30	26 - 230
Tetrachloroethene	2	34	7 - 25
Toluene	1	34	2 - 2
Total Xylenes	1	4	2 - 2
Trichloroethene	1	34	190 - 190
Group: SVOCs (µg/kg)			
bis(2-Ethylhexyl)phthalate	3	7	67 - 93
di-n-Butylphthalate	3	7	37 - 54
Diethylphthalate	1	7	350 - 350
Dimethylphthalate	1	7	120 - 120
Group: PAHs (µg/kg)			
Acenaphthene	2	37	88 - 2700
Anthracene	1	37	1500 - 1500
Benzo(a)anthracene	3	37	7100 - 14,000
Benzo(a)pyrene	2	37	4400 - 5800
Benzo(b&k)fluoranthene	3	30	7100 - 14,000
Benzo(g,h,i)perylene	1	37	2400 - 2400
Chrysene	2	37	26 - 11,000
Dibenzofuran	1	7	22 - 22
Fluoranthene	3	37	67 - 4600
Fluorene	2	37	38 - 2000
Indeno(123-cd)pyrene	1	37	22,000 - 22,000
Phenanthrene	4	37	40 - 4700
Pyrene	4	37	72 - 6300

Soil Borings (Deep) (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: PCBs (µg/kg)			
Aroclor-1248	3	34	2700 - 9300
Group: Pesticides (µg/kg)			
beta-BHC	1	4	5.3 - 5.3
Group: Inorganics (mg/kg)			
Aluminum	6	6	8690 - 12,400
Antimony	1	6	.93 - .93
Arsenic	31	36	6.2 - 65
Barium	36	36	15 - 170
Beryllium	6	6	.51 - .82
Cadmium	16	36	.39 - 89
Calcium	6	6	3590 - 11,300
Chromium	36	36	6.3 - 890
Cobalt	6	6	7.7 - 12.4
Copper	33	36	11 - 900
Iron	6	6	17,100 - 26,300
Lead	28	36	7.1 - 3600
Magnesium	6	6	2760 - 4910
Manganese	6	6	435 - 1200
Mercury	2	6	.06 - .24
Nickel	36	36	13 - 160
Potassium	6	6	613 - 1590
Selenium	4	6	.23 - 1.4
Sodium	5	6	58.3 - 127
Thallium	4	6	.47 - 1.6
Vanadium	6	6	22.1 - 28.1
Zinc	36	36	37 - 4100
Group: Miscellaneous (%)			
Percent Solids	30	30	76 - 95

Dot plots indicating distribution and total concentration of VOCs for surface and deep soil samples are shown on **Figures 4.4.1-7** and **4.4.1-8**, respectively. Dot plots indicating distribution and total concentration of PAHs for surface and deep soil samples are shown on **Figures 4.4.1-9** and **4.4.1-10**, respectively. Total PCB distribution and concentrations for surface and deep soil samples are shown on dot plot **Figures 4.4.1-11** and **4.4.1-12**, respectively. Cadmium distribution and concentrations for surface and deep soil samples are shown on **Figures 4.4.1-13** and **4.4.1-14**, respectively. Chromium surface (**Figure 4.4.1-15**) and deep (**Figure 4.4.1-16**) and lead surface (**Figure 4.4.1-17**) and deep (**Figure 4.4.1-18**) soil sample distribution and concentrations are shown on their respective dot plots.

Confirmatory Sample Results

Soil boring confirmatory samples analyzed by the U.S. EPACLP for VOCs, SVOCs, PAHs, PCBs, pesticides and metals are presented in **Table 4.4.1-13A** (shallow) and **Table 4.4.1-15A** (deep). Confirmatory samples were collected at the Main Plant soil boring sample locations SB-A1S, SB-B1S, SB-B2S, SB-B3S, SB-B3D, SB-B4S, SB-C4D, SB-C2S, SB-C5D, SB-E1S, SB-F3S, SB-F3D, SB-F4S, SB-F5S and SB-H3S. Duplicate samples SB-B3D-D, SB-C4D-D were collected at locations SB-B3D and SB-C4D, and respectively. Organic results were compared to the U.S. EPA sponsored FASP laboratory analyses and inorganic results to Kemron laboratory to insure accuracy. CLP VOC sample analyses for all samples listed confirm FASP lab VOC results except for methylene chloride which was detected in some CLP samples and in none of the FASP samples. Methylene chloride is a common laboratory contaminant and its detection in small amounts is not unusual. For sample SB-A1S the FASP result for trichloroethene was much higher than the CLP result and was qualified "E". This "E" indicates that trichloroethene was detected at a concentration exceeding the calibration range of the instrument and should be considered only as an estimation. [For sample SB-C2S, tetrachloroethene was detected by FASP at a level below the CLP quantitation limits and therefore was not listed as a CLP detect.] In all other cases in which CLP showed detections for an analyte that FASP analyzed for but did not detect, the FASP lab QLs were higher than the CLP detections.

CLP BNA (SVOC) sample analyses for all samples listed confirm FASP lab PAH results except for some phthalate esters which were detected in some CLP samples and in none of the FASP samples. Phthalate esters are common laboratory contaminants and detections in small amounts is not unusual. Some CLP BNA analytes showed detections for analytes that FASP analyzed for, but did not detect. This occurred only where the FASP lab QLs were higher than the CLP detections. In sample SB-F5S, many CLP BNA analyte results were reported at levels from two to ten times the FASP results. All of these CLP results were flagged "D" by the CLP lab which indicates that the compound identified in the analysis was diluted.

CLP PCB sample analyses for all samples listed confirm FASP lab PCB results except for a few results. This occurred only where the FASP lab QLs were higher than the CLP detections. FASP PCB results for SB-H3S report four analytes (Aroclor-1242, 1248, 1254 and 1260) with detections greater than 30 mg/kg which differ from the CLP results. The FASP lab result narrative states that an aroclor is present at greater than 30 mg/kg, but no identifiable pattern match was found. This result was actually inconclusive and listed under each aroclor analyte for conservative reporting.

Using gas chromatography/mass spectroscopy (GC/MS), the CLP lab was able to confirm that the PCB in question was Aroclor-1248. All other CLP PCB analytes are reported as non-detects.

CLP was the only lab program scheduled to analyze for pesticides. Therefore, there are no other pesticide lab results for comparison. CLP laboratory detected a total of 15 pesticides in the Main Plant subsurface soil samples. 4,4'-DDD was detected in SB-E1S (0-4 ft) at a concentration of 9.4 µg/kg. 4,4'-DDE was detected in four subsurface soil samples ranging at concentrations from 5.5 µg/kg (SB-C25 [0-4 ft]) to 280 µg/kg (SB-H35 [0-3 ft]). Shallow soil samples SB-B2S (0-4 ft) and SB-E1S (0-4 ft) contained 4,4'-DDT at concentrations of 18 µg/kg and 3.8 µg/kg, respectively. Aldrin was detected in subsurface soil samples SB-E1S (0-4 ft) and SB-H3S (0-3 ft) at concentrations of 3.9 µg/kg and 1,000 µg/kg, respectively. Alpha-chlordane was detected in four subsurface soil samples ranging at concentrations from 3.4 µg/kg (SB-C2S [0-4 ft]) to 320 µg/kg (SB-H3S [0-3 ft]). Beta-BHC was detected in SB-B2S (0-4 ft) at 2.4 µg/kg, SB-H3S (0-3 ft) at 360 µg/kg, and SB-C4D-D (4-12 ft) at 5.3 µg/kg. Dieldrin was detected at a concentration of 170 µg/kg in SB-H3S (0-3 ft). Endosulfan I was detected in SB-B2S (0-4 ft) at 2 µg/kg. Endosulfan II was detected in subsurface soil samples SB-B2S (0-4 ft) and SB-F5S (0-4 ft) at concentrations of 8 µg/kg and 7.7 µg/kg, respectively. Endrin aldehyde and endrin ketone were detected in SB-B2S (0-4 ft) at concentrations of 7.5 µg/kg and 15 µg/kg, respectively. Endosulfan sulfate was detected in SB-F5S (0-4 ft) at 2.7 µg/kg. Gamma-BHC (Lindane) was detected at a concentration of 190 µg/kg in SB-H3S (0-3 ft). Heptachlor was detected in soil borings SB-B2S (0-4 ft), SB-E1S (0-4 ft) and SB-H3S (0-3 ft) at concentrations of 8.8 µg/kg, 13 µg/kg and 280 µg/kg, respectively. Methoxychlor was detected in SB-B2S (0-4 ft) at a concentration of 21 µg/kg. With minor exceptions, CLP sample results for the VOC, SVOC, PAHs, PCBs and pesticides are consistent with the FASP results.

CLP total metal analyses confirm Kemron laboratory total metal results. Duplicate samples analyzed by both labs confirm that the sample heterogeneity common to environmental soil samples makes it more difficult to replicate the results. Even with sufficient field compositing, the existing soil matrix resists homogeneity. This is especially evident with metals which naturally occur in the soil. Thus, in some samples CLP and Kemron detected the same metals but at different concentrations. Some CLP metal results were qualified with an "E" and/or an "N". The "E" notation indicates that the reported value is estimated due to interferences and may account for any differences between CLP and Kemron results. The "N" notation indicates that the spike recovery was not within the lab control limits and CLP results were estimated due to sample matrix. As with the organic data, some CLP metal analytes showed detections that Kemron analyzed for but did not detect. This occurred only where CLP detections were below Kemron QLs.

4.4.1.4.5 Soil Gas Analytical Results

Soil gas sampling locations are shown on **Figure 4.4.1-5.** The distribution of cis-1,2-dichloroethene and trichloroethene concentrations are shown on **Figures 4.4.1-19** and **4.4.1-20**, respectively.

Cis-1,2-dichloroethene and trichloroethene were detected at soil gas sample location MPSG-12 at concentrations of 1 milligram per cubic meter (mg/m^3) and 2 mg/m^3, respectively. Trichloroethene was also detected at a concentration of 1 mg/m^3 in samples MPSG-14, MPSG-15 and MPSG-26, and

at a concentration of 2 mg/m^3 in MPSG-02. No other VOCs were detected in soil gas samples collected at the Main Plant.

4.4.1.4.6 Groundwater

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in groundwater samples collected from monitoring wells within and surrounding the Main Plant area is presented in **Table 4.4.1-17**. Selected groundwater monitoring wells in the vicinity of the Main Plant from which groundwater samples were collected are shown on **Figure 2-1**. Groundwater results are reported according to shallow (760 feet and up), intermediate (700 to 760 feet), and lower (660 to 700 feet) water-bearing units. The Main Plant area UA series monitoring wells (UA-02, UA-04, UA-10, UA-11, UA-13, UA-21, UA-24 and UA-32) are all screened within the shallow water-bearing zone and their frequency of detection results are reported together in **Table 4.4.1-18.** Groundwater frequency of detection and range of concentration results for LA-04 and LA-05, monitoring wells screened in the intermediate and lower water bearing units, are reported in **Tables 4.4.1-19** and **4.4.1-20**, respectively. The range of concentrations detected for each parameter are as follows [units: organics = µg/L (parts per billion) and inorganics = mg/L (parts per million)]:

Shallow Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1,1-Trichloroethane	1	9	1 - 1
1,1-Dichloroethene	3	9	3 - 3
1,2-Dichloroethane	1	9	2000 - 2000
Chloroform	1	9	19 - 19
cis-1,2-Dichloroethene	6	9	1 - 790
trans-1,2-Dichloroethene	3	9	3 - 5
Trichloroethene	3	9	1 - 2000
Vinyl Chloride	3	9	46 - 71
Group: SVOCs (µg/L)			
bis(2-Ethylhexyl)phthalate	2	3	2 - 8
di-n-Butylphthalate	1	3	2 - 2
Group: PAHs (µg/L)			
Naphthalene	1	12	1 - 1
Pyrene	1	3	.5 - .5

Shallow Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: PCBs (µg/L)			
Aroclor-1242	2	6	1.6 - 4.5
Aroclor-1248	2	6	5.8 - 6.4
Group: Pesticides (µg/L)			
alpha-Chlordane	2	3	.081 - .09
Group: Inorganics (mg/L)			
Aluminum	1	1	.775 - .775
Aluminum, Dissolved	1	10	.105 - .105
Antimony, Dissolved	1	10	.006 - .006
Arsenic	1	1	.013 - .013
Arsenic, Dissolved	4	10	.004 - .014
Barium	1	1	.169 - .169
Barium, Dissolved	10	10	.025 - .133
Cadmium	1	1	.0031 - .0031
Cadmium, Dissolved	1	10	.0004 - .0004
Calcium	1	1	131 - 131
Calcium, Dissolved	10	10	87 - 229
Copper	1	1	.016 - .016
Copper, Dissolved	3	10	.01 - .014
Iron	1	1	10.8 - 10.8
Iron, Dissolved	8	10	.086 - 7.11
Lead	1	1	.017 - .017
Magnesium	1	1	28 - 28
Magnesium, Dissolved	10	10	18 - 84
Manganese	1	1	1.77 - 1.77
Manganese, Dissolved	10	10	.009 - 1.71
Mercury	5	10	.0001 - .0002
Nickel, Dissolved	1	10	.021 - .021
Potassium, Dissolved	4	10	6 - 9
Sodium	1	1	75 - 75

Shallow Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (mg/L) (Continued)			
Sodium, Dissolved	10	10	19 - 105
Vanadium, Dissolved	2	10	.009 - .012
Zinc	1	1	.058 - .058
Zinc, Dissolved	2	10	.061 - .088
Group: Miscellaneous (mg/L)			
Alkalinity	1	1	310 - 310
Chloride	10	10	48 - 131
Sulfate	1	1	94 - 94
Total Phosphorous	1	1	.53 - .53

Intermediate Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethene	1	7	7 - 7
1,2-Dichloroethene (total)	1	1	2000 - 2000
Acetone	1	7	7 - 7
Acrylonitrile	2	6	19 - 34
cis-1,2-Dichloroethene	6	6	1 - 1900
Ethylbenzene	1	7	1 - 1
m&p-Xylene	1	6	4 - 4
Methylene Chloride	3	7	1 - 1
o-Xylene	1	6	1 - 1
Styrene	2	7	1 - 1
trans-1,2-Dichloroethene	2	6	3 - 15
Trichloroethene	4	7	13 - 5100

Intermediate Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L) (Continued)			
Vinyl Chloride	5	7	1 - 82

Note: Volatile organic compounds were analyzed by two different laboratories, CLP and FASP. The CLP laboratory reported total 1,2-dichloroethene and FASP reported the individual 1,2-dichloroethene isomers. Thus, both the total individual isomers were reported in this list.

Group: SVOCs (µg/L)			
Hexachlorobutadiene	1	6	1 - 1
Group: Inorganics (mg/L)			
Arsenic, Dissolved	2	6	.003 - .003
Barium, Dissolved	6	6	.034 - .087
Calcium, Dissolved	6	6	100 - 174
Iron, Dissolved	6	6	.387 - 2.74
Magnesium, Dissolved	6	6	31 - 43
Manganese, Dissolved	6	6	.013 - .23
Nickel, Dissolved	1	6	.032 - .032
Potassium, Dissolved	3	6	5 -14
Sodium, Dissolved	6	6	21 - 53
Zinc, Dissolved	3	6	.05 - .622
Group: Miscellaneous (mg/L)			
Chloride	6	6	35 - 184

Lower Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethene	1	2	2 - 2
Acrylonitrile	2	2	10 - 11
cis-1,2-Dichloroethene	2	2	1 - 700

Lower Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L) (Continued)			
Methylene Chloride	1	2	1 - 1
trans-1,2-Dichloroethene	1	2	3 - 3
Trichloroethene	1	2	5 - 5
Vinyl Chloride	1	2	330 - 330
Group: Inorganics (mg/L)			
Chloride	2	2	59 - 139
Barium, Dissolved	2	2	.058 - .141
Calcium, Dissolved	2	2	96 - 167
Iron, Dissolved	2	2	.155 - .903
Magnesium, Dissolved	2	2	39 - 62
Group: Inorganics (mg/L)			
Manganese, Dissolved	2	2	.014 - .025
Potassium, Dissolved	2	2	11 - 16
Sodium, Dissolved	2	2	42 - 47

4.4.1.4.7 Residential Surface Soil Analytical Results

A list of organic and inorganic compounds detected at or above laboratory quantitation limits in the Main Plant residential surface soil samples are presented in **Table 4.4.1-21**. Sampling locations are shown on **Figure 4.4.1-6**. **Table 4.4.1-22** shows the frequency of detection and range of concentrations for parameters detected in residential surface soil sample analyses. The range of concentrations detected for each parameter is as follows [units: organics = µg/kg (parts per billion) and inorganics = mg/kg (parts per million)]:

Residential Samples

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: SVOCs (µg/kg)			
2-Methylnaphthalene	4	6	27 - 400
Group: PAHs (µg/kg)			
Anthracene	2	36	22 - 37
Benzo(a)anthracene	6	36	36 - 11,000
Benzo(a)pyrene	6	36	39 - 1400
Benzo(b&k)fluoranthene	2	30	4500 - 4800
Benzo(b)fluoranthene	6	6	61 - 200
Benzo(g,h,i)perylene	6	36	58 - 4300
Benzo(k)fluoranthene	6	6	45 - 220
Butylbenzylphthalate	2	6	23 - 28
Carbazole	1	6	74 - 74
Chrysene	5	36	57 - 250
di-n-Octylphthalate	1	6	410 - 410
Dibenzo(a,h)anthracene	1	36	16,000 - 16,000
Diethylphthalate	5	6	20 - 32
Fluoranthene	8	36	58 - 2200
Indeno(123-cd)pyrene	7	36	31 - 16,000
Phenanthrene	6	36	29 - 210
Pyrene	8	36	50 - 2600
Group: PCBs (µg/kg)			
Aroclor-1254	3	36	120 - 1100
Group: Pesticides (µg/kg)			
4,4'-DDE	2	6	3.6 - 3.7
4,4'-DDT	5	6	2.5 - 25
Aldrin	5	6	1.2 - 2.3
Endrin	2	6	4 - 4.4
Endrin Ketone	3	6	1.9 - 3.3
gamma-Chlordane	2	6	2.6 - 3
Heptachlor Epoxide	3	6	.94 - 1.6

Residential Samples (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (mg/kg)			
Aluminum	6	6	3250 - 10,600
Antimony	4	6	.81 - 2.6
Arsenic	37	37	7.1 - 86
Barium	37	37	10 - 550
Beryllium	6	6	.47 - .68
Cadmium	28	37	2 - 73
Calcium	6	6	2220 - 105,000
Chromium	37	37	7 - 110
Cobalt	6	6	6.2 - 13.9
Copper	33	37	20 - 2630
Iron	6	6	17,500 - 25,000
Lead	35	37	50 - 1500
Magnesium	6	6	2340 - 39,200
Manganese	6	6	428 - 1550
Mercury	6	6	.14 - .37
Nickel	37	37	7 - 69
Potassium	6	6	1270 - 1720
Selenium	1	6	1.2 - 1.2
Silver	4	6	.55 - 2.8
Sodium	3	6	85.1 - 109
Vanadium	6	6	15.6 - 26.9
Zinc	37	37	21 - 6700
Group: Miscellaneous (%)			
Percent Solids	31	31	68.1 - 96.7

Confirmatory Sample Results

Main Plant residential surface soil confirmatory samples analyzed by the U.S. EPA CLP for VOCs, SVOCs, PAHs, PCBs, pesticides and metals are presented in **Table 4.4.1-21**. Confirmatory samples were collected at the Main Plant residential soil sample locations RS-05, RS-08, RS-15, RS-18, RS-22 and RS-05-D (duplicate sample). Organic results were compared to U.S. EPA sponsored FASP laboratory analyses and inorganic results to Kemron laboratory analyses to insure accuracy. CLP BNA (SVOC) results confirmed FASP laboratory PAH (organic) results except for anthracene. The

detection of anthracene by the CLP lab and not by FASP lab could be the result of matrix heterogeneity. Also, CLP results showed detections for BNAs that were not detected by the FASP lab. This difference exists because FASP lab quantitation limits were greater than the CLP detections. CLP PCB results confirmed FASP lab results except for Aroclor-1254 at RS-05. The difference in reported results may be the result of matrix heterogeneity. CLP metal sample analysis confirms Kemron laboratory metal results. However, CLP results for arsenic, lead and zinc differed minimally from Kemron results for the following reasons. CLP arsenic and zinc concentrations differed from Kemron results due to matrix heterogeneity. CLP lead results at RS-05 and RS-05-D were not within control limits due to matrix heterogeneity and the values were estimated.

4.4.1.5 Discussion

Constituent concentrations may be compared to the initial screening levels provided in **Tables 3.3.1-23** and **4.4.1-24** as a point of reference for the reader. The risk assessment report will provide information on risk based clean-up goals and backgorund levels as appropriate for contaminants of concern.

Buildings
Building surveys documented that the general condition of buildings at the site is poor with damage to ceilings, walls and windows creating conduits for potential contaminant migration outside the buildings through entrainment of contaminants by wind blowing through the buildings. Wipe samples collected from interior surfaces of buildings where gross decontamination was conducted confirm the presence of elevated concentrations of arsenic, cadmium, chromium, copper, lead, nickel and zinc.

Residential Surface Soils
Residential surface soil sample results confirm that airborne contaminants have migrated off-site as evidenced by the highest constituent concentrations (lead) being present at sample locations immediately adjacent to the plant. However, high volume air sample results indicate that although impact to downwind receptors is still occurring, sources other than the CSSS Main Plant appear to be contributing to residential surface soil impacts. The upgradient (upwind) samples indicated comparable particulates and metals results to those obtained downgradient. Residential surface soil results indicate that PAHs and PCBs observed at isolated locations are likely from sources other than CSSS Main Plant. Lead concentrations indicate airborne transport from CSSS and other sources is a likely mechanism to obtain the concentrations and distributions observed. Two samples contain elevated concentrations of arsenic.

An assessment of the risks associated with these contaminant concentrations is provided in the risk assessment.

Basements and Sewers as Potential Sources
Sources of releases to the subsurface primarily include surface spills or releases from subsurface containment or transport systems such as tanks, piping or sewers. Included in the containment systems are basements which, whether intended or not, act as collection and containment structures

which typically leak. The majority of the basements are distributed on the western half of the Main Plant due primarily to the operations conducted in these areas.

Volatile compounds, generally, are the most mobile of the COCs in the subsurface. Trichloroethene and cis-1,2-dichloroethene were the only VOCs detected in two of the 18 basements sampled. Location BS-15 was in the vicinity of an area which used trichloroethene in the manufacturing process and in the vicinity of a reported spill (Building 112-nail mill). Only cis-1,2-dichloroethene was detected at the other location (BS-20) in Building 71B (wire galvanizing). VOCs were also only detected in two sewer samples. Trichloroethene was detected in sample SR-01 at 2,600 µg/kg as well as cis-1,2-dichloroethene at 230 µg/kg. Sample SR-01 is located at a manhole which receives flow from Building 9 (rod cleaning). The second sample, SR-03, contained concentrations of chlorobenzene, ethylbenzene and o-xylene and is located in the maintenance building (Building 25). These four areas along with the sewer lines downgradient are considered potential chronic sources which, if releasing constituents to the subsurface, likely have been doing so for tens of years. The downgradient sewer lines are included as a potential source because of the age and construction of the sewers. The sewers are brick and tile construction and appear poorly maintained.

PAHs generally are less mobile than VOCs but still migrate in the subsurface. Five of the basements sampled (BS-02, BS-04, BS-05, BS-07 and BS-09) had PAHs detected and some had floating hydrocarbons present. One sample of oil from BS-14 was submitted for hydrocarbon "fingerprint" analysis and was qualitatively identified as hydraulic oil. Three of the sewer samples (SR-01, SR-03 and SR-04) exhibited elevated concentrations of PAHs. These five basements and the sewer lines associated with these three sewer samples are considered potential chronic sources which may have been releasing constituents to the subsurface for tens of years.

Aroclor-1242 was detected in sample BS-10 at a concentration of 11 ug/L. This pit in Building 9A (electrical substation) is believed to have formerly contained capacitors and transformers. This pit is also considered a potential chronic source.

Four metals were detected in basement samples above federal MCLs. Arsenic, cadmium and lead were detected above MCLs in samples BS-16, BS-06 and BS-05, respectively. Nickel was detected above MCLs in samples BS-02 and BS-06. These four basements are considered potential chronic sources which may have been releasing constituents to the subsurface for tens of years.

Surface Spills as Sources - Indications from Subsurface Soil Analytical Results

As indicated above, surface spills are a primary source of releases to the subsurface. Subsurface soil analytical results provide a means to evaluate the areal and vertical distribution of contaminants and in some instances identify or confirm historical spills. Identification of these spills is important at the Main Plant due to the shallow depth to bedrock (5-15 feet). Once contaminants reach bedrock their rates of migration increase and the cost of investigation and cleanup increases due to the higher costs required to obtain samples and affect changes to groundwater in bedrock.

Elevated concentrations of trichloroethene were detected in subsurface soil samples SB-A1S (5,600 µg/kg) and SB-A2D (190 µg/kg) in the vicinity of the reported spill at Building 112 (nail mill). Based on these results and those from BS-15, a confirmed release of trichloroethene has occurred to

the subsurface in this area. Groundwater analytical results from monitoring wells LA-04, UA-24 and UA-32 confirm that groundwater has been impacted by trichloroethene in this area. These results indicate that trichloroethene has entered the bedrock and is migrating along fractures and in groundwater. For additional information on hydrogeology and contaminant migration see Section 4.4.6 (Groundwater). The soils containing trichloroethene above bedrock are a chronic source and will continue to be a source until mitigated.

Tetrachloroethene was detected in only one soil sample at the site at SB-A2S (1,600 µg/kg). The tetrachlorethene was detected below a blower outlet for venting air/vapor from the nail mill. Tetrachloroethene is apparently limited to the shallow subsurface and has not been detected in groundwater in the vicinity. Only trichloroethene was detected in the deep sample at this location which may either be related to degredation of tetrachloroethene or the trichloroethene spill at the nail mill. The tetrachloroethane detected in this area, although limited in extent, is considered a chronic source which will continue to release tetrachloroethene as water is flushed through the soils.

Numerous other VOCs were detected across the site at lesser concentrations (**Figures 4.4.1-7** and **4.4.1-8**). These locations are all considered small point sources which may over time potentially contribute VOCs to groundwater. Those with the highest concentrations include shallow samples SB-F8 and SB-G4 and deep samples SB-A2, SB-F2 and SB-E2.

PAHs and observable hydrocarbon product were detected in several samples. While these constituents generally do not migrate as readily as VOCs, they do migrate at lower rates and several PAHs are significant risk drivers. Surface spills evidenced by PAHs and observable hydrocarbon product are limited to three areas at the Main Plant. The scrap storage yard located along the east side of Building 5 (open hearth furnaces), Building 42 (blooming mill) and Building 40 (billet mill) is the area with the most extensive observable hydrocarbon product. Mill filings were piled in this area to allow drainage of cutting and lubricating oils from the filings. This area indicates a confirmed release of hydrocarbons and is considered a chronic source of hydrocarbons and PAHs. Additionally, Aroclor-1242 and Aroclor-1248 were detected in SB-C1, SB-C3, SB-C5, SB-C7 and SB-G7. A confirmed release is indicated in the vicinity of these borings. The second area where a confirmed release of PAHs has occurred is at the south door of Building 20 (main machine shop). It is suspected that hydrocarbons were discarded out this door. These constituents were detected in the shallow soils only and do not appear to have reached bedrock at this time.

The third area where PAHs were observed is north of Kokomo Creek at SB-F2. Elevated concentrations of PAHs (108.7 mg/kg [total]) were detected in the shallow soils as well as in the deep sample (53.2 mg/kg [total]). Although coal was observed in this soil boring, hydrocarbons are believed to be the source of the PAHs due to the presence of Aroclor-1248 in both the shallow and deep soil samples. A confirmed release is indicated in the vicinity of this boring.

PCBs were detected in two soil boring samples in addition to those indicated above. Aroclor-1248 was detected in SB-G1S (9.9 mg/kg) and SB-H3S (30+ mg/kg). A confirmed release is indicated in the vicinity of these borings.

Pesticides were detected in seven samples. Aldrin was detected at its highest concentration in SB-H3S (1000 µg/kg). The remaining detections of pesticides are likely related to pesticide use around the plant site where as the high concentration at SB-H3S may be indicative of disposal practices in the immediate area. These practices are indicated by the presence of elevated concentrations of several constituents at this location as discussed above.

Lead distribution in the shallow samples is generally in seven areas around the site. The first four are in the vicinity of each of the four borings SB-E1, SB-F2, SB-F5 and SB-F8. The fifth area is in the corridor between Building 5 to the east and Buildings 34 and 37 (vicinity of SB-B3 and SB-B4). The sixth area is between Building 69 to the east and Building 42 to the west (vicinity of SB-C5 SB-C3, SB-C4 and SB-G3. The seventh area with the highest concentrations is south and east of Building 71B (vicinity of SB-H3 and SB-H4). The four deep samples do not correspond to the shallow sample locations with higher lead concentrations with the exception of SB-F2D. The remaining locations are in the vicinity of SB-C2D, SB-E4D and SB-F6D. With the exception of the samples collected in the vicinity of Building 71B (wire galvanizing), the distribution of higher lead concentrations does not readily correlate to known site operations.

Zinc was detected at elevated concentrations in four samples (SB-A1, SB-C2, SB-C4 and SB-H3). Elevated zinc concentrations at SB-A1S and SB-H3S may be attributed to galvanizing operations associated with processes in the adjacent buildings (Buildings 112 [nail mill] and 71B [wire galvanizing]).

TCLP analyses indicate the only metals that exceeded the TCLP criteria for metals were cadmium (SB-B4S) and lead (SB-B4S and SB-F2S). The only VOC that exceeded TCLP criteria was 1,2-dichloroethane (SB-B2S).

Indications from Groundwater Analytical Results

VOCs were detected in several samples along the west side of Building 112 and 112B (LA-04, LA-05, UA-12 and UA-24). These VOCs include trichloroethene and its degredation products. 1,2-Dichloroethene was detected in LA-04A at 2,000 µg/kg and trichloroethane was detected in LA-04 and UA-24 at elevated concentrations. Vinyl chloride was detected in samples collected from LA-04, LA-05 and UA-24. These results are consistent with the reported historical spill of trichloroethene in the vicinity of Building 112 (nail mill). Concentrations of cis- and trans-1,2-dichloroethene, trichloroethene and vinyl chloride are highest in the shallow water-bearing zone which is consistent with a surface spill source and the observed results for soil boring samples in the vicinity.

Other VOCs detected around the site were generally at or near method detection limits and are consistent with VOCs expected in an old industrial setting such as this. Analytical results for wells upgradient of the site are generally free of VOCs with the exception of UA-02 where 1,1,1-trichloroethane (1 µg/L) and chloroform (19 µg/L) were detected.

SVOCs were detected sporadically in groundwater across the site at or near method detection limits. Based on these results, off-site migration of SVOCs is not a concern at this time. PCBs were

detected in only one groundwater sample (UA-21). Aroclor -1242 was detected at 4.5 µg/L, however, the CLP confirmatory sampling identified Aroclor-1248 at a concentration of 6.4 µg/L.

Dissolved metals were not detected above MCLs in groundwater samples collected at the Main Plant.

4.4.2 Markland Avenue Quarry

4.4.2.1 Description

Markland Avenue Quarry was mined for limestone in the early 20th century prior to its purchase in 1947 by Continental Steel (CDM 1995a). The quarry was used until the early 1980's by Continental Steel for the disposal of waste materials from the steel processing operations. The approximately 23-acre quarry is bounded by Harrison Street to the north, Markland Avenue to the south, Courtland Avenue to the east, and Brandon Street to the west. The pond area covers approximately four acres and reaches a depth of about 50 feet for approximately 329,120 cubic yards of water. The fill areas cover approximately 10 acres and reach an unknown depth to the base of the quarry. The depth of fill material beneath the quarry pond is also unknown. Two commercial establishments, Moore Drugs and the Village Pantry convenience store, exist at the southeast corner of the former quarry at least partially on fill.

Review of historical aerial photographs show the original quarry as a large pond spanning the entire block, except for the unexcavated southwest corner and southern border, between Courtland Street and Brandon Street in August 1938 (state archive aerial photos). The historical aerial photographs indicate that a rail line ran over the filled area, near the northwestern edge of the fill and as the quarry was filled from southeast to northwest, the rail line was moved northwest with the edge of the fill (**Figure 4.4.2-1**). It was hypothesized that drums of solvents were disposed in the filled area much as they were in the pond, possibly having been transported to the area by rail and then dumped from the train cars. The June 1957 aerial photograph shows that the quarry had been half filled-in and evenly graded, and that a bank had been constructed along the southern edge of the area. A building occupied the southeast corner and the southwest remained unexcavated. By July 1964, the quarry had been filled even further with debris suspected to be from the Main Plant operations. The June 1972 photograph evidences no new filling of the quarry, but some new structures had been erected in the southeast corner as shown on the Site Feature Map, **Figure 4.4.2-1** (Note: Cross section A-A' is in reference to information presented in Section 4.4.6 (Groundwater).

As evidenced by aerial photograph review, waste materials generated during Continental Steel processing operations were disposed of in Markland Avenue Quarry. Quarry fill reportedly included slag, refractory brick, pig iron, baghouse dust, fly ash, and drums. According to former employees, the quarry served as a drum reclamation area where drums were dumped directly onto the ground and disposed of in the quarry pond (CDM 1995a). Previous United States Environmental Protection Agency (U.S. EPA) investigations (July 1986, May 1988) revealed approximately 400 (mostly empty) drums, an abandoned storage tank, and slag, ash and refractory brick piles in the area. In April 1990, the U.S. EPA conducted an underwater investigation and

discovered 1,150 drums, which were then removed from the quarry, sampled, catalogued and stored in the quarry area for subsequent disposal.

Previously the U.S. EPA sampled the contents of the drums, surficial sediments, and quarry pond sediments for numerous organic and inorganic contaminants (CDM 1995b). Analytical results for samples collected by ABB-ES from the quarry pond water and shallow subsurface soil/fill are summarized in **Tables 3-2, 3-3,** and **3-4** of the Focused Remedial Investigation/Feasibility Study (RI/FS) Work Plan (CDM 1995a). The results of these analytical tests indicate that soil, groundwater, quarry pond water and sediment were impacted by volatiles, semivolatiles, PCBs, and metals.

Contaminant characterization by CDM for this Remedial Investigation of the Markland Avenue Quarry, therefore, required diverse media sampling for a wide range of contaminants to delineate the extent, quantity, and type of contamination. Investigation objectives for Markland Avenue Quarry were as follows:

- Pond water and sediment sampling to characterize potential groundwater contaminant sources;
- Pond sediment sampling to identify and characterize the presence of dense non-aqueous phase liquids (DNAPL);
- Surficial soil sampling from the backfilled area to evaluate the potential risk of wind blown dust from this source;
- Residential soil sampling based upon quarry surficial sampling results to assist in risk assessment;
- Geoprobe soil gas surveying to pinpoint potential contaminant "hot spots";
- Groundwater screening for confirmation at soil gas survey "hot spots"; and
- Groundwater sampling at existing and newly installed monitoring wells to further characterize possible contaminant migration.

4.4.2.2 Potential Releases and Migration Pathways

Past dumping of drum contents and disposal of waste drums within the quarry pond and on surrounding soils in addition to the permeable nature of the backfilled material (slag) itself, resulted in the release of wastes into the Markland Avenue Quarry pond water, sediment, and soil/fill.

Two major subsurface pathways exist that serve as conduits for contaminant migration. Since the quarry pond is a surficial expression of the water table and is hydraulically connected to the local aquifer system, contaminants present within the pond water and sediment may migrate laterally and downward out of the pond into the shallow, intermediate and lower water-bearing zones.

Contaminants buried in drums within the soil and backfilled areas may also leach downward into the groundwater if released. The migration of contaminants via these two routes is dependent not only on groundwater flow gradient and direction but also on the physical characteristics of contaminants, physical characteristics of fill or soil pH.

Dense Non-Aqueous Phase Liquids (DNAPLs) present in the fill, at the quarry pond bottom or in bedrock may travel beyond Markland Avenue Quarry in a soluble and/or insoluble phase. As an insoluble contaminant, DNAPL migration is governed by gravity, viscosity, and physical subsurface structures including the relatively impermeable quarry floor as well as secondary porosity such as joints or fractures in bedrock. DNAPLs invading the joints may fill the interstitial pore space along fractures in the bedrock and may act as a source for releasing soluble-phase contaminants. Note that DNAPL travels at a different rate than groundwater, typically much slower, but depends on the fractures present. These soluble phase contaminants are dissolved and transported in groundwater and transported in the direction of groundwater flow. Thus, joints may act as a conduit for soluble and insoluble DNAPL migration.

Slag exposed at the ground surface at Markland Avenue Quarry may contain contaminants which might be released via tractive transport (picked up by air) and airborne dispersion of contaminants adsorbed or adhered to soil particles. Potential for contaminant release via airborne dispersion and potential for deposition into residential areas is discussed in detail in **Appendix E**. Also, the release of volatiles to the air during pond turnover is another possible surficial pathway for contaminant release.

4.4.2.3 Summary of Investigations

Delineation of the nature and extent of contaminants present and evaluation of releases from the backfilled area and quarry pond necessitated a diverse sampling program. The following summaries address the field investigation activities at Markland Avenue Quarry according to media and sample method. A more detailed discussion of hydrogeology and the groundwater is presented in Section 4.6.

Pond Water Sampling

To characterize the contaminants in the quarry pond water, samples were collected for chemical analysis at three depth intervals (labeled A, B and C for shallow, intermediate, and deep, respectively) within the pond water column at three locations according to the procedure outlined in the Work Plan and Field Sampling Plan (CDM 1995a and 1995b, respectively). The sample collection locations are identified as follows: SW-01A (29 ft), SW-01B (33 ft), SW-01C (48 ft), SW-02A (30 ft), SW-02B (33 ft), SW-02C (48 ft), SW-03A (31 ft), SW-03B (33 ft), SW-03C (48 ft) (also see **Figure 4.4.2-2**). Field interpretation of dissolved oxygen and conductivity values throughout the pond water column indicated a significant change in these two parameters at 33 feet and 28 to 29 feet. Based on the profile, samples collected at the 28 to 29 foot depth are representative of the values recorded from 0 to 29 feet.

Water column stratification profiling was to be employed during the summer and in the late fall to define the seasonal turnover/mixing in the pond and determine the potential for volatilization and

release to the air. Since the field work did not begin until the Work Plan was approved by the IDEM and U.S. EPA, in the fall, only one profile was collected. Results of the profile collected confirmed the presence of contaminants at the pond surface and the potential for migration of contaminants to the pond surface where volatilization and air dispersion can occur.

Water column profile results for pH, temperature, dissolved oxygen, and conductivity versus depth using a Grant/YSI Water Quality Monitoring System showed three distinct stratified layers with respect to parameter changes as shown in **Table 4.4.2-1**. A close correlation between pH and temperature exists. Due to this correlation, a water quality device that automatically adjusted pH results according to temperature was used. Samples were collected from each of the three layers using a vertical bottle sampler and analyzed for VOCs, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and metals. Confirmatory surface water samples were analyzed by the U.S. EPA Contract Laboratory Program (CLP) for VOCs, SVOCs, PCBs, pesticides and target analyte list (TAL) metals.

Initial samples were collected at SW-01 before water column stratification profiling was performed with the Grant/YSI Water Quality Monitoring System as specified in the FSP (1995b). That location (SW-01) was resampled following the profiling.

Pond Sediment Sampling

Characterization of quarry pond bottom sediments was accomplished by collecting and analyzing core samples at nine locations. The sample collection locations are identified as follows: SD-01, SD-02, SD-03, SD-04, SD-05, SD-06, SD-07, SD-08 (**Figure 4.4.2-2**). Sample recovery difficulties created by sediment softness and in some areas the absence of sediment (northwest corner) necessitated a change in the sample procedure and locations (CDM 1995a). The non-cohesive nature of the sediment inhibited collection of a shallow and deep sample and composite samples were collected instead. A dilution effect created by composite sampling rendered ultraviolet fluorescence and hydrophobic dye shaker testing (for DNAPL) ineffective, and they were not used. Sediment sample field screening results using a photo ionization detector (PID) and visual observation of product confirmed the presence of DNAPL, which was the objective outlined in the FSP (CDM 1995a). Quarry pond sediment composite samples were analyzed for VOCs, PAHs, PCBs and metals. Confirmatory quarry pond sediment samples were analyzed by the CLP laboratory for VOCs, SVOCs, PCBs, pesticides and Target Analyte List (TAL) metals.

Surface Soil Sampling

Markland Avenue Quarry surface soil samples were collected according to the Work Plan and FSP (CDM 1995a and 1995b) to evaluate the potential risk of airborne dust from the backfilled quarry areas. Surface soils were sampled at 26 locations and analyzed for PAHs, PCBs and metals (**Figure 4.4.2-3**). Confirmatory surface soil samples were analyzed by the CLP laboratory for SVOCs, PCBs, pesticides and TAL metals. Concentration plots for lead and total PCBs are presented on **Figures 4.4.2-4** and **4.4.2-5**, respectively.

Residential Surface Soil Sampling

Surface soil sampling was conducted at 10 residential locations and at two locations (RS-111, RS-112) in a proposed soccer field to determine the presence or absence of surficial contamination resulting

from wind borne transport of constituents from the site (**Figure 4.4.2-6**). Sample results were used to provide input to the risk assessment. Samples were collected according to the procedures outlined in the Work Plan and FSP (CDM 1995a and 1995b, respectively). Originally, only ten samples were to be collected and analyzed. However, IDEM requested collection of two additional samples at the proposed soccer field location west of the Fence Plant. Laboratory analysis was identical to that conducted on surface soil samples collected within Markland Avenue Quarry.

Soil Gas Survey

A soil gas survey was conducted to delineate the areal extent of potential impact to the subsurface and to identify hot spots indicative of buried drums or pockets of product within the fill. Eighty soil gas sampling locations were proposed in the Work Plan and FSP (CDM 1995a and 1995b, respectively), utilizing a 100-foot by 100-foot survey grid. A total of 77 soil gas samples were actually collected due to site conditions. Access could not be obtained to seven of the proposed locations which were located southeast of Markland Quarry in the Moore Drugs and Village Pantry parking lots. Due to inaccessibility or resistance when penetrating the slag, seven proposed locations within Markland Quarry were not sampled. Eleven additional samples MQSG-81 through MQSG-91 were collected in areas where field gas chromatography (GC) results showed elevated concentrations of VOCs in the soil gas. These samples were collected at 50 foot intervals centered on locations where elevated VOC concentrations were detected to further delineate the hot spots within the Quarry. A combination of geostatistical analysis and professional judgement was used to select additional sampling locations. **Figure 4.4.2-7** shows the 77 soil gas sampling locations.

Geo-EAS software (Version 1.2.1, U.S. EPA 1991) was used to perform two-dimensional geostatistical analysis of the spatially distributed soil gas data. Variograms were developed to assess the degree of correlation of soil gas concentrations in the quarry as a function of the distance and direction between samples. Kriging was then used to interpolate between existing sample data points to determine areas of greatest statistical uncertainty. Additional sampling points were selected in areas of greatest uncertainty, together with field judgement because of the large amount of scatter in the variograms.

The degree of spatial correlation for trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethene and vinyl chloride was difficult to assess because the variograms exhibited significant scatter. The poorly-defined variograms likely resulted from the relatively small number of samples with detectable concentrations, compared with the total number of soil gas samples. Variograms were not developed for tetrachloroethene and 1,1,1-trichloroethane because these compounds were not detected in any of the quarry soil gas samples. Because of the lack of well-defined variograms, professional judgment was the dominant method used for choosing fill-in sampling locations.

A geoprobe was utilized to perform the soil gas survey. Optimally, the hydraulically operated soil gas probe was driven to a depth of 8 to 10 feet and a soil gas sample was collected from that depth. However, due to resistance encountered in the slag fill, several options described in the FSP (1995b) were used to ensure sample collection. If geoprobe refusal was encountered within the first four feet, the sample location was moved within a ten-foot radius. A limit of three attempts per sample

location and a minimum depth of two feet was used throughout the survey. Using the two foot sample depth as a minimum (CDM 1995a) ensured that ambient air would not be sampled. Soil gas sampling depths ranged from 2 to 10 feet below ground surface. Soil gas samples were analyzed for trans-1,2-dichloroethene, cis-1,2-dichloroethene, tricholorethene, tetrachloroethene, vinyl chloride, 1,1,1-trichloroethane, and 1,1-dichloroethene.

Groundwater Screening
Groundwater sampling was attempted at locations showing elevated soil gas contaminant concentrations. According to the procedure outlined in the Work Plan and FSP (CDM 1995a and 1995b, respectively), CDM attempted three times to collect a groundwater sample at a depth of up to 50 feet below ground surface. Due to the resistance of the backfill (slag), sediment clogging the milled (slotted) rods, hole collapse and the absence of groundwater at many of the selected locations, only 6 of the 23 geoprobe groundwater screening samples were collected as follows: GW-35, GW-52, GW-85, GW-86, GW-87 and GW-88 as shown on **Figure 4.4.2-7**. Samples were collected according to sampling plan procedures at depths ranging from approximately 5 to 35 feet below ground surface. The samples were analyzed for volatile organic compounds (VOCs) by the U.S. EPA Field Analytical Services Program (FASP) laboratory.

Groundwater
One downgradient well, LA-101C, was installed at the western margin of the quarry (CDM 1995a) to better characterize the effects of contamination in the quarry on the local aquifer. Through comparison of groundwater elevation and water quality results at the two existing downgradient wells (UA-06 and LA-02) with results for new well LA-101C, the origin, extent, and presence of contamination could be more fully evaluated. Monitoring well LA-101C was screened at the approximate depth of the quarry bottom (78 to 88 feet in depth) and the installation and lithologic details are included in section 4.4.6 of the Remedial Investigation report. Groundwater samples were collected from upgradient wells (LA-01 and UA-01) and from UA-22 in the middle of the quarry (wells within the source area). Well locations are shown on **Figure 2-1**. A detailed discussion of groundwater and analytical results is also included in section 4.4.6 of the Remedial Investigation report.

4.4.2.4 Analytical Results

Results are presented in the text to provide an initial summary of contaminants detected within each sampled media. A complete list of all detections per each sample is given in the appropriate table located in the Tables section of this document.

4.4.2.4.1 Surface Water Analytical Results

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in surface water samples at the Markland Avenue Quarry pond is presented in **Table 4.4.2-2.** Sampling locations are shown on **Figure 4.4.2-2**. **Table 4.4.2-3** shows the frequency of detection and range of concentrations for parameters detected in surface water samples.

Note that two sets of analytical results are presented for samples SW-01A, SW-01B and SW-01C. One set of results are for samples collected at these locations on November 1, 1995, before pond surface water column profiling, and the other set of results are for samples collected at these locations on November 13, 1995, after water column profiling. Furthermore, the field blank sample taken at SW-01A showed a detection of 12 µg/L for methylene chloride which may be due to common laboratory contamination. Consequently, any detection of methylene chloride at a level less than or equal to 120 µg/L (10 times the blank level) should be considered probable lab contamination.

Field duplicate sample result concentrations for SW-02A-D (30 ft) compare well with results for the investigation water sample at SW-02A (30 ft).

The range of concentrations detected for each parameter are as follows [units: organics = µg/L (parts per billion) and inorganics mg/L (parts per million)]:

Surface Water Samples

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
Trichloroethene	13	13	13 - 3400
Methylene Chloride	3	13	8.6 - 19
cis-1,2-Dichloroethene	3	13	34 - 41
Group: Inorganics (mg/L)			
Arsenic, Total	1	13	.054 - .054
Barium, Total	11	13	.048 - .68
Zinc, Total	3	13	.02 - .12

4.4.2.4.2 Sediment Analytical Results

A list of organic and inorganic compounds detected in the pond sediment samples at the Markland Avenue Quarry is presented in **Table 4.4.2-4**. **Table 4.4.2-5** shows the frequency of detection and range of concentrations for parameters detected in pond sediment samples. Sampling locations are shown on **Figure 4.4.2-2**.

The range of concentrations detected for each parameter are as follows [units: organics µg/kg (parts per billion) and inorganics mg/kg (parts per million)]:

Pond Sediment Sample Results

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/kg)			
1,1-Dichloroethene	2	9	26 - 100
1,2-Dichloroethane	1	9	2 - 2
Benzene	2	9	20 - 28
Chlorobenzene	1	9	30 - 30
Ethylbenzene	4	9	5.1 - 4000
m&p-Xylene	3	9	5.7 - 330
o-Xylene	5	9	5.4 - 3400
Tetrachloroethene	3	9	5.8 - 75
Toluene	5	9	8 - 8600
Trichloroethene	9	9	260 - 13,000
Methylene Chloride	1	9	12 - 12
cis-1,2-Dichloroethene	5	9	6.8 - 260
trans-1,2-Dichloroethene	1	9	38 - 38
Group: PAHs (µg/kg)			
Acenaphthene	2	9	3100 - 3800
Acenaphthylene	2	9	3000 - 3900
Anthracene	2	9	2500 - 3000
Benzo(a)pyrene	4	9	3700 - 14,000
Benzo(a)anthracene	6	9	11,000 - 30,000
Benzo(b&k)fluoranthene	6	9	6000 - 24,000
Benzo(g,h,i)perylene	2	9	7400 - 8200
Fluoranthene	5	9	2500 - 9900
Fluorene	2	9	4300 - 5400
Indeno(1,2,3-cd)pyrene	3	9	15,000 - 28,000
Chrysene	3	9	22,000 - 28,000
Phenanthrene	5	9	2000 - 9300
Group: PCBs (µg/kg)			
Aroclor-1242	3	9	900 - 3300
Aroclor-1248	5	9	700 - 5100

Pond Sediment Sample Results (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (mg/kg)			
Arsenic, Total	7	9	13 - 73
Barium, Total	9	9	140 - 300
Cadmium, Total	9	9	5 - 18
Chromium, Total	9	9	33 - 190
Copper, Total	9	9	38 - 310
Lead, Total	9	9	500 - 1300
Nickel, Total	9	9	11 - 120
Zinc, Total	9	9	160 - 2900
Group: Miscellaneous (%)			
Percent Solids	9	9	45 - 79.8

4.4.2.4.3 Surface Soil Analytical Results

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in surface soil samples at the Markland Avenue Quarry is presented in **Table 4.4.2-6**. **Table 4.4.2-7** shows the frequency of detection and range of concentrations for parameters detected in surface soil samples. Sampling locations are shown on **Figure 4.4.2-3**. Concentration dot plots for both lead and total PCBs are also presented in **Figure 4.4.2-4** and **Figure 4.4.2-5**, respectively.

The range of concentrations detected for each parameter are as follows [units: organics µg/kg (parts per billion) and inorganics = mg/kg (parts per million)]:

Surface Soil Sample Results

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: PAHs (µg/kg)			
Acenaphthylene	1	29	1600 - 1600
Anthracene	3	29	2100 - 4200
Benzo(a)pyrene	3	29	4600 - 7600
Benzo(a)anthracene	3	29	11,000 - 18,000
Benzo(b&k)fluoranthene	4	29	5100 - 17,000

Surface Soil Sample Results (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: PAHs (µg/kg) (Continued)			
Benzo(g,h,i)perylene	4	29	3100 - 7100
Dibenzo(a,h)anthracene	1	29	22,000 - 22,000
Fluoranthene	4	29	2800 - 5300
Indeno(1,2,3-cd)pyrene	3	29	16,000 - 24,000
Chrysene	4	29	16,000 - 27,000
Phenanthrene	3	29	1800 - 4400
Group: PCBs (µg/kg)			
Aroclor-1248	6	29	670 - 16,000
Group: Inorganics (mg/kg)			
Arsenic, Total	29	29	42 - 140
Barium, Total	29	29	20 - 690
Cadmium, Total	24	29	4 - 36
Chromium, Total	29	29	10 - 2800
Copper, Total	28	29	29 - 1100
Lead, Total	28	29	77 - 2400
Nickel, Total	29	29	19 - 850
Zinc, Total	29	29	63 - 41,000
Group: Miscellaneous (%)			
Percent Solids	29	29	67.1 - 95.7

4.4.2.4.4 Residential Surface Soil Analytical Results

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in residential surface soil samples at the Markland Avenue Quarry is presented in **Table 4.4.2-8**. **Table 4.4.2-9** shows the frequency of detection and range of concentrations for parameters detected in residential surface soil samples. Sampling locations are shown on **Figure 4.4.2-6**.

The range of concentrations detected for each parameter are as follows [units: organics µg/kg (parts per billion) and inorganics = mg/kg (parts per million)]:

Residential Surface Soil Samples

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: PAHs (µg/kg)			
Benzo(g,h,i)perylene	1	12	3000 - 3000
Dibenzo(a,h)anthracene	1	12	15,000 - 15,000
Fluoranthene	2	12	2600 - 3100
Group: PCBs (µg/kg)			
Aroclor-1248	2	12	650 - 680
Group: Inorganics (mg/kg)			
Arsenic, Total	13	13	43 - 74
Barium, Total	13	13	46 - 130
Cadmium, Total	3	13	4 - 6
Chromium, Total	13	13	16 - 38
Copper, Total	11	13	20 - 57
Lead, Total	12	13	44 - 180
Nickel, Total	13	13	17 - 93
Zinc, Total	13	13	72 - 370
Group: Miscellaneous (%)			
Percent Solids	13	*13*	77 - 85.9

4.4.2.4.5 *Soil Gas Analytical Results*

A list of organic compounds detected in the soil gas samples at Markland Avenue Quarry is presented in **Table 4.4.2-10**. Soil gas sampling locations are shown on **Figure 4.4.2-7**. Concentrations dot plots showing the distribution of trans-1,2-dichloroethene, cis-1,2-dichloroethene, trichloroethene, vinyl chloride and 1,1-dichloroethene are presented in **Figures 4.4.2-8, 4.4.2-9, 4.4.2-10, 4.4.2-11** and **4.4.2-12**, respectively.

The range of concentrations detected for each parameter are as follows [units: organics = (mg/m^3)]:

Soil Gas Analytical Sample Results

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (mg/m^3)			
1,1-dichloroethene	6	77	1 - 32
Cis-1,2-dichloroethene	19	77	1 - 1980
Trans-1,2-dichloroethene	6	77	2 - 17
Trichloroethene	34	77	1 - 4530
Vinyl chloride	5	77	1 - 290

4.4.2.4.6 Groundwater Screening Analytical Results

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in groundwater screening samples at the Markland Avenue Quarry is presented in **Table 4.4.2-11**. **Table 4.4.2-12** shows the frequency of detection and range of concentrations detected in groundwater screening analyses. Sampling locations are shown on **Figure 4.4.2-7**.

The range of concentrations detected for each parameter are as follows [units: organics = µg/L (parts per billion)]:

Groundwater Screening Samples

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1,1-Trichloroethane	3	8	590 - 1200
1,2-Dichloroethane	2	8	560 - 700
cis-1,2-Dichloroethene	6	8	6.7 - 33,000
Benzene	1	8	20 - 20
Chlorobenzene	1	8	18 - 18
Ethylbenzene	1	8	18 - 18
Methylene Chloride	1	8	250 - 250
Toluene	1	8	22 - 22
Trichloroethene	7	8	6.6 - 3000
m&p-Xylene	1	8	20 - 20
o-Xylene	3	8	8 - 55

4.4.2.4.7 Groundwater Analytical Results

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in groundwater samples collected from the shallow, intermediate and lower water-bearing unit monitoring wells within and surrounding the Markland Avenue Quarry is presented in **Tables 4.4.2-13, 4.4.2-16** and **4.4.2-19**, respectively. Selected groundwater monitoring wells in the vicinity of the Markland Avenue Quarry from which groundwater samples were collected are shown in **Figure 2-1**. Groundwater results are reported according to shallow (760 feet above mean sea level (amsl) and above), intermediate (700 to 760 feet (amsl)), and lower (660 to 700 feet (amsl)) water bearing units. Monitoring wells LA-01, UA-01, UA-04 and UA-22 are screened in the shallow water-bearing unit, LA-01B, LA-02A, LA-02B and LA-101C are screened in the intermediate water-bearing unit and LA-01C and LA-02C are screened in the lower water-bearing unit. Groundwater frequency of detection and range of concentrations for parameters detected in shallow, intermediate and lower water-bearing zones for CDM groundwater samples are found in **Tables 4.4.2-14, 4.4.2-17** and **4.4.2-20**, respectively, and for ABB-ES groundwater samples in **Tables 4.4.2-15, 4.4.2-18** and **4.4.2-21**, respectively.

The range of concentrations detected during CDM's 1995 investigation for each parameter are as follows [units: organics = µg/kg (parts per billion) and inorganics = mg/kg (parts per million)]:

Shallow Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethene	1	4	1 - 1
Acetone	1	4	3 - 3
Benzene	1	4	1 - 1
cis-1,2-Dichloroethene	1	4	150 - 150
m&p-Xylene	1	4	1 - 1
Methylene Chloride	1	4	1 - 1
o-Xylene	1	4	2 - 2
trans-1,2-Dichloroethene	1	4	5 - 5
Trichloroethene	1	4	440 - 440
Vinyl Chloride	1	4	4 - 4
Group: SVOCs (µg/L)			
1,2,4-Trimethylbenzene	1	4	9 - 9
1,3,5-Trimethylbenzene	1	4	4 - 4

Shallow Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: PAHs (µg/L)			
Naphthalene	1	4	16 - 16
Group: Inorganics (mg/L)			
Aluminum, Dissolved	2	4	.082 - .646
Antimony, Dissolved	1	4	.006 - .006
Barium, Dissolved	4	4	.039 - .358
Cadmium, Dissolved	1	4	.0004 - .0004
Calcium, Dissolved	4	4	87 - 205
Copper, Dissolved	2	4	.013 - .013
Iron, Dissolved	1	4	.083 - .083
Lead, Dissolved	1	4	.12 - .12
Magnesium, Dissolved	3	4	11 - 25
Manganese, Dissolved	4	4	.01 - .07
Mercury	2	4	.0002 - .0003
Nickel, Dissolved	1	4	.021 - .021
Potassium, Dissolved	1	4	79 - 79
Sodium, Dissolved	4	4	61 - 139
Zinc, Dissolved	1	4	.621 - .621
Group: Miscellaneous (mg/L)			
Chloride	3	4	51 - 265

Intermediate Water-bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethene	1	5	3 - 3
Acetone	1	4	14 - 14
Benzene	1	5	1 - 1
Chloromethane	1	4	1 - 1
cis-1,2-Dichloroethene	4	5	44 - 1400

Intermediate Water-bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L) (Continued)			
m&p-Xylene	1	5	1 - 1
Toluene	1	5	1 - 1
trans-1,2-Dichloroethene	3	5	12 - 29
Trichloroethene	4	5	11 - 720
Vinyl Chloride	2	4	3 - 5
Group: Inorganics (mg/L)			
Aluminum, Dissolved	1	4	.101 - .101
Antimony, Dissolved	1	4	.002 - .002
Arsenic, Dissolved	1	4	.003 - .003
Barium, Dissolved	4	4	.012 - .106
Calcium, Dissolved	4	4	3 - 102
Copper, Dissolved	2	4	.007 - .009
Iron, Dissolved	2	4	.266 - .347
Magnesium, Dissolved	3	4	3 - 31
Manganese, Dissolved	2	4	.027 - .049
Potassium, Dissolved	2	4	7 - 53
Sodium, Dissolved	4	4	16 - 72
Group: Miscellaneous (mg/L)			
Chloride	4	4	29 - 107

Lower Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
Acetone	1	2	18 - 18
Acrylonitrile	2	2	21 - 85
Carbon Disulfide	1	2	2 - 2
cis-1,2-Dichloroethene	1	2	19 - 19

Lower Water-bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L) (Continued)			
m&p-Xylene	1	2	1 - 1
Styrene	1	2	6 - 6
trans-1,2-Dichloroethene	1	2	1 - 1
Trichloroethene	1	2	62 - 62
Group: PAHs (µg/L)			
Naphthalene	1	2	1 - 1
Group: Inorganics (mg/L)			
Barium, Dissolved	2	2	.038 - .114
Calcium, Dissolved	2	2	13 - 104
Chromium, Dissolved	1	2	.016 - .016
Iron, Dissolved	1	2	.261 - .261
Magnesium, Dissolved	2	2	6 - 37
Manganese, Dissolved	1	2	.014 - .014
Potassium, Dissolved	1	2	11 - 11
Sodium, Dissolved	2	2	23 - 36
Group: Miscellaneous (mg/L)			
Chloride	2	2	51 - 65

4.4.2.5 Discussion

The previous investigation conducted by ABB-ES in 1992 did not include an investigation of the Markland Avenue Quarry area. One monitoring well was installed, UA-22, and soil samples from fill were collected during drilling to a depth of 60 feet below ground surface. Contaminants of concern that were detected in the subsurface samples from UA-22 included VOCs, PAHs and metals. U.S. EPA's work in the quarry area in 1987 indicated that VOCs, SVOCs, PCBs and metals were present in the quarry sediments. Pond water samples contained VOCs, SVOCs and metals and a pH of 11.5 near the surface to 12.7 at depth. CDM's investigation confirms the presence of the contaminant groups previously identified, and defines the nature and extent of the contamination in the quarry area.

The soil gas survey was conducted in the filled area of the quarry to identify potential areas of high VOC contamination. The historical aerial photographs indicate that a rail line ran over the filled

area, near the northwestern edge of the fill and as the quarry was filled from southeast to northwest, the rail line was moved northwest with the edge of the fill (**Figure 4.4.2-1**). It was hypothesized that drums of solvents were disposed in the filled area much as they were in the pond, possibly having been transported to the area by rail and then dumped from the train cars.

Constituent concentrations may be compared to the initial screening levels provided in **Tables 4.4.1-23** and **4.4.1-24** as a point of reference for the reader. The risk assessment will provide information on risk based clean-up goals and background levels as appropriate for contaminants of concern.

Soil Gas Survey and Groundwater Screening

The soil gas data indicate three hot spots of VOC contamination, consisting primarily of trichloroethene and its degradation products, cis-1,2-dichloroethene, trans-1,2-dichloroethene and vinyl chloride (**Figures 4.4.2-8, 4.4.2-9, 4.4.2-10** and **4.4.2-11**). The area with the highest contaminant concentration is located just north of the abandoned concrete structure in the southwest portion of the site. This area is of particular concern because of the relatively high concentration detected of degradation product vinyl chloride (**Figure 4.4.2-11**). The other two areas and an area of lesser concentration are located along a line from southwest to northeast that parallels the old rail line. Note that at soil gas location MQSG-35 (**Figure 4.4.2-7**), resistance was encountered when advancing the rod. The possibility exists that the resistance was a drum as the rod was coated with free product when pulled from the hole.

Although the soil gas survey did not define the vertical extent of VOC contamination, it served as a qualitative screening tool by detecting VOC hot spots. These VOC contaminated areas indicate either a source within the vadose zone (unsaturated zone) or the shallow groundwater. Vadose zone and shallow groundwater VOC contamination in the Markland Avenue Quarry may have resulted from past disposal activities including solvent dumping and drum disposal and burial.

The Work Plan (CDM 1995a) discussed the option of subsurface air migration modeling if elevated levels of VOCs are detected along the exterior of commercial buildings in the southeast portion of the quarry. The VOCs were detected primarily in the areas indicated above within the fill and fall off to non-detects at the quarry fence line. Samples were not collected from these commercial properties due to the inability to clear subsurface utilities on the property. Because no constituents were detected adjacent to buildings along the quarry fence line, subsurface air migration modeling was not performed.

The groundwater screening samples collected do not provide sufficient coverage to fully evaluate vertical extent of contamination at the source areas. Most locations where sampling was successful were in the central, most impacted area (**Figure 4.4.2-7**). The groundwater analytical results at this location indicate trichloroethene and cis-1,2-dichloroethene at a depth of 10 feet below ground surface at concentrations up to 3,000 µg/L and 33,000 µg/L, respectively and only ppb (parts per billion) level trichloroethene at depths of 28 and 35 feet below ground surface.

Groundwater analytical results were collected from shallow depths at sample locations GW-35, GW-52, GW-85, GW-86, GW-87 and GW-88 (**Figure 4.4.2-7**) and indicated trichloroethene, benzene, toluene, ethylbenzene and xylene (BTEX) at concentrations up to 3,000 µg/L (trichoroethene) (**Table**

4.4.2-11). The presence of the BTEX compounds within the fill indicate that light petroleum products similar to gasoline were also disposed in the fill area. Shallow groundwater at the central impact area is present at a depth of approximately eight feet. No groundwater results are available for evaluation of the two remaining impacted areas.

Surface Water and Sediment

The surface water samples show a distinct pattern of VOC contamination, trending from lower concentrations to higher concentrations with depth. The primary VOC detected was trichloroethene, with low level detections of the degradation product cis-1,2-dichloroethene. Methylene chloride detections are likely a result of laboratory contamination as it was detected in the field and laboratory blanks.

VOC contamination in the pond is likely a result of a combination of migration of contaminated groundwater from the adjacent fill area where trichloroethene is the primary VOC detected and dissolution from VOC contamination in the pond sediments. The stratification of contamination is likely due to the nature of the VOCs impacting lower depth of water from the bottom sediments. The detected VOCs have a specific gravity greater than 1 (the specific gravity of water) which results in an accumulation of the VOCs in lowest parts in the pond. As these compounds enter the dissolved phase, they tend to stay near the bottom unless influenced by seasonal turnover in the pond. As the VOCs near the surface, their concentration will be decreased through volatilization and UV (ultraviolet) oxidation from sunlight. Dissolved oxygen and conductivity distributions indicate aerobic degradation is occurring to depths of approximately 30 feet and that aerobic biodegradation is occurring at low rates below 30 feet. Some evidence of biodegradation was observed at depth, but is likely being impeded by the high pH in the pond water.

Based on surface water stratification profiling results collected in early November, 1995 it appears the pond was in the process of turnover (**Table 4.4.2-1**). The warmest temperatures were observed at depths of 30 to 38 feet in the middle of the water column. Additionally, water temperatures were fairly consistent with the largest temperature differential throughout the column of 1.3 degrees Celsius. These temperature measurements indicate thermal mixing or turnover has occurred. Comparison of samples SW-01B and SW-01C collected November 1, 1995 to SW-01B and SW-01C collected November 13, 1995 indicate a decrease in concentration at these intervals by an order of magnitude which may be a result of mixing (**Table 4.4.2-2**). Stratification of contaminants is more pronounced in the earlier samples which also supports the observation that mixing occurs in the pond. Sample results for SW-01A collected November 1, 1995 at a depth of one foot indicate 59 µg/L of trichloroethene at the pond surface which confirms that volatilization may be occurring from the pond surface. The presence of trichloroethene at the pond surface confirms that mixing or distribution of VOCs occurs in the pond and sample concentrations confirm that contaminants are leaching from the pond sediments or adjacent fill into the pond surface water. Based on these results, no further sampling of pond water is recommended at this time.

The pond surface water did not contain any PAHs or PCBs and only three metals were detected but the levels are below the benchmark screening levels for surface water. Surface water and sediment benchmark criteria are provided in the risk assessment. PAHs and PCBs are relatively insoluble and

are not likely to leach into the surface water. The solubility of metals is strongly dependent on pH, redox potential, and the presence of both complexing ligands and adsorbing surfaces. The pH of the Markland Avenue Quarry surface waters was observed to range from 11.4 to 12.6. Because only pH data is available, this information can not be used to determine the solubility of the metals present but can be used to narrow the field of possible metal species and their solubilities. Seasonal variation would not be expected to change the measured pH values by a significant amount. Furthermore, the precision of the pH observations is sufficient for the discussion of metal solubility.

At a pH range of 11.4 to 12.6, arsenic, barium, chromium, nickel and zinc may form either soluble metal complexes (depending on the environment) or insoluble hydroxides, carbonates, sulfide, sulfates or arsenates. Cadmium, copper and lead will typically form complexes with low solubilities. The presence of arsenic, barium and zinc in the surface water may indicate that some of the soluble complexes of these metals have been formed while lead chromium and copper are likely present in a less soluble form.

The pond sediment is contaminated at ppm levels with VOCs, PAHs, PCBs and metals. Most of the parameters detected in the sediment exceed sediment benchmark screening levels, which are based on aquatic toxicity. Trichloroethene is the most prevalent VOC and was detected at the highest concentration (of 40,000 µg/L at SD-09) (**Figure 4.4.2-2**). This is consistent with the surface water and soil gas data collected in the quarry area. Visual observations by both CDM and the U.S. EPA (during drum removal) confirm that DNAPL pockets exist in the sediment and along the quarry bottom. The presence of contaminants and the DNAPL is likely to be a direct result of past dumping of drums into the pond. Currently, contaminants may be migrating into the pond sediments from the fill either in the dissolved form via groundwater and subsequent sorption or as DNAPL traveling down through the fill and into the pond.

Groundwater

CDM's 1995 groundwater data and ABB-ES 1993 groundwater data were evaluated for wells bordering the quarry on the east, north and west. A detailed discussion of groundwater is presented in Section 4.4.6 of this report. A summary of detections for the shallow, intermediate and lower water-bearing zone-wells sampled by CDM (1995) and ABB-ES in 1992 is presented in **Tables 4.4.2-13, 4.4.2-16** and **4.4.2-19**, respectively. CDM frequency of detection results are reported for shallow, intermediate and lower water-bearing zones in **Tables 4.4.2-14, 4.4.2-17** and **4.4.2-20.** The corresponding ABB-ES groundwater frequency of detection results are reported in **Tables 4.4.2-15, 4.4.2-18** and **4.4.2-21**, respectively. Upgradient wells UA-03 and UA- 27 were unimpacted based on the 1993 data and were not resampled by CDM in 1995. The other two upgradient wells, UA-01 and LA-01 were also not impacted by contaminants from the quarry based on both sets of data. There were low level detections of pesticides in both wells in the ABB-ES data set that are below the groundwater screening criteria. As pesticides were not a contaminant of concern for this area they were not resampled. CDM observed a low level detection of acrylonitrile in LA-01 in the lower aquifer. The source of this VOC is unknown.

The monitoring wells located within the quarry fill and downgradient contained primarily VOCs, including trichloroethene, cis-1,2-dichloroethene and vinyl chloride. CDM and ABB-ES data are

consistent, with the prevalence of degradation products increasing in the 1995 samples. This would be expected over time as the degradation of the contaminants progresses.

The intermediate zone appears to be the most contaminated as evidenced by the data from LA-02 at 72 feet and LA-101C at 100 feet. The degradation product cis-1,2-dichloroethene is present at a part per million with ppb levels of trichloroethene, indicating that degradation is well progressed outside of the quarry fill area. The other downgradient well, UA-04, is unimpacted, likely because the well is not screened in a fracture zone as indicated by the slow recharge rate. Furthermore, UA-04 is a shallow well with a depth of only 13 feet. Most contaminants at the site are denser than water and would be expected to be present at greater depths.

It is likely that contamination from the quarry sediment and surface water is migrating into the groundwater and moving downward as it moves to the west with groundwater flow.

Any DNAPL that migrates out of the pond would follow preferential flow pathways such as fractures or a confining layer and be influenced more by gravity than by flow direction. The ppm (parts per million) levels of degradation product likely indicate an older slug of contamination moving through the intermediate aquifer just outside the quarry boundary.

The groundwater data is in good agreement with the constituent detected in soil gas, surface water and sediment data. Trichloroethene is the primary contaminant detected in the source areas with degradation products becoming more prevalent with depth and distance from the source.

Surface Soil

Surface soil samples were collected within the quarry fill boundaries and at selected residences upgradient and downgradient of the quarry area to evaluate the potential risks associated with the surficial soils. The metals data from the quarry area was used to perform a preliminary screening level air impact analysis.

The surface soils in the quarry fill area were contaminated primarily with PAHs, the PCB Aroclor-1248 and metals (arsenic, lead and zinc) at elevated levels. While background surface soil values were considered, in all cases except PCBs, the background surface soil values were significantly lower than the residential land use screening criteria. Aroclor-1248 values also exceed the background value of 0.44 mg/kg.

The contaminants in the surface soils are wide spread and do not necessarily coincide with the VOC hot spots. The PAH and PCB contamination appear primarily in the southern half of the fill area. Two of the PCB detections are in the soil gas hot spots indicating that the disposal activities in these areas may have included PCBs in addition to the solvents.

The lead and arsenic contamination are widespread and the zinc contamination is sporadic. The distribution of the PAHs and metals in the surface soils is likely not related to drum disposal episodes but is more likely attributable to slag and baghouse dust disposal and filling and potential deposition of emissions from the Main Plant.

The residential soil sampling downgradient from the quarry shows only isolated detections of contaminants. The migration pathway being evaluated using this data is the air migration pathway. The most likely contaminants to migrate via this pathway are the metals. However, only small metal concentrations were detected. There was one detection of Aroclor-1248 and one detection of dibenzo(a,h)anthracene. Because of the isolated nature of the detections and the industrial nature of the community in this area, it is not possible to attribute these detections to the quarry area with any degree of certainty.

Two surface soil samples (RS-111 and RS-112) were collected in an area being evaluated for construction of soccer fields west and upwind of the quarry (**Figure 4.4.2-6**) at IDEM's request to evaluate impact from other sources. PAHs and PCBs were detected at the western most location. The source of the PCBs in this location may be attributable to past industrial operations in the area (see Section 3.0 Characterization of Adjacent Industrial Properties). PCBs were commonly used as a dielectric fluid in electrical equipment.

The screening level air dispersion model predicted the off-site impacts for arsenic, barium, cadmium, chromium and lead if they were to migrate via the air pathway. Of these metals, lead and arsenic were detected at elevated levels.

The dispersion model predicted that only lead could exceed the Indiana air toxics standard. While this dispersion modeling does not predict deposition, it is logical that lead would be the most likely metal to be present off-site at elevated levels. However, lead was detected at only minor levels off-site of Markland Quarry.

4.4.3 Lagoon Area Technical Memorandum

4.4.3.1 Description

The investigation of the Lagoon Area was conducted to build upon site information collected from previous investigations, to characterize the nature and extent of contamination and to help determine appropriate remedial action alternatives (**Figure 2-1**).

The Lagoon Area is located approximately 0.3 miles west of the Main Plant along the south side of West Markland Avenue as shown on **Figure 2-1.** The 56 acre area is composed of 10 lagoons including five polishing lagoons, two acid (hazardous waste storage) lagoons, and three sludge drying beds. The area is bordered to the south and west by Wildcat Creek, to the east by the City of Kokomo Wastewater Treatment Plant and to the north by Markland Avenue. To the west of the Wildcat Creek lies the Haynes International Defenbaugh Street Operations facility and its RCRA closed (capped and lined) landfill along the south bank of the creek.

A series of aerial photographs was reviewed to gather information regarding the history of the Lagoon Area (August 1938, June 1957, July 1964, and June 1972). The photographs showed that in August of 1938 only one lagoon existed in the southeast corner of the area, and another lagoon was being developed in the southwest corner of the area. By June of 1957, the Lagoon Area appeared

much as it does today. Photographs from 1957 and 1964 showed evidence of drum storage along the banks of the two southern lagoons. By June 1972, the photographs no longer showed drums, possibly because the drums had been buried.

While the Continental Steel facility was in operation, spent pickle liquor (inorganic acid used to remove impurities from metal surfaces) was transferred via direct pipeline from the Main Plant to the two hazardous waste storage lagoons. The stored spent pickle liquor was then pumped to a neutralization and treatment system. The neutralized pickle liquor and sludge generated during treatment were deposited in one of the five polishing lagoons. The treated liquid was discharged to Wildcat Creek and the sludge was placed into three drying beds.

The Continental Steel facility received interim status as a hazardous waste treatment, storage and disposal facility under RCRA in 1980. Subsequent sampling indicated the presence of metals and trace organic compounds and an elevated pH in the groundwater within the limestone aquifer underlying the lagoons, and an impact to Wildcat Creek water, sediments, and fish. Concentrations in the groundwater exceeded Safe Drinking Water Act (SDWA) standards for chromium, iron, sulfate, manganese, and pH. Sampling of Wildcat Creek near the lagoons in the fall of 1987 indicated the presence of elevated levels of cadmium in sediments, and tetrachloroethene (PCE) in the surface water. A pH of 1.8 and concentrations of heavy metals were detected in acid lagoon wastewater in November of 1987. Low concentrations of organics were measured in the acid lagoon sediments.

Drums and waste piles of slag were observed during RCRA inspections. Sampling of waste piles indicated the presence of cadmium, chromium, and lead. In November of 1985, Continental Steel's interim RCRA permit was revoked due to improper storage of baghouse wastes and PCB containing materials. Untreated pickle liquor, lime-stabilized waste pickle liquor, and treated effluent were observed during IDEM inspections of the Lagoon Area in April 1986. In order to control the source area, the pickle liquor was treated and discharged to the City of Kokomo Wastewater Treatment Plant between the fall of 1989 and summer of 1990.

In March of 1989, the Lagoon Area of the Continental Steel facility was placed on the National Priorities List (NPL). Shortly thereafter, the Main Plant and Markland Avenue Quarry were added to the CSSS due to the presence of similar contaminants originating from the same manufacturing processes.

A Remedial Investigation of the Lagoon Area was initiated by the previous IDEM contractor, ABB-Environmental Services, Inc. (ABB-ES), in 1992. Samples were collected of lagoon surface water, lagoon sludge, soils underlying and adjacent to the lagoons, waste piles, sludge within mixing and clarifier tanks at the treatment building, and water in the basement of the treatment building. Eight types of waste piles with a total estimated volume of 349 cubic yards were identified. Removal actions were conducted by the U.S. EPA in 1993. An estimated 1,350 buried drums, the majority of which contained oil, grease, slag, scale, dirt, and garbage, were removed from the southwest side of the Lagoon Area. Approximately 100 cubic yards of trichloroethene contaminated soil was removed in the vicinity of an excavation where several drums of trichloroethene were discovered. An

additional 250 cubic yards of oil stained soils were removed from an area of an excavation that contained oil drums.

The ABB-ES investigation of the Lagoon Area provided sufficient data to characterize the nature and extent of contamination for the majority of the area. Treatability testing is being performed to evaluate remedial options for these materials. Based on ABB's soil boring information, CDM estimates that there are approximately 788,000 cubic yards of materials including soil, sludge, slag, and clay, overlying the bedrock in the Lagoon Area. Approximately 482,000 cubic yards is considered to be from the surficial unit, 151,000 cubic yards are clay fill below the surficial unit and the remaining 155,000 cubic yards are the basal soils directly above the bedrock. The only area not well characterized was the lagoon entrance area and this was the focus of CDM's study.

4.4.3.2 Potential Releases and Migration Pathways

The primary sources of contamination at the Lagoon Area are the two acid lagoons, five polishing lagoons and three drying beds. Other potential sources identified in the Lagoon Area include soil at the lagoon entrance, waste piles, soil berm construction (buried drums), and the clarifier and treatment buildings and tanks. VOC, PAH, PCB, and/or metal contaminated soils, sludges, surface water, and groundwater may have migrated and still may be migrating from the Lagoon Area. The primary media impacted by a release from the Lagoon Area are creek surface water and sediments, soils, and groundwater. Potential migration pathways for the potential contaminants of concern are summarized below.

The primary contaminant migration pathways from the acid and polishing lagoons are by leaching through the soil to groundwater and surface water runoff to Wildcat Creek. Contaminant source areas in the northeast corner of the Lagoon Area include the sludge drying beds and the lagoon entrance. Contaminants within the drying beds and soils at the lagoon entrance may leach downward into the groundwater and migrate off-site in the direction of groundwater flow. For a more detailed explanation of groundwater flow see the Section 4.4.6 (Groundwater). Also, soils may be impacted due to runoff from waste piles. Contamination associated with the drum storage area and lagoon berms has the potential to migrate to Wildcat Creek affecting surface water and sediments. Groundwater and soils may also be impacted due to surface water runoff and groundwater infiltration. During periods of high flow, creek sediments may be carried to downstream locations. Therefore, the Lagoon Area may be a source for metals that have been reported downstream of the Lagoon Area.

On-site and off-site human and ecological receptors of contaminants detected in the Lagoon Area are concerns. The Lagoon Area is encompassed by a fence along the entire perimeter with a locked front gate which inhibits trespassers from entering by vehicle. However, visitors or trespassers on foot can access the site and human exposure has likely ocurred in the Lagoon Area during incidences of trespassing. Such exposures may include incidental ingestion of contaminated soil/sludges, and incidental ingestion of and dermal contact with surface water in lagoons that collect sufficient rainwater. Other potential receptor groups include future workers at the Lagoon Area who may be exposed to contaminated surface soil, shallow groundwater or volatile organic

vapors during the course of their work. Ecological exposure may include dermal contact and ingestion of surface water and sediments by terrestrial and aquatic organisms.

4.4.3.3 Summary of Investigation

The field investigation proposed at the Lagoon Area consisted of a soil gas survey in the entrance area and groundwater sampling. In addition, a soil sample was collected from one soil boring installed on the northeastern side of the lagoon area entrance. All field activities and sample collection of groundwater and soil gas were conducted according to the Work Plan and FSP (CDM 1995a and 1995b). A summary of the sampling completed for analysis during the investigation is given below.

4.4.3.3.1 Soil Gas

The soil gas sampling was conducted to investigate hot spots of volatile organic compound (VOC) contamination in soils and sludge at the lagoon entrance area. Elevated concentrations of VOCs were detected in a shallow groundwater monitoring well and soil/sludge samples during previous investigations in this area. Buried drums may be a potential source of the VOC contamination. The soil gas survey was conducted to identify areas which may be considered for an emergency removal action which may require trenching to evaluate the need for this action.

Lagoon Area soil gas samples were collected with a geoprobe and analyzed with the assistance of analytical subcontractors, Dispersion and Matrix Environmental Group, Inc. Sample locations are shown on **Figure 4.4.3-1**. The samples were analyzed using a portable gas chromatograph (GC) to provide real-time screening level analyses. Soil gas samples were analyzed by GC for the following VOCs: trichloroethene, tetrachloroethene, 1,1-dichloroethene, trans-1,2-dichloroethene, cis-1,2-dichloroethene, 1,1,1-trichloroethane, and vinyl chloride.

The sampling grid interval spacing for the Lagoon Area soil gas survey was approximately 50 feet. According to the soil gas sampling procedure, the sampling probe was to be driven via Geoprobe to approximately 8 to 10 feet below ground surface or refusal. A limit of three attempts were made at each sample point if refusal was encountered in the upper four feet. A soil gas sample was collected on the third attempt if the sampling rod could be driven more than two feet below ground surface. A sampling depth of two feet or greater ensured that ambient air from above the ground surface would not be sampled. If a sampling depth of two feet could not be reached, the crew advanced to the next sampling point. Due to subsurface variability and surface topography, soil gas samples were collected at depths ranging from 2 to 20 feet below ground surface.

A total of 87 soil gas samples were collected in the Lagoon Area as shown on **Figure 4.4.3-1.** A maximum of 100 soil gas sample locations in the lagoon entrance area and sludge drying beds were proposed in the FSP (CDM 1995b). Samples were collected outside of the Lagoon Area, north of West Markland Avenue, in the northwestern portion of the lagoon area, within the western drying bed, and in the fenced East Lagoon Area based on GC screening results.

4.4.3.3.2 Subsurface Soil

During soil gas sample collection at LASG-09, an oily coating was observed on the Geoprobe rods upon removal. A soil boring was advanced to 12 feet via Geoprobe in the vicinity of the soil gas sampling location (**Figure 4.4.3-1**) and a soil sample was collected. Samples were characterized at four foot intervals for soil color, consistency, soil type, and other physical observations. A sample was collected from a depth of 10 feet to 11 feet 2 inches and submitted to the CLP laboratory for VOC, SVOC, PCBs, pesticides and total metals.

4.4.3.3.3 Groundwater

A more detailed examination of the procedures implemented and results obtained from groundwater sampling in the vicinity of the Lagoon Area can be found in Section 4.4.6 (Groundwater). Groundwater was sampled from twelve monitoring wells located upgradient, downgradient, and within the Lagoon Area. One monitoring well, LA-07, was a Westbay™ Multi-Port monitoring well from which groundwater samples were also collected from the intermediate (LA-07A, B and C) and lower (LA-07D) water-bearing zones. Groundwater samples were collected from six monitoring wells screened in the shallow water-bearing zone (EW-06, EW-08, EW-11, EW-18, EW-28 and UA-105), four intermediate-water-bearing zone monitoring wells (EW-16, LA-105C, LA-106C and LA-07A, B and C), and three lower water-bearing zone monitoring wells (LA-104E, LA-105E and LA-07D). Groundwater samples were analyzed for VOCs, SVOCs, PAHs, PCBs, pesticides and metals.

4.4.3.4 Analytical Results

4.4.3.4.1 Soil Gas

A list of organic compounds detected in the soil gas samples at the Lagoon and East Lagoon Area is presented in **Table 4.4.3-1**. Soil gas sampling locations are shown on **Figure 4.4.3-1**.

Trans-1,2-dichloroethene was detected in five soil gas samples collected in the Lagoon Area at concentrations ranging from 1 milligram per cubic meter (mg/m^3) at LASG-60 and LASG-67 to 19 mg/m^3 at LASG-51. A site plan showing the distribution of trans-1,2-dichloroethene is provided as **Figure 4.4.3-2**. Twenty-six soil gas samples contained cis-1,2-dichloroethene, at levels ranging from 1 mg/m^3 in 10 samples to 540 mg/m^3 in LASG-51. **Figure 4.4.3-3** shows the concentrations of cis-1,2-dichloroethene at the Lagoon Area.

Tetrachloroethene and trichloroethene were detected in 10 and 40 of the Lagoon Area soil gas samples, respectively. Concentrations of tetrachloroethene ranged from 1 mg/m^3 (LASG-26, LASG-29 and LASG-85) to 14 mg/m^3 in LASG-37. Trichloroethene was detected from 1 mg/m^3 in eight soil gas samples to 640 mg/m^3 at LASG-52. Isoconcentration maps of tetrachlorethene and trichloroethene are included as **Figure 4.4.3-4** and **Figure 4.4.3-5**, respectively.

Vinyl chloride was detected at LASG-51, LASG-59 and LASG-94 at concentrations of 510 mg/m^3, 160 mg/m^3, and 2 mg/m^3, respectively. Vinyl chloride concentrations are depicted on

Figure 4.4.3-6. One soil gas sample, LASG-85, contained 1 mg/m^3 of 1,1,1-trichloroethane. Concentrations of 1,1-dichloroethene were detected in four samples at concentrations ranging from 1 mg/m^3 (LASG-94) to 10 mg/m^3 (LASG-51). **Figure 4.4.3-7** shows the concentrations of 1,1-dichloroethene at the Lagoon Area. No other VOCs were detected in soil gas samples collected in the Lagoon Area.

4.4.3.4.2 Subsurface Soil

One subsurface soil sample was collected from the Lagoon Area near soil gas location LASG-09 (**Figure 4.4.3-1**). The sample label LASG-09 assigned in the field for this subsurface soil sample was maintained for the laboratory results. A list of organic and inorganic compounds detected in subsurface soil sample LASG-09 is presented in **Table 4.4.3-2**. **Table 4-1** contains the definitions of data qualifiers and terms used in the summary of detections table.

Toluene was detected in the LASG-09 subsurface soil sample at the concentration of 2 µg/kg. No other VOCs were detected in subsurface soil sample LASG-09 from the Lagoon Area. No BNA (SVOC) compounds were detected in subsurface soil sample LASG-09 from the Lagoon Area.

Heptachlor epoxide and 4,4'-DDT were detected in the LASG-09 subsurface soil sample at concentrations of 2.3 µg/kg and 19 µg/kg, respectively. No other pesticide compounds and no PCBs were detected in subsurface soil sample LASG-09 from the Lagoon Area.

Analysis for metals produced the following results for subsurface soil sample LASG-09. Aluminum, antimony and arsenic were detected at concentrations of 6,600 mg/kg, 8.6 mg/kg and 1.5 mg/kg, respectively. Barium, beryllium and calcium were detected at concentrations of 82.2 mg/kg, 0.65 mg/kg and 171,000 mg/kg, respectively. Chromium, cobalt and copper were detected at concentrations of 2620 mg/kg, 14.3 mg/kg and 200 mg/kg, respectively. Iron, lead and magnesium were detected at concentrations of 170,000 mg/kg, 2.4 mg/kg and 20,700 mg/kg, respectively. Manganese, nickel and silver were detected at concentrations of 34,800 mg/kg, 112 mg/kg and 61.5 mg/kg. Sodium, vanadium and zinc were detected at concentrations of 291 mg/kg, 203 mg/kg and 268 mg/kg, respectively. No other metals were detected in subsurface soil sample LASG-09 from the Lagoon Area.

4.4.3.4.3 Groundwater

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in groundwater samples collected from monitoring wells within and surrounding the Lagoon Area is presented in **Table 4.4.3-3**. Selected groundwater monitoring wells in the vicinity of the Lagoon Area from which groundwater samples were collected are shown on **Figure 2-1**. Groundwater frequency of detection and range of concentration results for shallow (760 feet and up), intermediate (700 to 760 feet), and lower (660 to 700 feet) water-bearing zones are reported in **Table 4.4.3-4** (shallow), **Table 4.4.3-5** (intermediate) and **Table 4.4.3-6** (lower). Water-bearing zone elevations were calculated with the N.G.V.D. 1929 as the reference. Monitoring well ground surface elevations in the Lagoon Area are approximately 793 feet (N.G.V.D. 1929). The range of concentrations

detected for each parameter are as follows [units: organics = µg/L (parts per billion) and inorganics = mg/L (parts per million)]:

Shallow Water-Bearing Zone

	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCS (µg/L)			
1,1-Dichloroethene	1	3	2 - 2
Acrylonitrile	1	3	8 - 8
Carbon Disulfide	1	3	1 - 1
Chloromethane	1	3	1 - 1
cis-1,2-Dichloroethene	3	3	4 - 630
Styrene	1	3	1 - 1
trans-1,2-Dichloroethene	1	3	3 - 3
Trichloroethene	2	3	1 - 160
Vinyl Chloride	3	3	1 - 25
Group: Inorganics (mg/L)			
Aluminum, Dissolved	2	3	.1 - .119
Antimony, Dissolved	1	3	.002 - .002
Barium, Dissolved	3	3	.033 - .159
Cadmium, Dissolved	1	3	.0003 - .0003
Calcium, Dissolved	3	3	69 - 160
Copper, Dissolved	2	3	.007 - .007
Iron, Dissolved	3	3	.128 - 1.09
Magnesium, Dissolved	3	3	32 - 51
Manganese, Dissolved	3	3	.009 - .135
Potassium, Dissolved	3	3	7 - 13
Sodium, Dissolved	3	3	33 - 64
Zinc, Dissolved	2	3	.056 - .062
Group: Miscellaneous (mg/L)			
Chloride	3	3	22 - 112

Intermediate Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethane	2	6	1 - 2
1,1-Dichloroethene	4	6	1 - 4
Acrylonitrile	1	6	140 - 140
Carbon Disulfide	1	6	3 - 3
cis-1,2-Dichloroethene	6	6	2 - 1100
Styrene	1	6	11 - 11
trans-1,2-Dichloroethene	4	6	2 - 6
Trichloroethene	3	6	5 - 1300
Vinyl Chloride	5	6	2 - 110
Group: Inorganics (mg/L)			
Aluminum, Dissolved	2	6	.082 - .118
Antimony, Dissolved	3	6	.002 - .004
Barium, Dissolved	6	6	.018 - .278
Calcium, Dissolved	6	6	53 - 427
Chromium, Dissolved	1	6	.048 - .048
Copper, Dissolved	4	6	.007 - .011
Iron, Dissolved	5	6	.29 - 13.9
Magnesium, Dissolved	6	6	18 - 248
Manganese, Dissolved	6	6	.006 - .204
Nickel, Dissolved	1	6	.272 - .272
Potassium, Dissolved	3	6	8 - 47
Sodium, Dissolved	6	6	21 - 82
Vanadium, Dissolved	1	6	.016 - .016
Group: Miscellaneous (mg/L)			
Chloride	6	6	24 - 211

Lower Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethane	1	7	3 - 3
1,1-Dichloroethene	2	7	2 - 7
1,2-Dichloroethene (total)	2	2	320 - 400
Acetone	1	7	4 - 4
Benzene	3	7	1 - 1
cis-1,2-Dichloroethene	5	5	4 - 410
Methylene Chloride	1	7	1 - 1
Tetrachloroethene	3	7	2 - 350
trans-1,2-Dichloroethene	4	5	1 - 7
Trichloroethene	7	7	1 - 710
Vinyl Chloride	4	7	1 - 110

Note: Volatile organic compounds were analyzed by two different laboratories, CLP and CRL. The CLP laboratory reported total 1,2-dichloroethene and CRL reported the individual isomers. Thus, both the total (CLP) and individual isomers (CRL) were reported in this range list.

Group: BNAs (µg/L)			
1,4-Dichlorobenzene	1	5	2 - 2
Group: Inorganics (mg/L)			
Aluminum	2	2	.344 - .484
Aluminum, Dissolved	3	7	.103 - .923
Antimony, Dissolved	1	7	.002 - .002
Arsenic	1	2	.003 - .003
Arsenic, Dissolved	2	7	.007 - .009
Barium	2	2	.137 - .138
Barium, Dissolved	6	7	.018 - .129
Cadmium	2	2	.0003 - .0003
Cadmium, Dissolved	1	7	.0007 - .0007
Calcium	2	2	224 - 235
Calcium, Dissolved	7	7	13 - 620
Chromium, Dissolved	3	7	.017 - .066
Cobalt, Dissolved	1	7	.13 - .13
Copper, Dissolved	4	7	.01 - .015

Lower Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (mg/L)			
Iron	2	2	7.58 - 12.5
Iron, Dissolved	7	7	.111 - 3050
Lead	2	2	.009 - .011
Magnesium	2	2	45 - 49
Magnesium, Dissolved	7	7	35 - 236
Manganese	2	2	1.4 - 1.54
Manganese, Dissolved	7	7	.032 - 38.7
Mercury	2	7	.0001 - .0001
Nickel, Dissolved	5	7	.024 - .875
Potassium	1	2	5.24 - 5.24
Potassium, Dissolved	7	7	6 -32
Sodium	2	2	125 - 127
Sodium, Dissolved	7	7	95 - 456
Vanadium	1	2	.009 - .009
Vanadium, Dissolved	2	7	.008 - .008
Zinc	2	2	.15 - .246
Zinc, Dissolved	4	7	.045 - .491
Group: INDIC (mg/L)			
Alkalinity	2	2	460 - 460
Chloride	7	7	90 - 195
Nitrate/Nitrite Nitrogen	2	2	4.75 - 4.89
Sulfate	2	2	172 - 182
Total Phosphorous	2	2	.08 - .08

4.4.3.5 Discussion

During the first phase of the RI in 1993, ABB-ES collected data for the lagoon surface water, soils underlying and adjacent to the lagoons, lagoon sludge, waste piles and sludge within the clarifier tanks at the treatment building. This data was evaluated in CDM's Work Plan (CDM 1995a). This data is considered sufficient to evaluate permanent remedies for the Lagoon Area. The data summaries are provided in **Tables 4.4.3-7** through **4.4.3-11**.

An evaluation of the data for the waste piles in the Lagoon Area indicated that four waste piles (WP-03, WP-07, WP-08, Misc. Pile WP-02/07) contained at least one contaminant at elevated levels, for an estimated contaminated material volume of 149 cubic yards. The waste pile data will be compared to the clean-up criteria defined in the risk assessment and actual volumes of contaminated material will be provided in the feasibility study.

In the lagoons, an estimated total of 641,000 cubic yards of material was determined to contain elevated levels of contaminants. The sludge drying beds have by far the deepest contamination extending 20 feet below the surface. The acid lagoons had elevated levels of contaminants to a depth of about five feet. The polishing lagoons had elevated levels at depth varying typically from 10 feet below surface in the central portion to about five feet in the southern portion. Contamination throughout the lagoons includes, VOCs, PAHs, PCBs, chromium, lead and zinc. The lagoon data will be compared in the feasibility study to the cleanup goals established in the risk assessment. The FS will determine actual volumes of contaminated materials. As a point of reference, the reader may compare the contaminant concentration to the screening values provided in **Tables 4.4.1-23** and **4.4.1-24**.

CDM's additional investigation of the Lagoon Area was based on the high concentration of VOCs at EW-08. While removal actions were performed in other areas of the lagoons, no work has been done near the entrance. The soil gas survey and monitoring well sampling were designed to evaluate the need for additional removal actions near the lagoon entrance.

The soil gas survey results indicate that several coalesced plumes of VOCs in the soil gas originate near the lagoon entrance. Two plumes trend northwest and originate near EW-08 and the drying bed to the west. Two plumes displaying lower concentrations are present along the two roads to the south and east of the entrance, respectively. The primary VOCs detected in the soil gas were cis-1,2-dichloroethene, trichloroethene and vinyl chloride. The groundwater data for EW-08 showed cis-1,2-dichloroethene (400ppb) and trichloroethene (710 ppb). EW-08 is an upper aquifer well that would be indicative of a near surface source. This data indicates the potential for a remaining source near the surface at the lagoon entrance and at the drying bed to the west. The size of the impacted area is approximately 400 square feet, approximately bounded by the 10 ppb isoconcentration line for trichloroethene.

The downgradient well nest, consisting of UA-105 in the shallow water-bearing zone, LA-105C in the intermediate water-bearing zone and LA-105E in the lower water-bearing zone showed detections of the same three primary VOCs as in the soil gas. The proportion of trichloroethene to the two daughter products, cis-1,2-dichloroethene and vinyl chloride decreased as expected likely due to the distance from the source and the age of the source. The lower aquifer well at this location is the most contaminated indicating that the plume is migrating downward as it moves downgradient.

The monitoring well EW-28, located upgradient from EW-08 and the lagoon entrance also contained cis-1,2-dichloroethene, trichloroethene and vinyl chloride in proportions similar to the soil gas results. The lower aquifer well at this location contained low levels of the degradation products but

no trichloroethene. The soil gas survey did not extend as far east as EW-28; however, the soil gas data did indicate that VOCs were not present in the near subsurface between EW-08 and EW-28. This contamination could be from the Main Plant or it could be indicative of another near surface source in the area of EW-28.

The shallow water-bearing zone wells that were sampled along the west side of the Lagoon Area included EW-06 and EW-11. EW-06 was the least contaminated of these wells, containing only low ppb levels of VOCs. This agrees well with ABB-ES's data from the lagoon soils and sediments in lagoons 1 and 2 (**Appendix I**).

The shallow water-bearing zone well, EW-11, located at the southwest edge of the Lagoon Area, contains low levels of degradation products. This well is located downgradient from the drum removal area and it is possible that a contaminant plume has already moved through this area and the local source has been removed. The intermediate level well at this location shows significantly higher concentrations of degradation products, however no parent products, such as trichloroethene or tetrachloroethene were detected. This would further support the theory that a plume has moved through and the local source is no longer available to supply parent products to the groundwater. The lower water-bearing zone well at this location was clean.

Well EW-18 along the west side of the creek was contaminated, showing almost a part per million of total VOCs. This well may be influenced by Haynes facility rather than the Lagoon Area since it is screened above the stream elevation, has tetrachloroethene present in the well and is upgradient in the shallow water-bearing zone. Monitoring well EW-16 was also sampled to evaluate impacts from the Lagoon Area. Based on other data obtained during the investigation, it is likely that these wells are influenced not only by the Lagoon Area but also by the Haynes International Defenbaugh Street Operations facility located west of the wells. A more thorough evaluation of the groundwater is provided in Section 4.4.6 (Groundwater).

The data indicates that no BNAs, PCBs or pesticides were detected in groundwater samples collected. These compounds are present in the lagoon soils and sediments; however, they do not migrate readily from the solids into the groundwater.

There are three metals present in the Lagoon Area groundwater that exceed (**Table 4.4.3-3**) maximum contaminant levels (MCLs). These metals are nickel, iron and manganese. According to the ABB-ES data for lagoon soils and sediments, iron and manganese were consistently present in the soils at high levels. Nickel, while consistently detected was not present at as high levels, however it may have been disposed in a more soluble form. The other metal that was present consistently was lead. However, lead was not detected in the lagoon groundwater above MCLs.

4.4.4 Slag Processing Area

4.4.4.1 Description

The investigation of the Slag Processing Area was conducted to characterize the possible contaminants in the slag, to confirm or deny that drums with solvents have been buried in the backfilled area of the quarry, to evaluate the potential impacts to Wildcat Creek and to help determine appropriate remedial action alternatives.

Slag material generated from Continental Steel operations was processed in an area along West Markland Avenue approximately 0.5 miles west of the Main Plant. This nine-acre area is bounded by Markland Avenue to the north, Wildcat Creek to the south and west, and the Lagoon Area to the east (**Figure 2-1**). Historical aerial photograph analysis (August 1938, June 1957, July 1964, and June 1972) and site research indicates the former presence of a quarry (Chaffin Quarry) located in the southwest quarter of the Slag Processing Area. The June 1972 aerial photograph shows that Chaffin Quarry, previously filled with water, had been filled with slag. Presently, the entire area is covered with slag. A 50 foot high hill encompasses the west/northwest section of the area and a depression occurs in the southwest corner. The remainder of the area is graded.

Past activities within this area involved the storage of undetermined amounts of slag and reclamation of metals from the slag (CDM 1995a). Calcium and iron oxides with smaller amounts of aluminum, chromium, lead, manganese, magnesium, and zinc oxides typically comprise the slag.

Field investigation objectives included performing an active soil gas survey and surficial soil/slag sampling to characterize the areal extent of possible organic impact to subsurface media and to identify potential contaminant hot spots that may indicate buried drums or pockets of product.

4.4.4.2 Potential Releases and Migration Pathways

The primary pathway for releases from this area is through the leaching of hazardous constituents from buried drums (if present) and via leaching of oils and solvents that may have coated slag material. The tightly compacted and horizontally stratified slag layers provide a weak vertical but strong horizontal route for contaminant migration. Thus, horizontal contaminant migration may predominate (if organic contamination is present) due to the compaction and stratification of the processed slag. Contaminants that reach groundwater may migrate south or west in the direction of groundwater flow. (See Section 4.4.6 Groundwater). Also, possible contaminants within the fill may leach horizontally and into Wildcat Creek. Surface water runoff may also introduce possible contaminants within the slag exposed at ground surface into Wildcat Creek. Potential contaminants within the slag exposed at ground surface may also migrate off-site via windborne dispersion.

4.4.4.3 Summary of Investigation

The objectives of the investigation at the Slag Processing Area were to:

- Characterize the contaminants in the slag;

- Confirm or deny that drums with solvents have been buried in the backfilled area of the quarry;
- Evaluate the potential impacts to Wildcat Creek; and
- Evaluate remedial options for the environmental restoration of the area.

Slag Processing Area investigations included a soil gas survey, surface soil sampling, a site inspection, and groundwater sampling. A soil gas survey was conducted to delineate the areal extent of potential impact to subsurface media and to identify potential contaminant hot spots indicative of buried drums or pockets of product within the fill. In compliance with the Work Plan and FSP (CDM 1995a and 1995b, respectively), a 100-foot by 100-foot survey grid containing 38 soil gas sampling locations was established (**Figure 4.4.4-1**). Initially, soil gas surveying was performed in accordance with the FSP (CDM 1995b) along northeast/southwest and northwest/southeast 200-foot transects across the area. Soil gas surveying then proceeded along 100-foot by 100-foot spaced perimeter sample locations except where utility clearance had yet to be given. Following this initial sampling, the remainder of the soil gas locations were sampled.

A geoprobe was utilized to perform the soil gas survey. Optimally, the hydraulically operated soil gas probe was driven to a depth of 8 to 10 feet and a soil gas sample was collected from that depth. However, due to resistance encountered in the slag fill, several options described in the FSP to insure sample collection, were followed in the survey. If geoprobe refusal was encountered within the first four feet, the sample location was moved within a ten-foot radius. A maximum of three attempts per sample location and minimum depth of two feet for sample collection was implemented throughout the survey. Using the 2-foot sample depth as a minimum for sample collection insured that ambient air would not be sampled. Due to difficulty in penetrating the slag, 35 of the 38 marked soil gas locations were sampled at depths ranging from 2.5 to 9.5 feet. Portable GC analysis of the initial soil gas data yielded only one detection (at the method detection limit of 1 mg/m^3) for trichloroethene at soil gas sample point SPSG-24 (**Figure 4.4.4-2**). Geostatistical analysis was not implemented due to the paucity of data.

Surficial soil/slag samples were collected for laboratory analysis to characterize potential impact to surficial soils at the Slag Processing Area. Soil/slag samples were proposed to be collected based upon the results of the site inspection and soil gas survey at areas suspected of having contamination representative of the slag piles (CDM 1995a). However, ambient air field screening with a photoionization detector (PID) and soil gas survey results showed only one detection of trichloroethene (1 mg/m^3 at SPSG-24). Therefore, surface soil/slag samples were collected at that location (SPSG-24) and at randomly selected locations spanning the entire area (**Figure 4.4.4-1**). Composite samples were collected as outlined in the FSP (CDM 1995b). A total of 10 surface soil/slag samples was collected at depths ranging from 4 to 14 inches. A spud bar was used to break up the slag and a hand auger was utilized for sampling. Although the 2-foot sample depth objective was not reached due to the rigidity of the slag, sample collection met FSP requirements.

Observations were made during the soil gas survey and surface soil/slag sampling which fulfilled many of the site inspection objectives outlined in the Work Plan (CDM 1995a). During the soil gas survey slag piles were monitored for organic vapors using a PID, slag pile dimensions were

approximated, and any observed industrial wastes were noted. An approximately 4-foot high berm separating the south margin of the area from Wildcat Creek was noted. The western and eastern margins bounded by Wildcat Creek and a small creek discharging into Wildcat, respectively, may serve as potential areas for surface water runoff and direct discharge into the creek.

Wildcat Creek banks were also examined for evidence of drums and seeps. Eight empty drums were observed along the creek bank and within and on top of the large slag hill in the area. Use of high sensitivity electro-magnetics (EM) was considered to determine buried drum locations, however, EM would likely be ineffective due to similar conductivities of metals within the slag and drums. Therefore, CDM deemed electro-magnetic geophysical surveying impractical.

Selected, previously installed, monitoring wells were sampled to evaluate groundwater quality within the Slag Processing Area. Groundwater samples were collected from two monitoring wells, LA-06 and UA-17, located at the western margin of the Slag Processing Area (**Figure 2-1**). Samples were collected from the lower, intermediate, and upper water-bearing zones from monitoring well LA-06 and from the upper water-bearing zone at UA-17. A detailed discussion of groundwater and analytical results is included in Section 4.4.6 (Groundwater).

4.4.4.4 Analytical Results

4.4.4.4.1 Soil Gas

Sampling locations are shown on **Figure 4.4.4-1**. Field-laboratory soil gas analysis results are presented on **Figure 4.4.4-2**. Trichloroethene was detected at only one location (SPSG -24 [6.5 ft]) at a concentration of 1 mg/m^3. No other VOCs were detected in soil gas samples collected at this unit.

4.4.4.4.2 Surface Soil

A list of organic and inorganic compounds detected in the surface soil samples at the Slag Processing Area is presented in **Table 4.4.4-1A**. **Table 4-1** contains the definitions of data qualifiers and terms used in the summary of detection tables. Sampling locations are shown on **Figure 4.4.4-1**. The range of concentrations detected for each parameter are as follows [units: organics = µg/kg (parts per billion) and inorganics = mg/kg (parts per million)]:

	Surface Soil Samples		
Parameter	**No. of Detects**	**No. of Samples Analyzed**	**Range of Concentrations Detected**
Group: VOCs (µg/kg)			
Methylene Chloride	10	14	27 - 100

Surface Soil Samples (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: SVOCs (µg/kg)			
4-Choro-3-methylphenol	1	3	12 - 12
1,2,4-Trichlorobenzene	1	3	2 - 2
2-Methylnaphthalene	1	3	5 - 5
di-n-Butylphthalate	1	3	16 - 16
Diethylphthalate	2	3	4 - 17
Group: PAHs (µg/kg)			
Acenaphthene	2	14	1 - 7
Anthracene	1	14	4 - 4
Benzo(a)pyrene	3	14	4 - 18
Benzo(b)fluoranthene	3	3	7 - 25
Benzo(g,h,i)xperylene	2	14	10 - 11
Benzo(k)fluoranthene	3	3	2 - 8
Chrysene	3	14	8 - 28
Fluoranthene	3	14	11 - 41
Ideno(1,2,3-cd)pyrene	2	14	7 - 8
Phenanthrene	2	14	29 - 34
Pyrene	2	14	30 - 42
Group: PCBs (µg/kg)			
Aroclor-1242	2	14	160 - 210
Aroclor-1254	3	14	12 - 72
Group: Pesticides (µg/kg)			
4,4'-DDE	1	3	1.5 - 1.5
Alpha-Chlordane	1	3	0.76 - 0.76
Heptachlor Epoxide	3	3	0.74 - 5.1
Methoxychlor	1	3	2 - 2
Group: Inorganics (mg/L)			
Aluminum	3	3	16,800 - 20,900
Antimony	3	3	8.9 - 20.4
Arsenic	14	14	6 - 140
Barium	14	14	290 - 660

Surface Soil Samples (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (mg/L) (Continued)			
Beryllium	3	3	0.55 - 0.46
Cadmium	14	14	5.2 - 73
Calcium	3	3	137,000 - 206,000
Chromium	14	14	2770 - 4700
Cobalt	3	3	6.9 - 17.8
Copper	14	14	86 - 647
Iron	3	3	176,000 - 338,000
Lead	14	14	160 - 6800
Magnesium	3	3	32,400 - 41,100
Manganese	3	3	22,000 - 37,000
Mercury	3	3	0.24 - 0.32
Nickel	14	14	33 - 328
Potassium	1	3	135 - 135
Selenium	2	3	0.45 - 0.73
Silver	3	3	2.2 - 6.6
Sodium	3	3	295 - 423
Vanadium	3	3	179 - 234
Zinc	14	14	473 - 67,000
Group: Miscellaneous (%)			
Percent Solids	11	11	91.3 - 96.8

Methylene chloride was detected in nine surface soil samples collected at this unit at concentrations ranging from 27 µg/kg (SS-06) to 100 µg/kg (SS-09). As explained in the laboratory narrative, the presence of methylene chloride in the samples is likely a laboratory contaminant coming from the PAH extraction procedure. No other VOCs were detected in the surface soil samples collected at this unit.

Surface soil confirmatory samples analyzed by the U.S. EPA Contract Laboratory Program (CLP) for VOCs, SVOCs, PAHs, PCBs, pesticides and metals are presented in **Table 4.4.4-1A**. Confirmatory samples were collected at Slag Processing Area surface soil sample locations SS-03 and SS-05. A duplicate sample, SS-05-D, was also collected at location SS-05. Organic results were compared to the U.S. EPA sponsored Field Analytical Services Program (FASP) laboratory analyses and inorganic results to Kemron Environmental Services (Kemron) laboratory analyses to insure

accuracy. CLP VOC sample analyses for SS-03, SS-05 and SS-05-D confirm FASP lab VOC results except for methylene chloride which was detected in FASP lab samples and not in the confirmatory CLP samples. Methylene chloride is a common laboratory contaminant and its detection in small amounts is not unusual. CLP results from SS-03, SS-05 and SS-05-D show detections for SVOCs, PAHs, PCBs and pesticides that were not detected by the FASP lab. This difference exists because the FASP lab quantitation limits (QLs) were higher than the CLP SVOC, PAH, PCB and pesticide detections. CLP was the only lab program scheduled to analyze for pesticides. Therefore, there are no other pesticide lab results for comparison.

The CLP metal sample analysis confirms Kemron laboratory metal results. However, CLP results for arsenic, copper, nickel, and zinc differed from Kemron results for the following reasons. First, the heterogeneous nature of the slag/sediment can cause different result concentrations. Second, two laboratories, CLP and Kemron, analyzed the slag and differing results from different laboratories are not uncommon. Third, CLP results are considered a higher level of data quality than Kemron due to stringent CLP sample analysis methods and heightened quality assurance/quality control procedures.

The CLP surface soil sample report for arsenic in samples SS-03, SS-05, and SS-05-D indicate the spiked sample recovery in each sample was not within control limits and the reported values were estimated. CLP copper concentrations in SS-05-D were slightly higher than Kemron copper concentrations. The CLP lab flagged this result because copper was found in the associated lab blank and therefore the copper concentration is an estimated value.

Slag Processing Area surface soil/slag samples were also analyzed by the U.S. EPA Central Regional Laboratory (CRL) for toxicity characteristic leaching procedure (TCLP) organics and RCRA (Resource Conservation and Recovery Act) metals (**Table 4.4.4-1B**). Comparison of the detections of TCLP organics and RCRA metals with the Code of Federal Regulations (40 CFR 261.24) maximum concentration of contaminants for the toxicity characteristic shows that all detected concentrations are below TCLP limits.

4.4.4.4.3 Groundwater

A list of organic and inorganic compounds detected in groundwater samples collected from monitoring wells within the Slag Processing Area is presented in **Table 4.4.4-2**. Refer to **Table 4-1** for definitions of data qualifiers and terms used in the summary of detection tables. Groundwater monitoring wells located in the Slag Processing Area are shown on **Figure 2-1**. Groundwater results are reported according to shallow (760 feet and up), intermediate (700 to 760 feet) and lower (660 to 700 feet) water-bearing zones. Monitoring well UA-17 is screened within the shallow water bearing zone. Since monitoring well LA-06 is a Westbay™ Multi-Port sampling well, discrete groundwater samples were collected from the intermediate (LA-06A and LA-06B) and lower (LA-06C) water-bearing zones. The range of concentrations detected for each parameter are as follows:

Shallow Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
cis-1,2-Dichloroethene	2	2	1 - 1
Group: Inorganics (mg/L)			
Arsenic, Dissolved	2	2	.004 - .005
Barium, Dissolved	2	2	.084 - .097
Calcium, Dissolved	2	2	108 - 115
Cobalt, Dissolved	2	2	.007 - .007
Copper, Dissolved	2	2	.006 - .008
Iron, Dissolved	2	2	.701 - .767
Magnesium, Dissolved	2	2	30 - 32
Manganese, Dissolved	2	2	.981 - 1.05
Mercury	1	2	.0001 - .0001
Sodium, Dissolved	2	2	57 - 61
Vanadium, Dissolved	1	2	.009 - .009
Group: Miscellaneous (mg/L)			
Chloride	1	2	24 - 24

Intermediate Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethane	2	3	2 - 4
1,1-Dichloroethene	1	3	2 - 2
cis-1,2-dichloroethene	3	3	76 -800
m&p-Xylene	1	3	1 - 1
trans-1,2-Dichloroethene	2	3	1 - 3
Trichloroethene	2	3	110 - 140
Vinyl Chloride	3	3	8 - 34

Intermediate Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (mg/L)			
Arsenic, Dissolved	3	3	.003 - .004
Barium, Dissolved	3	3	.04 - .083
Calcium, Dissolved	3	3	137 - 166
Cobalt, Dissolved	2	3	.019 - .019
Iron, Dissolved	3	3	1.74 - 2.19
Magnesium, Dissolved	3	3	36 - 47
Manganese, Dissolved	3	3	.139 - .38
Nickel, Dissolved	2	3	.052 - .056
Potassium, Dissolved	3	3	6 - 14
Sodium, Dissolved	3	3	53 - 83
Group: Miscellaneous (mg/L)			
Chloride	3	3	110 - 115

Lower Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethane	1	1	1 - 1
Aerylonitrile	1	1	150 - 150
cis-1,2-Dichloroethene	1	1	2 - 2
Group: Inorganics (mg/L)			
Barium, Dissolved	1	1	.062 - .062
Calcium, Dissolved	1	1	102 - 102
Iron, Dissolved	1	1	.525 - .525
Magnesium, Dissolved	1	1	35 - 35
Manganese, Dissolved	1	1	.026 - .026
Potassium, Dissolved	1	1	6 - 6
Sodium, Dissolved	1	1	38 - 38

Lower Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Miscellaneous (%)			
Chloride	1	1	59 - 59

4.4.4.5 Discussion

VOCs were not detected in soil gas samples collected at the Slag Processing Area with the exception of one detection of trichloroethene at the method detection limit. No VOCs were detected in surface soil samples with the exception of methylene chloride which is a common laboratory contaminant. The presence of methylene chloride is probably not a result of site activities. As explained in the FASP lab narrative, methylene chloride is probably a lab contaminant coming from the PAH extraction procedure. Additionally, no SVOCs or PCBs were detected in surface soil samples analyzed. Although not conclusive, these results give no indication of residual contamination resulting from surface spills or leaking buried drums.

Evidence of disposal of drums at the Slag Processing Area was observed - a partially decayed drum was observed protruding from the side of a vertical cut in the slag approximately five feet below the surface of the slag. Additionally, eight drums were observed along the creek bank and on the large slag pile protruding from or on top of the slag. The observation of these drums combined with the confirmation of drum disposal at other CSSS properties including Markland Avenue Quarry and the Lagoon Area (CDM 1995a) indicates, at a minimum, that drum burial was a standard practice. It should be noted that the drums observed in this area were in varying states of decay with the majority of the drums appearing crushed or bent-possibly indicating these drums may have been empty or near empty at the time of disposal or burial. Several drums were also noted in a relatively intact state. The absence of contamination in the shallow slag indicates a lack of chemical impact in the shallow subsurface, however, as indicated previously, the stratification of slag in the area appears to reduce vertical permeability and as a result may reduce upward migration of soil gas. The soil gas survey effectively characterized shallow subsurface VOC contamination but probably was less effective in deep subsurface contamination detection.

No VOCs were detected in the shallow water-bearing zone with the exception of cis-1,2-dichloroethene (UA-17) at the method detection limit of 1 µg/L. Several VOCs were detected at LA-06 in the intermediate water-bearing zone including significant concentrations of trichloroethene (140 µg/L), cis-1,2-dichloroethene (800 µg/L) and vinyl chloride (34 µg/L). Low concentrations of cis-1,2-dichloroethene and 1,1-dichloroethane were detected in the lower water-bearing zone as well as acrylonitrile at a concentration of 150 µg/L. This vertical distribution of VOCs, while not conclusive based on the results of one well in the area, indicates impact from VOCs likely originates from upgradient rather than from the immediate vicinity of the well at the Slag Processing Area. These results also would be consistent with leakage from drums at depth,

however, compounds are consistent with those observed upgradient in the vicinity of the Lagoon Area.

4.4.5 Kokomo and Wildcat Creeks

4.4.5.1 Description

This section documents the methodologies and results of field activities generated during CDM's Remedial Investigation of the Continental Steel Superfund Site (CSSS) and the impacts the site has imparted on Kokomo and Wildcat Creeks (OU3) in Kokomo, Indiana (**Figure 2-1**). Previously, ABB-ES investigated the creeks including a study of creek water, creek sediment and shallow groundwater due to their close proximity to the CSSS Main Plant, Lagoon and Slag Processing Areas. ABB-ES' analyses of the above environmental media have been examined by CDM and are summarized herein. Discussion of analytical results focuses on CDMs sampling due to the mobile and retrogenous nature of surface water and sediment in the creeks and the fact that CDMs data is more representative of current conditions.

Kokomo Creek, directly south of the Main Plant, flows west until its confluence with Wildcat Creek (**Figure 2-1**). Wildcat Creek flows south along Park Avenue between the CSSS Main Plant and the city of Kokomo wastewater treatment facility and combines with Kokomo Creek north of Defenbaugh Road. Wildcat creek flows along the south and west boundaries of both the Lagoon and Slag Processing Areas.

CDM sampled sediments and surface water from Kokomo and Wildcat Creeks and shallow groundwater from monitoring wells adjacent to the creeks to accomplish the following: confirm previous results; further characterize Kokomo and Wildcat Creeks surface water quality and sediment contaminant concentrations; examine the interrelationship between shallow groundwater quality and creek sediment and surface water; determine the potential impacts from the surrounding properties; and provide information for the evaluation of remedial alternatives if necessary.

Previous ABB-ES water and sediment analyses served as the basis for laboratory testing. Background samples were also collected to establish a site-specific reference-based cleanup standard. Groundwater samples were collected from the shallow water-bearing zone (760 feet MSL and up) monitoring wells in close proximity to the creeks. Groundwater sampling results are compared to Kokomo and Wildcat Creeks sediment and surface water analytical results to evaluate the interrelationship of the creeks and groundwater.

4.4.5.2 Potential Releases and Migration Pathways

Creek water contamination can occur via three major and several less significant routes. Contaminant movement into the creeks as surface water runoff is one potential route. Creek water may be discharged to a hydraulically connected shallow aquifer, or groundwater may recharge hydraulically connected creeks. This creek-aquifer interrelationship is dependent on seasonal fluctuations in precipitation affecting stage elevation which, in turn, affect water levels in the

hydraulically connected shallow groundwater-bearing zone. This seasonal fluctuation in creek stage in conjunction with local subsurface geology determine whether the creeks are gaining (receiving water from the shallow-water bearing zone) or losing (losing water to the shallow-water bearing zone). Thus, in a second migration pathway, Kokomo and Wildcat Creeks sediments and surface water may receive contaminants from or contribute contaminants to the shallow water-bearing zone. Third, outfalls, if discharging, could provide a third pathway for contaminant migration from surrounding properties into the creeks. Other potential contaminant and release routes to the creeks include windblown dust, direct leakage from possible buried drums, and anthropologenic (i.e., vandalism, illegal dumping, etc.) activities.

4.4.5.3 Summary of Investigation

The objectives of the Kokomo and Wildcat Creeks investigation were to:

- Confirm existing information from the ABB-ES creek investigation;
- Further characterize Kokomo and Wildcat Creeks surface water quality and sediment contaminant concentrations;
- Examine the interrelationship if any exists between shallow groundwater quality and creek sediment and surface water;
- Determine the potential impacts from the surrounding properties; and
- Collect sufficient confirmatory data to evaluate the need for expedited remedial measures.

Kokomo and Wildcat Creeks investigation included creeks surface water and sediment sampling and groundwater sampling from the shallow water-bearing zone monitoring wells in close proximity to the creeks. All field activities and sample collection procedures were conducted according to the Work Plan and FSP unless otherwise noted (CDM 1995a and 1995b, respectively). Creek surface water and sediment sample locations, originally numbered SW/SD-101 through SW/SD-127 in the FSP (CDM 1995b), were changed to SW/SD-201 through SW/SD-227 to avoid identification overlap with prior ABB-ES labeling.

<u>Kokomo and Wildcat Creeks Surface Water</u>
Confirmation of previous ABB-ES surface water sample results and further determination of the presence and extent of contamination within Kokomo and Wildcat Creeks surface water was attempted via the collection of 27 samples according to the procedures outlined in the Work Plan and FSP (CDM 1995a and 1995b). The FSP (CDM 1995b) directed surface water samples to be collected with a 1-liter sample bottle which, in turn, would be used to fill the other sample bottles. The FSP (CDM 1995b) also called for undisturbed samples to be collected from both high and low velocity flow zones within the creeks. While following the FSP (CDM 1995b), the samplers agitated the sediment when walking into the creeks and could not easily collect an undisturbed sample. Instead, a PVC pole with a sample cup affixed to the end was used ("creek sampler") and decontaminated effectively (no hits in the field blank samples) between each sample location. This sampling methodology allowed for collection of an undisturbed sample and extended the reach of the sampling personnel to collect samples from high and low velocity creek areas.

Figure 4.4.5-1 shows CDM's surface water and sediment sample locations for Kokomo and Wildcat Creeks. Creek sediment samples were also collected at the same locations as the surface water samples. ABB-ES Kokomo and Wildcat Creeks surface water and sediment sample locations are shown on **Figure 4.4.5-2.** Many of the water and sediment sampling locations were located near outfalls identified during the ABB-ES investigation (see **Appendix I** for outfall locations)

At each location, surface water samples were collected prior to sediment sampling to insure an undisturbed sample. Surface water samples were field screened for temperature, conductivity, turbidity, dissolved oxygen, salinity, and redox potential using a daily calibrated Horiba U-10 water quality checker. Additionally, surface water samples were analyzed for nitrate/nitrite as nitrogen, ammonia, phosphorous, total dissolved solids, total suspended solids, and metals by the U.S. EPA Central Regional Laboratory (CRL). Nitrate/nitrite samples were collected in accordance with the FSP (CDM 1995b) which did not require sample preservation. At the request of the laboratory, re-sampling for preserved nitrates/nitrites was necessary but this does not compromise the useability or completeness of the data.

Kokomo and Wildcat Creeks Sediment Sampling

Sediment samples were collected after surface water sampling at each of the 27 locations following the procedures in the FSP (CDM 1995b). Sediments were characterized to confirm existing information, delineate contaminants present, determine the potential impacts from the contiguous properties, and design appropriate remedial actions. Kokomo and Wildcat Creeks sediment sample locations are depicted on **Figure 4.4.5-1**. Creek sediment samples were analyzed for VOCs, PAHs, PCBs, pesticides and total metals by the U.S. EPA Contract Laboratory Program (CLP).

Previously, sediment thickness was measured by ABB-ES at each sample location in Kokomo and Wildcat Creeks (CDM 1995a). In this investigation sample collection methodology did not include the method for determination of sediment thickness. Although an approximate thickness at each location could be derived, coring and surveying of the creek was necessary for mappable and useable results.

Seven background sediment samples were collected from both Kokomo and Wildcat Creeks (14 total) to establish a site-specific reference-based cleanup standard. In Kokomo Creek, SW/SD-201 was considered background and six additional background sediment samples were taken upstream of the CSSS in the vicinity of SW/SD-201 according to the procedures outlined in the FSP (CDM 1995b). In Wildcat Creek, SW-SD-226 was considered background and six additional background sediment samples were taken upstream of the CSSS in the vicinity of SW/SD-226 following the same procedure.

Groundwater Sampling

A more detailed examination of the procedures implemented and results obtained from groundwater sampling of the shallow water-bearing zone can be found in the Groundwater Technical Memorandum (Section 4.4.6 of the Remedial Investigation Report).

Groundwater was sampled from 12 shallow water-bearing zone monitoring wells located along Kokomo and Wildcat Creeks to evaluate groundwater quality and the relationship between the

shallow groundwater and hydraulically connected Kokomo and Wildcat Creeks (**Figure 2-1**). Groundwater sample results are reported according to the respective creek reaches where the monitoring wells are located. Creek reaches, numbered Reach 1 through Reach 6, are shown on **Figure 4.4.5-1**. Shallow water-bearing unit monitoring wells UA-28, UA-29, and LA-03A are located in Reach 6 of Wildcat Creek. Reach 5 contains shallow water-bearing unit monitoring wells UA-32, UA-11, UA-24, and UA-13. Monitoring well UA-10 is located in Reach 4 of Kokomo Creek. Monitoring wells EW-11, EW-18, and EW-06 are located in Reach 3 of Wildcat Creek. Only one monitoring well, UA-17, was sampled in Reach 2 of Wildcat Creek. No monitoring wells were sampled in Reach 1 of Wildcat Creek.

Groundwater samples were analyzed by CLP for VOCs, filtered and unfiltered metals, nitrate/nitrite as nitrogen, sulfate, chloride, mercury, alkalinity, total phosphorous, total suspended solids, and total dissolved solids. Several samples were analyzed for PAHs, PCBs, and pesticides.

4.4.5.4 Analytical Results

4.4.5.4.1 Surface Water Analytical Results

Surface water samples are reported by reach. Reaches 1, 2, 3, 5 and 6 correspond to Wildcat Creek and Reach 4 corresponds to Kokomo Creek. The surface water sampling and reach locations for CDM are shown on **Figure 4.4.5-1**. The following is a list of surface water samples collected within each creek reach:

- Reach 1: SW-218 through SW-221;
- Reach 2: SW-216, SW-222 and SW-223;
- Reach 3: SW-211 through SW-215 and SW-217;
- Reach 4: SW-224 through SW-227;
- Reach 5: SW-204 through SW-210; and
- Reach 6: SW-201, SW-202 and SW-203.

Sampling and reach locations for ABB-ES are located on **Figure 4.4.5-2**. The reach breakdown is the same for both CDM and ABB-ES, only sampling location and sample identification are different.

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in the surface water samples collected from Kokomo and Wildcat Creeks by ABB-ES and CDM is presented in **Table 4.4.5-1**. **Table 4.1** defines data qualifiers and terms used in Summary of Detection Tables. ABB-ES collected creek surface water samples during the months of April - August, 1993. CDM collected samples in October - November, 1995. Frequency of detections for parameters detected in surface water samples for both CDM and ABB-ES are in **Tables 4.4.5-2** through **4.4.5-13A**. The tables are separated by reach and investigator (ABB-ES or CDM). A summary of the range of concentrations for each parameter detected in samples collected by CDM is presented by reach in **Table 4.4.5-13B**.

4.4.5.4.2 Sediment Analytical Results

Kokomo and Wildcat Creeks sediment samples are also reported by reach. The same reach divisions apply to the sediment samples as apply to the surface water samples. Sediment sampling and reach locations for samples collected by CDM are shown on **Figure 4.4.5-1**. The following is a list of sediment samples collected within each reach.

- Reach 1: SD-218 through SD-221;
- Reach 2: SD-216, SD-222 and SD-223;
- Reach 3: SD-211 through SD-215 and SD-217;
- Reach 4: SD-224 through SD-227;
- Reach 5: SD-204 through SD-210; and
- Reach 6: SD-201, SD-202 and SD-203.

ABB-ES sampling and reach locations are presented on **Figure 4.4.5-2**. The reach breakdown is the same for both CDM and ABB-ES, only the sampling locations and sample identification are different.

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits for sediment samples collected by ABB-ES and CDM is found in **Table 4.4.5-14**. Kokomo and Wildcat Creeks sediment samples taken by ABB-ES were collected during the months of April - August, 1993. CDM collected samples in October - November, 1995. Frequency of detections for parameters detected in sediment samples for both CDM and ABB-ES are presented in **Tables 4.4.5-15** through **4.4.5-26A**. The tables are separated by reach and investigator (ABB-ES or CDM). A summary of the range of concentrations for each parameter detected in samples collected by CDM is presented by reach in **Table 4.4.5-26B**.

A dot plot indicating distribution and total concentration of VOCs for Kokomo and Wildcat Creek sediment samples is shown on **Figure 4.4.5-3**. **Figure 4.4.5-4** is a dot plot showing total PAH concentrations for Kokomo and Wildcat Creeks sediments. **Figure 4.4.5-5** is a dot plot showing total PCB concentrations for Kokomo and Wildcat Creeks sediments. **Figure 4.4.5-6** is a dot plot showing total pesticide concentrations for Kokomo and Wildcat Creeks sediments. Cadmium, copper and lead distribution and concentrations are shown on dot plot **Figures 4.4.5-7, 4.4.5-8** and **4.4.5-9**, respectively.

4.4.5.4.3 Groundwater Analytical Results

Table 4.4.5-27 contains a summary of detections for the organic and inorganic compounds detected at or above the laboratory quantitation limits for groundwater samples collected by ABB-ES and CDM. Selected groundwater monitoring wells in the vicinity of the Kokomo and Wildcat Creeks from which groundwater samples were taken and all of the area monitoring wells are shown on **Figure 2-1**. Shallow water-bearing unit monitoring wells UA-28, UA-29 and LA-03A are located in Reach 6 of Wildcat Creek. Reach 5 contains shallow water-bearing unit monitoring wells UA-32, UA-11, UA-24 and UA-13. Monitoring well UA-10 is located in Reach 4 of Kokomo Creek. Monitoring wells EW-11, EW-18 and EW-06 are located in Reach 3 of Wildcat Creek. Only one

monitoring well, UA-17, was sampled in Reach 2 of Wildcat Creek. No monitoring wells were sampled in Reach 1 of Wildcat Creek.

Groundwater results are reported from monitoring wells in the shallow (760 feet and up) water-bearing unit. Samples taken by ABB-ES were collected in 1992 and 1993. CDM collected samples in October - November, 1995. Summary statistics for parameters detected in the shallow-water bearing zone for both CDM and ABB-ES are presented in **Table 4.4.5-28**. The results that CDM obtained for each sample are listed below. The range of concentrations detected for each parameter is as follows [units: organics = µg/L (parts per billion) and inorganics = mg/L (parts per million)]:

Shallow Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1,1-Trichloroethane	3	14	1 - 2
1,1-Dichloroethane	4	14	1 - 3
1,1-Dichloroethene	8	14	1 - 7
1,2-Dichloroethane	1	14	2000 - 2000
Acetone	2	14	3 - 4
Benzene	3	14	1 - 1
Chloroform	1	14	1 - 1
cis-1,2-Dichloroethene	13	14	1 - 880
Methylene Chloride	1	14	1 - 1
Tetrachloroethene	6	14	4 - 600
trans-1,2-Dichloroethene	9	14	1 - 5
Trichloroethene	9	14	1 - 2000
Vinyl Chloride	9	14	17 - 110
Group: SVOCs (µg/L)			
1,4-Dichlorobenzene	1	15	2 - 2
di-n-Butylphthalate	1	1	2 - 2
Group: PAHs (µg/L)			
Naphthalene	1	15	1 - 1
Pyrene	1	1	.5 - .5
Group: Inorganics (mg/L)			
Aluminum	1	1	.775 - .775

Shallow Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (mg/L) (Continued)			
Aluminum, Dissolved	3	15	.101 - .923
Arsenic	1	1	.013 - .013
Arsenic, Dissolved	6	15	.004 - .009
Barium	1	1	.169 - .169
Barium, Dissolved	14	15	.025 - .181
Cadmium	1	1	.0031 - .0031
Cadmium, Dissolved	1	15	.0004 - .0004
Calcium	1	1	131 - 131
Calcium, Dissolved	15	15	13 - 548
Chromium, Dissolved	3	15	.017 - .066
Cobalt, Dissolved	3	15	.007 - .13
Copper	1	1	.016 - .016
Copper, Dissolved	7	15	.006 - .015
Iron	1	1	10.8 - 10.8
Iron, Dissolved	14	15	.086 - 3050
Lead	1	1	.017 - .017
Magnesium	1	1	28 - 28
Magnesium, Dissolved	15	15	23 - 236
Manganese	1	1	1.77 - 1.77
Manganese, Dissolved	15	15	.027 - 38.7
Mercury	6	15	.0001 - .0001
Nickel, Dissolved	3	15	.055 - .875
Potassium, Dissolved	8	15	6 - 32
Sodium	1	1	75 - 75
Sodium, Dissolved	15	15	34 - 456
Vanadium, Dissolved	3	15	.009 - .012
Zinc	1	1	.058 - .058
Zinc, Dissolved	4	15	.061 - .491

Note: Several dissolved metals (calcium magnesium, manganese, sodium and zinc) are listed as having greater concentrations than the total than the total concentration for the same metal. This discrepancy occurs because only one sample was analyzed for the total metal versus 15 samples analyzed for the dissolved metal.

Shallow Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Miscellaneous (mg/L)			
Alkalinity	1	1	310 - 310
Chloride	14	15	48 - 214
Sulfate	1	1	94 - 94
Total Phosphorous	1	1	.53 - .53

4.4.5.5 Discussion

Constituent concentrations from this investigation are compared to past results collected by ABB-ES in 1992 for surface water, sediment and groundwater samples (**Table 4.4.5-1** through **4.4.5-28**). Data gathered during the ABB-ES 1992 investigation of Kokomo and Wildcat Creek surface water, sediment and shallow groundwater is considered sufficient for comparison with results from CDM's phase of the RI and is included in the tables associated with the creeks. Kokomo and Wildcat Creeks surface water constituent concentrations are compared to the Indiana Water Quality Standards (IWQS) (327 I.A.C 2-1-6) and the U.S. EPA Ambient Water Quality Criteria (Fresh Chronic Criteria) (U.S. EPA 1992). These criteria are used as the benchmark values for surface water in **Table-4.4.5-13B**. Creek sediment results are compared to background concentrations and sediment benchmark criteria taken from the following sources in order of priority: U.S. EPA SQC (U.S. EPA 1993), Persaud *et al.*, (1993), NYSDEC (1993) and NOAA (1994). Surface water and sediment benchmark criteria are provided in CDM's risk assessment. Groundwater constituent concentrations are compared to U.S. EPA MCLs (**Table 4.4.1-23**.

4.4.5.5.1 Surface Water

Surface water inorganic concentrations are compared to background concentrations and surface water benchmark values taken from Indiana Water Quality Standards (327 I.A.C 2-1-6) and U.S. EPA Ambient Water Quality Criteria (Fresh Chronic Criteria) (U.S. EPA 1992). A detailed discussion of surface water results in comparison to background concentrations and surface water benchmark values is found in the ecological assessment sections of CDM's risk assessment report. Background surface water values were collected at locations upstream from the CSSS on both Kokomo and Wildcat Creeks and from the minor tributaries feeding each creek.

Field filtered samples are defined as dissolved concentrations and unfiltered samples are defined as total concentrations. Total and dissolved inorganics in surface water samples are summarized with the exception of calcium, magnesium, potassium and sodium which are toxic only at very high concentrations. The following discussion examines surface water results by reach that exceed benchmark values.

Reach 1
Seven dissolved metals and nine total metals were detected above quantitation limits in Reach 1 surface water samples. Only copper and lead exceeded the surface water benchmark criteria at location SW-219 in Reach 1.

Reach 2
Eight dissolved metals and eight total metals were detected above quantitation limits in Reach 2 surface water samples. Only sample SW-216 contained total copper and lead concentrations slightly above surface water benchmark criteria.

Reach 3
Ten dissolved metals and eleven total metals were detected above quantitation limits in Reach 3 surface water samples. Total copper was detected above surface water benchmark values for all surface water samples collected from Reach 3 of Wildcat Creek. Lead was also detected at a concentration only slightly above surface water benchmark criteria.

Reach 4
Five dissolved metals and ten total metals were detected above quantitation limits in Reach 4 surface water samples. Copper, lead and mercury were detected above surface water benchmark values for surface water in Reach 4 of Kokomo Creek.

Reach 5
Ten dissolved metals and eleven total metals were detected above quantitation limits in Reach 5 surface water samples. All surface water samples from Reach 5 contained total copper at concentrations slightly above surface water benchmark criteria. Lead was detected above surface water benchmark values in five of the seven surface water samples from Reach 5 of Wildcat Creek. Mercury was detected in only one sample, SW-207, at a concentration in excess of the benchmark criteria.

Reach 6
Six dissolved metals and seven total metals were detected above quantitation limits in Reach 6 surface water samples. Only lead was detected above surface water benchmark values in one-third of the samples collected from Reach 6 of Wildcat Creek.

Copper and lead were detected in excess of benchmark criteria in all reaches of the creeks except Reach 6 where only lead was present. Additionally, mercury was found in excess of the benchmark criteria in Reach 4 and 5. Overall, these detected concentrations were generally at or minimally above the benchmark criteria.

Comparison of previous ABB-ES creek surface water sample with data generated from this investigation produced a good correlation except for several analytes. CDM surface water total copper results was generally higher in Reaches 2-5 than past copper results (except for Reach 1 where ABB-ES detected copper and CDM had a non-detect). Similarly, lead was detected in CDM

Reach 6 samples above the benchmark criteria but was not detected in ABB-ES Reach 6 samples **Tables 4.4.5-1, 4.4.5-12** and **4.4.5-13**).

4.4.5.5.2 Sediment

Kokomo and Wildcat Creeks sediment inorganic and organic concentrations are compared to background concentrations and sediment benchmark values taken from the following sources in order of priority: U.S. EPA SQC (U.S. EPA 1993), Persaud *et al.* (1993), NYSDEC (1993) and NOAA (1994). Prioritization of this list occurred through consultation with U.S. EPA Region V. A detailed discussion of creek sediment results in comparison to background concentrations and sediment benchmark values is found in the ecological assessment sections of CDM's risk assessment report. Background sediment values were statistically analyzed and a 95 percent upper confidence limit (UCL) value was calculated and used for comparison with actual creek sediment results. A complete discussion of the statistical analysis employed to determine Kokomo and Wildcat Creek background sediment values is found in CDM's risk assessment.

Due to the heterogeneous nature of the sediment, sample collection by ABB-ES and CDM from different locations in each creek reach, and the greater number of samples collected by ABB-ES, comparison and correlation of ABB-ES results with CDM sediment results was difficult (**Table 4.4.5-14**). Overall, when ABB-ES and CDM detected a common organic or inorganic constituent within a reach, the values reasonably correspond. Several VOCs were detected in ABB-ES sediment samples from Reach 2, 4, 5, and 6 that were not detected in CDM sediment samples from the same reaches. Similarly, several PAHs detected in past samples were not by detected through CDM sampling. However, total PAH values from each result set correlated reasonably well. PCBs including Aroclor-1260, Aroclor-1254 and Aroclor-1016 were detected in CDM data from Kokomo and Wildcat Creeks but were not detected by ABB-ES. Also, ABB-ES detected Aroclor-1242 in several creek reaches, but CDM data yielded a non-detection. Kokomo and Wildcat Creek sediment pesticide concentrations could not be compared, since ABB-ES sampling did not include analysis for pesticides. Finally, metal results compared well for the contaminants of concern which included cadmium, copper and lead.

The following discussion examines CDM creek sediment concentration exceedences of both background and benchmark criteria as contained in **Table-4.4.5-26B**. Due to the large number of creek sediment samples that exceed the background and benchmark criteria and the importance of denoting the magnitude of each exceedence, parameters, in the following discussion, are described as slightly (0 to 3 times), moderately (3 to 10 times), and greatly (> 10 times) exceeding the background and benchmark criteria. When differing concentrations of a parameter are detected in samples from an individual reach, the highest value is reported. VOCs for which no benchmark values are available include: 2-butanone, carbon disulfide, toluene, total 1,2-dichloroethane, trichloroethane, and vinyl chloride. A benchmark value was also not available for thallium.

<u>Reach 1</u>
No VOCs exceed the sediment background or benchmark criteria for Reach 1 of Wildcat Creek. Fluoranthene is the only PAH that slightly exceeds the background sediment value. No other VOCs or PAHs exceed the background and benchmark criteria for Reach 1 of Wildcat Creek.

Aroclor 1248, 1254 and 1260 greatly exceed the background and benchmark criteria for Reach 1 of Wildcat Creek.

The following pesticides greatly exceed the background criteria: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, dieldrin, endrin, endrin aldehyde, gamma-chlordane, heptachlor, and heptaclor epoxide. 4,4'-DDE, 4,4'-DDT, aldrin, gamma-chlordane, heptachlor and heptaclor epoxide greatly exceed the benchmark criteria. 4,4,'-DDD, dieldrin and endrin aldehyde moderately exceed the benchmark criteria. Endrin slightly exceeds benchmark criteria.

The following metals greatly exceed the background criteria: arsenic, cadmium, chromium, cobalt, copper, iron, lead, nickel and zinc. Barium, mercury, selenium, silver and thallium moderately exceed background criteria. Aluminum, beryllium, manganese and vanadium were slightly over the background criteria. Aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, silver and zinc greatly exceed the benchmark criteria. Mercury and selenium moderately exceed the benchmark criteria. Cobalt and manganese slightly exceed the benchmark criteria.

Reach 2

No VOCs or SVOCs exceed the background and benchmark criteria for Reach 2 of Wildcat Creek. Fluoranthene is the only PAH to slightly exceed the background value and anthracene is the only PAH to slightly exceed the benchmark criteria.

Aroclor-1248, 1254 and 1260 greatly exceed both the benchmark criteria and the background criteria.

The following pesticides in Reach 2 greatly exceed both the benchmark and background values: 4,4'-DDE, 4,4'-DDT and aldrin. The concentrations of endrin aldehyde and dieldrin greatly exceed background criteria. The concentrations of gamma-chlordane and heptachlor greatly exceed benchmark criteria. The concentration of gamma-chlordane and heptachlor epoxide moderately exceed the background values. Endrin aldehyde is only slightly higher than the benchmark value.

In Wildcat Creek Reach 2 the following inorganics were found above the benchmark and the background criteria: arsenic, barium, cadmium, chromium, copper, lead, manganese, nickel and zinc. Aluminum and cadmium greatly exceed benchmark criteria. Cadmium, chromium and lead were moderately above the background criteria. Arsenic, barium, copper, manganese, nickel and zinc are only slightly above both background and benchmark criteria. Cobalt, iron and vanadium are slightly above only background criteria. Benchmark criteria are slightly exceeded by chromium, lead and silver.

Reach 3

Toluene slightly exceeds the background criteria for Reach 3. The SVOC, 4-methylphenol, is moderately above the background and greatly above the benchmark criteria.

The following compounds moderately exceed the background limit values for Reach 3: benzo (a) anthracene, benzo (a) pyrene, benzo (b) fluoranthene, benzo (k) fluoranthene, chrysene,

fluoranthene, phenanthrene, pyrene. Anthracene, benzo (g,h,i) perylene and indeno (1,2,3-c,d) pyrene slightly exceed the background criteria.

Benzo (a) anthracene, benzo (a) pyrene, benzo (b) fluoranthene, benzo (g,h,i) perylene, benzo (k) fluoranthene, chrysene, dibenzo (a,h) anthracene, indeno (1,2,3-c,d) pyrene and pyrene moderately exceed the benchmark criteria. Acenaphthene, anthracene and phenanthrene slightly exceed the benchmark criteria.

The following PCBs greatly exceed the background criteria for Reach 3: Aroclor-1248, Aroclor-1254 and Aroclor-1260. Aroclor-1016 moderately exceeds the background limit value. The benchmark values were greatly exceeded by Aroclors-1016, 1248, 1254 and 1260.

The following pesticides greatly exceed the background criteria for Reach 3: 4,4'-DDE, 4,4'-DDT, aldrin, dieldrin, gamma-chlordane and heptachlor epoxide. Alpha-chlordane, endrin, endrin aldehyde and gamma-BHC (lindane) exceed the background criteria by a moderate amount. The benchmark limit values were greatly exceeded by the following pesticides: 4,4'-DDE, 4,4'-DDT, aldrin, gamma chlordane and heptachlor epoxide. Gamma-BHC (lindane) moderately exceeds the benchmark limit value. Alpha-chlordane and dieldrin slightly exceed the benchmark criteria.

The following metals greatly exceeded the background criteria for Reach 3: cadmium, chromium, copper, iron, lead, nickel and zinc. Cobalt, manganese, and thallium moderately exceed the background criteria. Aluminum, arsenic, barium, beryllium, mercury, selenium and vanadium slightly exceed the background criteria. The benchmark criteria was greatly exceeded by the following metals: aluminum, cadmium, chromium, copper, lead, nickel and zinc. The metals that moderately exceed the benchmark criteria are as follows: arsenic, barium, iron and silver. Manganese, mercury and selenium slightly exceed the benchmark criteria.

<u>Reach 4</u>
Benchmark criteria are greatly exceeded and background criteria moderately exceeded by 2-methylnapthalene. Bis (2-ethylhexyl) phthalate moderately exceeds the benchmark criteria in Reach 4 of Kokomo Creek. No other SVOCs and no VOCs exceed the background or benchmark criteria.

The following PAHs greatly exceed both sediment background and benchmark criteria for Reach 4: acenapthene, anthracene, benzo (a) anthracene, benzo (a) pyrene, benzo (b) fluoranthene, benzo (g,h,i) perylene, benzo (k) fluroanthene, chrysene, dibenzofuran, fluorene, indeno (1,2,3-cd) pyrene, napthalene, phenanthrene and pyrene. Carbazole greatly exceeds the background value but a benchmark value is not available. Dibenzo(a,h)anthracene moderately exceeds background criteria and fluoranthene moderately exceeds benchmark criteria.

PCBs that greatly exceed benchmark and background criteria include Aroclor-1016, Aroclor-1248, Aroclor-1254 and Aroclor-1260.

Aldrin and gamma-BHC (lindane) greatly exceed the sediment background criteria for Reach 4. 4,4'-DDE and alpha-chlordane moderately exceed and gamma-chlordane slightly exceeds creek

sediment background criteria. Aldrin, endosulfan II and gamma-BHC (lindane) greatly exceed the sediment benchmark criteria. 4,4'-DDE and alpha-chlordane moderately exceed and gamma-chlordane slightly exceeds creek sediment benchmark criteria.

The following metals greatly exceed the sediment background criteria for Reach 4: cadmium, chromium, copper and zinc. Barium, cobalt, iron, lead and nickel moderately exceed the background criteria. Aluminum, manganese, mercury and vanadium slightly exceed the background criteria for Reach 4. Aluminum, cadmium and copper greatly exceed the sediment benchmark criteria for Reach 4. Barium, chromium, lead, nickel and zinc moderately exceed the sediment benchmark criteria. Iron, mercury and manganese only slightly exceed the inorganic benchmark criteria.

Reach 5

Vinyl chloride and total 1,2-dichloroethane greatly exceed the background criteria. Carbon disulfide slightly exceeds the background criteria. Acetone slightly exceeds the benchmark criteria. No other VOCs exceed the background or available benchmark criteria.

4-Methylphenol greatly exceeds benchmark values. Bis (2-ethylhexyl) phthalate and 2-methylnapthalene moderately exceed the benchmark criteria. No other SVOCs exceed the background or benchmark criteria in Reach 5.

Pyrene was the only PAH to greatly exceed the both the background and benchmark criteria in this reach. Phenanthrene greatly exceeds only the background criteria. Benzo (a) anthracene, benzo (b) fluoranthene, chrysene and fluoranthene moderately exceed the background criteria. PAHs slightly exceeding background criteria include: anthracene, benzo (a) pyrene, benzo (k) fluoranthene, carbazole and fluorene. PAHs moderately exceeding benchmark criteria include acenapthene, anthracene, benzo (a) anthracene, benzo (a) pyrene, benzo (b) fluoranthene, chrysene, and fluorene. Benzo (k) fluoranthene, indeno (1,2,3-cd) pyrene, napthalene and phenanthrene only slightly exceed the benchmark criteria.

The following PCBs greatly exceed both sediment background and benchmark criteria for Reach 5: Aroclor-1260, Aroclor-1254, Aroclor-1248 and Aroclor-1016.

The following pesticides greatly exceed the background criteria for Reach 5: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, dieldrin, endosulfan II, endrin aldehyde, gamma-BHC (lindane) and gamma-chlordane. The following constituents greatly exceeded the benchmark criteria: 4,4'-DDE, 4,4'-DDT, aldrin, endosulfan II, gamma-chlordane and gamma-BHC (lindane). Alpha-chlordane moderately exceeds background criteria. Endrin aldehyde and 4,4'-DDD moderately exceed the benchmark criteria. Dieldrin and alpha-chlordane slightly exceed the benchmark criteria.

The following metals greatly exceed the background criteria for Reach 5: antimony, cadmium, chromium, copper, iron, lead, mercury, nickel, silver and zinc. The background criteria were moderately exceeded by these metals: arsenic, barium, cobalt, manganese and vanadium. Aluminum and beryllium slightly exceed the background criteria. The following metals greatly exceed the benchmark criteria for Reach 5: aluminum, antimony, barium, cadmium, chromium,

Reach 1 and 2
Due to the paucity of monitoring wells within Reaches 1 and 2 of Wildcat Creek, only one shallow water-bearing unit monitoring well, UA-17, was sampled. Results show no VOC metal concentrations above the MCLs.

Reach 3
Slightly elevated levels of VOCs were detected in EW-11, located at the southwest corner of the Lagoon Area, and EW-18, located at the southeast corner of the Haynes facility Defenbaugh Street Operations (DSO) North landfill. Monitoring well EW-11 contained concentrations of cis-1,2-dichloroethene (19 µg/L) and vinyl chloride (29 µg/L) in excess of the MCLs. This well is located downgradient of the former drum disposal area and it is possible that a contaminant plume has already moved through this area and the local source has been removed. Since the contaminants present are degradation products and no parent products are present, the hypothesis that a local source is no longer available to supply the parent VOCs to the groundwater is further supported.

EW-18 groundwater results show elevated levels of tetrachloroethene (350 µg/L), trichloroethene (140 µg/L), cis-1,2-dichloroethene (380 µg/L), 1,1-dichloroethene (7 µg/L) and vinyl chloride (110 µg/L). The contaminant source area may be the Haynes facility landfill rather than the Lagoon Area since it is screened above the stream elevation, has tetrachloroethane present in the well and is upgradient in the shallow water-bearing zone.

Elevated concentrations of nickel were detected in EW-11 (212 µg/L) and EW-06 (875 µg/L). According to ABB-ES data for lagoon soils and sediments (**Appendix I**), nickel was present but at low levels. However, it may have been disposed in a more soluble form.

Reach 4
No VOCs or metals were detected in excess of MCLs from shallow water-bearing zone monitoring well UA-10.

Reach 5
VOCs were detected in shallow water-bearing zone monitoring wells UA-32 and UA-24 west of the CSSS Main Plant Area in Reach 5 of Wildcat Creek. Elevated levels of trichloroethene and its degradation products, cis-1,2-dichloroethene and vinyl chloride, were detected in UA-32 and UA-24. 1,2-Dichloroethane was detected in UA-24 at a concentration of 2,000 µg/L. These results are consistent with the reported historical spill of trichloroethene in the vicinity of Building 112B (nail mill) located at the northwest margin of the Main Plant.

UA-11 contained only one metal, lead (17 µg/L), in excess of the MCLs (15 µg/L). No other metals were detected in the groundwater samples collected from the monitoring wells located in Wildcat Creek Reach 5.

Reach 6
VOCs were detected in all three shallow water-bearing unit monitoring wells, UA-28, UA-29 and LA-03A. VOCs exceeding the MCLs included tetrachloroethene and its degradation products trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Tetrachloroethene was detected at

and sewers potentially containing contaminants may leak into soils before reaching the creeks. Fill along utilities may also act as conduits for contaminant migration.

Contaminants entering the shallow water-bearing zone may migrate into the intermediate and lower water-bearing zones via open fractures, joints, bedding planes and solutional channels within the bedrock. The orientation of fractures and bedding planes within the three water-bearing zones in addition to hydraulic gradient, control the vertical and horizontal movement of water and contaminant transport.

Based on regional information (Smith *et al.*, 1980) and the results of groundwater modeling for CSSS (CDM 1996), shallow groundwater generally discharges to Wildcat and Kokomo Creeks. As discussed in Section 4.4.6.5.1, Site Hydrogeology, the hydraulic relationship between Kokomo and Wildcat Creeks and the shallow water-bearing zone depends upon the hydraulic head difference between groundwater and surface water at a specific location. Fluctuations in precipitation affect creek stage and determine whether the creeks are losing water to or are gaining water from the shallow water-bearing zone. Thus, contaminant migration between the creeks and the shallow water-bearing zone may occur. Contaminants may migrate into the groundwater by leaching through the soils or through the hydraulic connection with the creeks. The influx of water from the creeks to the surrounding zone likely affects a limited area adjacent to the creeks and is dependent on the pervasiveness of open fractures and the potentiometric head in the adjacent shallow water-bearing zone. Contribution of contaminants to groundwater from creek surface water is likely minimal to nonexistent since influx of surface water to the shallow water-bearing zones would occur during high-flow or flooding conditions.

4.4.6.3 Summary of Investigation

The objectives of the groundwater investigation are presented below:

- Characterize groundwater flow, groundwater quality and contamination;
- Delineate horizontal and vertical extent of contamination;
- Document the horizontal and vertical extent of migration farther from the site;
- Determine the various potential sources of contamination;
- Evaluate the interrelationship among the three water-bearing zones; and
- Provide information for the evaluation of appropriate remedial action alternatives if necessary.

Field activities were conducted in accordance with the FSP with the exception of several monitoring well installation specification changes and an IDEM approved change to the groundwater sampling procedure described below.

<u>Monitoring Well Installation</u>
The groundwater investigation included the installation of monitoring wells, well development, hydraulic conductivity testing, and groundwater collection and analysis. Ten new groundwater monitoring wells and four replacement wells were installed during the field investigation during October through December 1995 to allow collection of water samples for water quality

characterization and to document groundwater flow patterns and hydraulic conductivity. The four replacement wells (UA-32, LA-103A, LA-103C and LA-103E) were not described in the Work Plan (CDM 1995a) or FSP (CDM 1995b). These wells were installed as supplemental work approved by IDEM to replace the former UA-32 and the multi level probe LA-03 which were destroyed during sewer construction by the City of Kokomo - refer to **Table 4.4.6-1** for well completion data. CDM and ABB-ES well construction logs are presented in **Appendix F**.

During the drilling and installation of the new and replacement monitoring wells, significantly more water was encountered in the upper fractured bedrock than anticipated. As a result, the drilling and monitoring well installation was slowed due to frequent water disposition. Due to the large volume of water encountered, the drillers (EDAC) chose to install a permanent surface casing extending through the overburden and a short distance into bedrock instead of the temporary casing as proposed in the Work Plan (CDM 1995a). Permanent casing installation inhibited borehole collapse which would have slowed drilling and increased expense.

Well drilling at each well location was initiated with hollow-stem auger drilling to characterize overburden and set casings. Air rotary drilling methods were used at each location, however, if water production at a well location inhibited drilling or became excessive then mud-rotary techniques were used to complete the borehole.

Delays in well completion due to the excess water affected the time frame in which developing, purging and sampling could take place. The threat of government shutdown due to federal budgetary issues complicated matters by creating a deadline for sample submittal after which samples might not be analyzed by the U.S. EPA CRL. Consequently, several of the newly installed wells were sampled prior to expiration of the two week waiting period specified in the FSP (CDM 1995b). This modification should not affect analytical results.

As outlined in the Work Plan (CDM 1995a) a medium coarse sand was used as the sand pack. A two-foot thick fine grained sand pack was placed above the medium sand. Due to excess water encountered in the monitoring wells during drilling, a thick bentonite slurry was tremied into the wells above the fine grained sand instead of a two-foot thick pelletized bentonite layer. Field conditions (excess water in the borehole) may have caused the pelletized bentonite to float or backup below the water table. Therefore, the tremied thick bentonite slurry was substituted for bentonite pellets.

Two monitoring well locations proposed in the Work Plan (CDM 1995a) and FSP (CDM 1995b) were modified due to existing site conditions. The proposed location for LA-101C was moved from the west side of Brandon Street west of Markland Avenue Quarry to inside the western margin of the quarry to protect the well (**Figure 2-1**). The proposed location was in the middle of the semi-truck parking lot for Syndicate Sales. Monitoring well LA-106C was moved to the northwest of the proposed location next to EW-06 to more effectively monitor groundwater impacts from the sludge drying bed.

During the packer test for LA-101C (46 to 56 foot interval), only 1.3 times the well volume instead of three well volumes was purged before sample collection due to slow recharge of the packer interval. CDM conducted this test for 46 hours before sample collection.

Monitoring well LA-101C was screened at a depth different than what was anticipated in the Work Plan (CDM 1995a). Initially, LA-101C was proposed to be screened at the approximate depth (50 to 55 feet) of the quarry floor. Review of the well log for UA-22 indicated the depth of the quarry is in excess of 72 feet. Therefore, LA-101C was screened between 82 and 92 feet below the surface at the suspected depth of the quarry bottom.

Following well completion, wells were developed by surge and evacuation methods as described in the FSP (CDM 1995b).

Groundwater Sampling

Groundwater samples were collected for laboratory analysis from 13 of the newly installed wells and 52 previously installed wells. The FSP (CDM 1995b) provides justification for sampling specified wells during field activities as well as sampling procedures and QA/QC procedures. Samples were not collected from UA-03, UA-05, UA-11, UA-27, EW-19 and DW-150. Domestic well 150 (DW-150) was selected for sampling; however, it was not sampled as planned because it could not be found and the residence is now served by a public water supply. Monitoring wells, UA-03, UA-27 and LA-03C were not sampled after successive water level measurements confirmed that the wells were dry. The water table fell below the screened interval in UA-03 and UA-27 due to water table fluctuation. LA-03C failed to recharge adequately during the time available for sampling following well development and purging. Well LA-03C is a supplemental replacement well and was not included in the proposed sampling as specified in the Work Plan (CDM 1995a). Monitoring well EW-19 is located at the Haynes International, Inc. facility, and according to Haynes International staff, EW-19 has been abandoned.

With the exception of the Westbay MP System™ wells, the remaining monitoring wells scheduled for sampling were sampled using a methodology other than that described in the FSP (CDM 1995b). The FSP (CDM 1995b) required micropurging prior to sampling. This technique was determined not to be feasible due to the limitations of available equipment and the low productivity of some wells, which would result in significant drawdown in the water column. Micropurging was originally selected as the preferred sampling methodology to minimize the generation and long-term storage of purge water from each well. Purge water disposition through a city sanitary sewer was arranged following appropriate characterization of purge water and city approval, therefore, the need for purge water minimization was reduced. A standard sampling methodology was used in place of micropurging where a minimum three well volumes of water were removed (up to a maximum of five well volumes) or the well was bailed dry. This was performed using either a disposable Teflon bailer or Grundfos submersible pump and dedicated polyethylene tubing. Prior to implementation, the sampling methodology was presented to and approved by IDEM.

The FSP (CDM 1995b) required measurement of Oxygen Reduction Potential (eH) for every groundwater sample collected. Procedures for eH determination stated that if dissolved oxygen

(DO) levels exceeded 0.01 mg/L, DO measurements would be more useful than eH measurements. Field measurements of DO were detected in a range of 0.54 mg/L to 15.11 mg/L (**Table 4.4.6-17**). As a result of these DO measurements, eH measurements were not collected for most wells.

Table 1-1 of the FSP (CDM 1995b) outlines the compounds sampled for in each well. Sample analytical results are discussed in Section 4.4.6.6.

Hydraulic Conductivity Test
Hydraulic conductivity testing was conducted to help characterize the three water bearing zones. Slug tests were performed on ten monitoring wells installed by CDM to obtain hydraulic conductivity values for use in groundwater flow and contaminant transport modeling. The screened interval length was used for the calculation of transmissivity values and for comparison with previously determined hydraulic conductivities.

The hydraulic conductivities varied across the site and may be due to several subsurface conditions. It is likely that in some wells the interval actually tested is smaller than the screen interval length which was assumed for calculations (i.e., fracture openings [which are small] may actually have been tested). The variability in conductivities may be due to this or presence or absence of fractures at the well location or screened interval. Additionally, the anisotropy of the bedrock may be responsible for variability in conductivities. Slug tests were not conducted or analyzed for replacement monitoring wells LA-03A, LA-03C, LA-03E and LA-103C. Well LA-03A did not produce enough data to be analyzed because the well recovered too rapidly. Slug tests could not be conducted on LA-103C and LA-03E because these wells were still rising over a 45 hour waiting period. LA-03C contained less than one-foot of water. Slug tests were conducted following the FSP (CDM 1995b), and the only deviation from the procedure was the use of a dedicated 1.25-inch diameter PVC slug instead of a Teflon slug for each well. The slugs were pre-cleaned and properly disposed following test completion. The use of PVC eliminated the need for field decontamination of the Teflon slug between well locations. Slug test results are presented in **Appendix A**.

4.4.6.4 Site Hydrogeology

4.4.6.4.1 General

Water-bearing zones, based on field observations and for the purposes of evaluation and discussion, were divided into three zones - the shallow, intermediate and lower water-bearing zones. Based on field observations, the upper water-bearing zone extends from approximately 800 feet above mean sea level (MSL) to approximately 760 feet MSL. The intermediate water-bearing zone extends from 760 feet MSL to 700 feet MSL. The lower water-bearing zone extends from 700 feet MSL to 660 feet MSL. Monitoring well locations are provided on **Figure 2-1** and well construction and water level information is provided in **Table 4.4.6-1**.

Shallow Water-Bearing Zone
The shallow water-bearing zone across the majority of the site consists of 5 to 20 feet of variable fill material and/or native silty clay overlying up to 40 feet of highly fractured and weathered Kokomo

Limestone (CDM 1995a). Monitoring wells completed in the shallow water-bearing zone tend to be the most prolific groundwater producers of the three zones with estimated discharge rates up to over 20 gallons per minute (gpm). Although high hydraulic conductivities (10^{-2} centimeters per second [cm/s]) are observed in the shallow water-bearing zone (**Appendix G**), hydraulic conductivities vary significantly with location and may be as low as 2×10^{-5}cm/s in UA-07 (**Appendix I**). The variability in hydraulic conductivities observed in monitoring wells screened within a single water-bearing zone is dependent on the following factors:

- Whether the well intersects a water-bearing fracture;
- Depth of the screened interval (intersection of water-bearing bedding plane fractures); and
- How well the intersected fracture system is developed.

These fractures and subsequent enlargement by dissolution represent secondary porosity; primary porosity is the porosity of the unfractured rock itself. The permeability associated with the secondary porosity generally is orders of magnitude greater than the permeability accounted with primary porosity and is responsible for the most significant transport of groundwater and contaminants in bedrock environments underlying the CSSS.

Higher yields were observed in the shallow water-bearing zone where wells were proximal to Wildcat or Kokomo Creek (LA-03A, UA-32 [**Figure 2-1**]). Higher yields observed along creeks are likely due to development of the secondary porosity and associated permeability. Development of secondary porosity in bedrock along the creeks may be attributed to higher rates of dissolution along fractures due to enhancement of groundwater flow by stream induced gradients (due to rising and falling creek levels).

Groundwater flow in the upper-water bearing zone is toward the creeks and the water table generally follows surface topographic features (**Figure 4.4.6-1**). These generalities are true with the exception of the Lagoon Area where mounding of the water table is present which results in a localized northerly flow along the north side of the Lagoon Area.

Response of the shallow water-bearing zone to precipitation was observed repeatedly during well development and groundwater gauging and sampling in wells located adjacent to the creeks. Response observed was likely the result of infiltration of meteoric water and the rise of nearby creeks. Rapidly rising water levels were observed in wells over periods of days and were likely the result of the creeks being hydraulically connected to the shallow water-bearing zone. The following water level fluctuations were observed after a three foot slug was inserted into well LA-103C for a falling-head slug test:

Date	Time	Water Level (Depth To Water In Feet)
1/18/96	16:12	30.29
	19:12	30.13
1/19/96	10:88	29.57
	15:53	29.32
	18:43	29.20
1/20/96	08:23	28.58

Water-level rise of over one foot per day was observed and indicates communication between the shallow water-bearing zone and the creek. The influx of water from the creeks to the surrounding units likely affects a limited area adjacent to the creeks and is dependent on the pervasiveness of open fractures and the potentiometric head (groundwater elevations) in the adjacent shallow water-bearing zone. Contribution of contaminants to groundwater from creek surface water is likely minimal since influx of surface water to the shallow water-bearing zone would occur during high-flow or flooding conditions. Likewise, flow volumes in the creeks will likely minimize potential impact of contaminated groundwater discharging to creeks via the large dilution which occurs.

Intermediate Water-Bearing Zone

The intermediate water-bearing zone consists of up to 60 feet of fine grained argillaceous (contains clay minerals) limestone. The intermediate water-bearing zone consists of the lower 10 feet of the Kokomo Limestone and the Liston Creek Limestone below. Wells completed in this water-bearing zone tend to produce less water than those completed in the shallow and lower water-bearing zones. Hydraulic conductivities in the intermediate zone vary from less than 10^{-7}cm/s to 10^{-2}cm/s based on slug tests at eight wells (**Appendix G**).

Flow characteristics are similar to those described above for the shallow water-bearing zone in that flow is dependent on open fractures, however, a combination of the fine grained nature of the limestone and paucity of open fractures in the intermediate zone result in lower yielding wells. Based on observations made at the Martin Marietta Quarry, significant water bearing fractures or fractures with evidence of having contained water in the past are widely spaced (greater than 100 feet between fractures) and tend to be narrow with little or no evidence of dissolution along fractures. Bedding plane fractures tend to be more widely spaced (.75 to 3 feet) and tighter than observed in the overlying Kokomo Limestone. Although the intermediate water-bearing zone tends to have lower hydraulic conductivities than the shallow water-bearing zone, the presence of contaminants confirms there is at least some communication between these zones. Communication between these zones likely varies with location. In one location (LA-103C) substantial water-level

elevation variations were observed which suggest hydraulic communication with Wildcat Creek. This may be an indication that secondary porosity is well developed in the bedrock along the creeks and that secondary porosity development may extend into the intermediate water-bearing zone.

Groundwater flow in the intermediate water-bearing zone on the eastern two thirds of the site is due west with a horizontal gradient of 0.01 ft/ft (**Figure 4.4.6-2**). High pumping rates at Martin Marietta Quarry affect large areas in intermediate and lower water-bearing zones (see Groundwater Modeling Technical Memorandum). Hydraulic influence from pumping at the Martin Marietta Quarry west of Dixon Road Quarry is first observed in the vicinity of the Slag Processing Area where the hydraulic gradient steepens to 0.02 ft/ft.

Lower Water-bearing Zone

The lower water-bearing zone consists of the lower 10 to 20 feet of the Liston Creek Limestone. The lower water-bearing zone also includes the upper 5 to 20 feet of the Mississinewa Shale. This water-bearing zone consists of well-developed bedding plane fractures which have been weathered by groundwater flow along the top of the Mississinewa Shale - the lower less permeable unit. Wells completed in this zone generally produce more water than the intermediate water-bearing zone and less than the shallow water-bearing zone. Hydraulic conductivities in the lower water-bearing zone vary from 1.6×10^{-4} cm/s (LA-104E) to 9.4×10^{-3} cm/s (LA-107E). Yields from individual wells depend in large part on whether a fracture is encountered, the size of the fracture, and in the lower water-bearing zone, how weathered and developed the secondary porosity has become. The thickness and development of this zone varies with location. No communication between the lower water-bearing zone and the creeks was observed during the field investigation (comparable water-level fluctuations), however, the presence of contaminants in the lower water-bearing zone indicates at least minimal communication is present. Poorly completed private or industrial wells may be a possible pathway to this core. The lower water-bearing zone was not observed at the Martin Marietta Quarry since the base of the quarry is just above this zone, however, the operations manager (John Wakefield, personal communication, February 6, 1996) indicated the quarry dewatering is accomplished by pumping from this zone. The characteristics of the Mississinewa Shale beneath this zone were not observed or evaluated since all wells in this and previous investigations were completed in the vicinity of Liston Creek Limestone / Mississinewa Shale contact.

Groundwater flow in the lower water-bearing zone is to the northwest and west (**Figure 4.4.6-3**) along the structural dip of the bedrock (see Section 2 Geology). Hydraulic gradients vary across the site with the steepest gradients between the main plant and Lagoon Area and west of the Slag Processing Area. West of the Slag Processing Area potentiometric surface contours become more concentric indicating influence from the pumping at the Martin Marietta Quarry. The steep gradient just west of the Main Plant (west of LA-04 and LA-05) likely indicates that pumping from the quarry influences the lower water-bearing zone as far east as the Main Plant, however, the paucity of wells in this water-bearing zone both at the site and beyond site boundaries precludes other interpretation of the results (straight contours in the vicinity of the main plant). The relatively flat contours in the vicinity of the Lagoon and Slag Processing Areas may be attributable

to the higher hydraulic conductivities observed in this area (10^{-3} cm/s) and possible mounding affects.

Vertical hydraulic gradients have been qualitatively measured at nested well site locations across the site. Due to the heterogeneous nature of the water-bearing units and the variable hydraulic conductivities with depth, quantitative gradients could not be calculated. Vertical gradients vary both in direction and magnitude with location and depth and can not be applied across the site for great distances. Vertical gradients, therefore are discussed in the sections that follow, by area, due to these local variances.

The following sections further detail the geology and hydrogeology as it pertains to groundwater flow in the vicinity of the operable units (see Section 1) at the CSSS.

4.4.6.4.2 Markland Avenue Quarry (Operable Unit #4)

Groundwater flow and contaminant transport in the vicinity of Markland Avenue Quarry is greatly influenced by the fill in the quarry and the fractured dolomitic limestone beneath and bordering the fill. The fill at the former limestone quarry extends to a depth of greater than 72 feet below ground surface (bgs) or below an elevation of 737.68 feet MSL (UA-22, ABB-ES, **Appendix F**). The fill occupies the extent of the quarry with the exception of the northwest corner of the quarry which is filled with water (the quarry pond) to a depth of approximately 50 feet. The remaining 22 plus feet below the quarry pond, and above the bedrock is likely comprised of sediment and fill.

The fill at Markland Avenue Quarry consists primarily of slag with localized pockets of various wastes including but not limited to steel fragments, refractory brick, drums and other miscellaneous solid waste. Based on the pattern of disposal the subsurface structure is likely similar to the subsurface structure of slag observed in a vertical cut at the Slag Processing Area. Slag was transported to Markland Avenue Quarry by rail car and removed by crane. Slag was placed along side the tracks and allowed to drop down along the embankment to the unfilled portion of the quarry. The tracks were originally laid parallel to Markland Avenue along the south side of the quarry (**Figure 4.4.2-1**). New tracks were installed as the quarry was filled the second and third set of tracks also paralleled Markland Avenue (Jack Markley, former locomotive engineer and crane operator at Markland Avenue Quarry, personal communication, November 6, 1995). The fourth and fifth sets of tracks were laid trending northeast subparallel and parallel, respectively, to the filled side of the quarry pond (southeast side). As a result of the pattern of disposal, the subsurface structure of the slag/fill is likely to consist of parallel bedding plane horizons or layers along the southern quarter of the site trending east-west and dipping or inclined downward to the north at approximately 35 to 40 degrees (**Figure 4.4.6-4**). North of this area bedding planes likely trend northeast-southwest and dip northwest at approximately 35 to 40 degrees. The bedding planes likely continue beneath the quarry pond and truncate along the base of the quarry.

The structure of the slag fill likely influences groundwater flow and contaminant transport. Based on observations made of the slag/fill at the Slag Processing Area, permeabilities parallel to bedding planes are likely greater than perpendicular (across) bedding planes as is typically the case in the subsurface. This inclined bedding at Markland Avenue Quarry would likely result in decreased

groundwater-flow velocities where gradients are perpendicular or subperpendicular to bedding planes. Greater flow velocities may be present where gradients are parallel or subparallel to bedding planes. Higher flow velocities may also occur downward along bedding planes which parallel or subparallel downward vertical gradients. Transport of dissolved contaminant would be similarly affected resulting in structurally controlled contaminant distributions. Contaminants denser than water would more readily migrate downward along dipping bedding planes under the added force of density-driven flow. These conditions are limited to within the boundaries of the excavated quarry in the saturated fill. Bedrock becomes the groundwater flow matrix at the base and sides of the quarry.

Bedrock bordering the quarry consists of fractured dolomitic Kokomo Limestone along the sides of the quarry to a depth of approximately 50 feet (753 ft MSL) (Shaver 1961). The Liston Creek Limestone makes up the walls and floor of the quarry extending from 50 feet to 72 plus feet depth (total depth of quarry is unknown but is believed to be 70 to 100 feet). Based on observations, fractures are vertical and oriented north-northwest, west-northwest and east-northeast with the latter being the predominant fracture orientation with the largest open fractures. These vertical fractures are more predominant and closely spaced in the shallow units - the Kokomo Limestone and Upper Liston Creek Limestone.

Horizontal bedding plane fractures are present throughout the stratigraphic column. These fractures are distributed at intervals ranging from inches in the Kokomo Limestone to one to three feet in the Liston Creek Limestone. Flow along bedding plane fractures was observed at the Martin Marietta Quarry at the base of the Kokomo Limestone. Based on examination of the Kokomo Limestone, flow along bedding plane fractures may the predominant flow pathway for groundwater in areas where vertical fractures are absent or widely spaced.

Groundwater flow in the vicinity of Markland Avenue Quarry in the upper water-bearing zone is characterized by westerly flow in a radial fashion (**Figure 4.4.6-1**). Much of Markland Avenue Quarry likely acts as a recharge zone for the shallow, intermediate and possibly lower water-bearing zones. As indicated above, higher flow and contaminant transport velocities are expected along vertical and bedding plane fractures as well as parallel to the strike of slag "bedding"or along slag "bedding planes" within the boundaries of the quarry. No hydraulic conductivity testing has been conducted to date within the slag at Markland Avenue Quarry. Hydraulic conductivity testing was conducted within the shallow water bearing zone in the bedrock bordering the quarry at UA-05 by ABB-ES (**Appendix G**) and indicated a hydraulic conductivity of approximately 6.9×10^{-4} cm/s, however, hydraulic conductivities in the shallow bedrock (Kokomo Limestone) around the site vary from 10^{-4} to 10^{-2} cm/s. The variability in hydraulic conductivities is likely due to whether the wells intersected fractures and the extent of weathering in the shallow dolomitic limestone in the vicinity of individual wells.

Groundwater flow in the intermediate water-bearing zone in the vicinity of Markland Avenue Quarry is characterized by a mounding effect at the quarry with an overall westerly flow (**Figure 4.4.6-2**). The quarry pond and the unvegetated slag covering the quarry permit more perco-lation of meteoric water to the subsurface which results in the mounding effect observed. The filled

quarry may also act like a bathtub for the accumulation of water since the bedrock bordering the quarry may be less permeable than the fill. Since the major contaminants observed at the quarry are denser than water when present as separate, non-aqueous phase liquids, migrating contaminants have likely occupied the lower portions of the quarry which are adjacent to the Liston Creek Limestone in the intermediate water-bearing zone. The Liston Creek Limestone also makes up the floor of the quarry.

Groundwater flow in the lower water-bearing zone in the vicinity of Markland Avenue Quarry is characterized by flow to the northwest at a gradient of 0.01 ft/ft. Gradient increases to 0.03 ft/ft west of Markland Avenue Quarry near Wildcat Creek. Evidence of mounding or recharge was not observed in the lower water-bearing zone in the vicinity of the quarry in this zone, however, this is likely due to the limited number of wells installed in the lower water-bearing zone in this area (**Figure 4.4.6-3**). Although no evidence of recharge to the lower water-bearing zone was observed, geology of the area suggests that fractures are likely present in the bedrock which forms the floor of the quarry. Therefore groundwater flow to the lower water-bearing zone is likely as is potential migration of DNAPLs and impacted groundwater from the quarry to the lower water-bearing zone. Additionally, vertical gradients in the vicinity of Markland Avenue Quarry (LA-01 and LA-02) are downward and promote downward contaminant migration - especially where vertical fractures are encountered (**Figures 4.4.6-1** and **4.4.6-3**). Shallow and deep water-level measurements at LA-01 are 794.42 feet MSL and 791.02 feet MSL, respectively. Shallow and deep water-level measurements at LA-02 are 790.31 feet MSL and 782.95 feet MSL, respectively.

4.4.6.4.3 Main Plant and Fence Plant Areas (Operable Unit #5)

Hydrogeology in the vicinity of the Main Plant and Fence Plant Areas is characterized by 5 to 15 feet of fill over Kokomo Limestone. Fill at the Main Plant consists of crushed slag which locally may overlie native silty clays. Fill at the Fence Plant Area was not characterized but is believed to be similar to that observed at the Main Plant. Fill and native sediments in this area are important to groundwater flow only in that the minimal thickness of overburden allows infiltration of meteoric water to the bedrock surface and ultimately to the shallow water-bearing zone. Groundwater generally occupies fractures in the Kokomo Limestone and only under extreme precipitation conditions is groundwater likely to rise to occupy the overburden fill and sediments. Groundwater flow in the shallow water-bearing zone is generally to the west at the Main Plant and Fence Plant areas with the exception of the southern third of the Main Plant where groundwater flow is toward Kokomo Creek (**Figure 4.4.6-1**).

Groundwater flow in the intermediate water-bearing zone is to the west as described above in Section 4.4.6.5.1. No connection with the shallow water-bearing zone was observed with the exception of those described in Section 4.4.6.5.1.

Groundwater flow in the lower water-bearing zone is to the northwest at a gradient of 0.02 ft/ft No direct hydraulic communication (comparable water-level fluctuations) with the shallow and intermediate water-bearing zones was observed, but of contaminants were detected in the lower water-bearing zone, which also were observed in these overlying zones. Evidence of mounding or recharge was not observed in the vicinity of the Main Plant, however, this cannot be ruled out due

to the limited number wells installed in the lower water-bearing zone in this area. Although no evidence of recharge to the lower water-bearing zone was observed, geology of the area suggests that fractures are likely present in the bedrock. Therefore groundwater flow to the lower water-bearing zone is likely as is potential migration of any impacted groundwater and DNAPLs that may be present from the shallow to the lower water-bearing zone. Additionally, vertical gradients in the vicinity (LA-04 and LA-05) are generally downward and promote contaminant migration - especially where vertical fractures are encountered. Water levels in wells completed in the lower water-bearing zone are comparable to those measured in the shallow water-bearing zone indicating hydraulic communication between the zones is probable (water-bearing zones separated by a confining layer typically have hydraulic heads [water levels] that vary significantly across the confining layer).

4.4.6.4.4 Lagoon Area (Operable Unit #2)

Hydrogeology in the vicinity of the Lagoon Area is characterized by 8 to 20 feet of surficial sediments over Operable Unit #2 weathered and fractured Kokomo Limestone. Surficial sediments in the area consist of 2 to 19 feet of sludge in the lagoons and drying beds, with slag outside the lagoons and drying beds (**Appendix I**). Clayey fill is present in some areas beneath the sludge/slag at thicknesses up to 14 feet. Glacial sands and gravels and alluvial silts and sands may be present at thicknesses of up to 8 feet and where the clayey fill is absent may directly underlie sludge/slag (**Appendix I**). The bedrock surface is present at elevations of approximately 770 feet (MSL) to 785 feet (MSL). Depth to water in the area is generally 5 to 10 feet. Shallow groundwater flow in the vicinity of the Lagoon Area is in a radial pattern away from the lagoons. At the time of this investigation, water levels in the Lagoon Area were observed at elevations of approximately 780 feet (MSL) to 785 (MSL). Depth to water in the area is generally 5 to 10 feet. Although the water levels are affected by precipitation and fluctuate throughout the year, water-level elevations in shallow water-bearing zones at the Lagoon appear to fluctuate less than five feet between the measurements collected by ABB-ES in the spring and summer of 1993 and those collected in the winter of 1995 (**Table 4.4.6-1**). The unvegetated ground surface and open lagoons and drying beds in this area facilitate infiltration of meteoric water to the shallow water-bearing zone which creates mounding of the water table (**Figure 4.4.6-1**). The water table in the Lagoon Area resides in the surficial sediments within the sludge/slag materials. The radial flow in this area induces flow in the water-bearing to the north and east and to Wildcat Creek to the south and west. Wildcat Creek acts as a transport barrier and sump for potentially impacted groundwater in the shallow water-bearing zone migrating to the south and west, however, migration beneath the creek is possible if contaminants migrate into the shallow bedrock. Investigations conducted for Haynes International indicate that groundwater flow direction may vary in the shallow water-bearing zone with time and precipitation (see Section 3.1.4.3.3). Wildcat Creek may not be a hydrologic barrier to contaminant transport in the intermediate and lower water-bearing zones.

Groundwater flow in the intermediate water-bearing zone is to the west (**Figure 4.4.6-2**) as described above in Section 4.4.6.5.1. No connection with the shallow water-bearing zone was observed in this area, however, impact to the intermediate water-bearing zone indicates migration may have occurred from the shallow to intermediate water-bearing zone. Hydraulic conductivities

observed in the Lagoon Area are the highest observed at the site in the intermediate water-bearing zone.

Hydraulic conductivities observed in the Lagoon Area are the highest observed in the intermediate water-bearing zone (10^{-3} to 10^{-2} cm/s in well LA-105C, LA-106C and LA-107C) at the CSSS. Although Wildcat Creek serves as a hydraulic barrier to flow in the shallow water-bearing zone, the affects of Wildcat Creek on the intermediate water-bearing zone are likely minimal. Therefore, the creek would not provide a barrier to contaminant migration in this zone.

Groundwater flow in the lower water-bearing zone is to the northwest (**Figure 4.4.6-3**) as groundwater enters the Lagoon Area from the southeast. Groundwater flow direction bends to the west as it moves across the Lagoon and Slag Processing Areas - likely the result of influence from pumping at the Martin Marietta Quarry. Potentiometric surface contours flatten in the vicinity of the Lagoon and Slag Processing Area likely due to the higher conductivities observed in the area and recharge from above. No hydraulic communication (comparable water-level fluctuations) with the shallow and intermediate water-bearing zones was observed other than the presence of contaminants in the lower water-bearing zone which were observed in the upper zones.

4.4.6.4.5 Slag Processing Area (Operable Unit #6)

Hydrogeology in the vicinity of the Slag Processing Area is characterized by 16 to 28 feet of slag fill overlying 17 feet of Kokomo Limestone. The depth of slag fill in the former limestone quarry (Chaffin Quarry) is unknown. The Kokomo Limestone overlies 61 feet of Liston Creek Limestone. The bedrock surface is present at elevations of approximately 761 feet MSL (UA-25) to 776 feet MSL (UA-16).

The fill at the Slag Processing Area consists of relatively inert, non-hazardous slag generated during steel production. Ground-surface elevation over the majority of the area is approximately 790 feet MSL to 795 feet MSL A hill of unprocessed (cobble size) slag rises approximately 45 feet (approximately 840 feet MSL) above the base level in the Slag Processing Area. Although 16 to 28 feet of fill is present where wells were installed, the bedrock surface elevation is only nine feet below the elevation of Wildcat Creek. The depth of the augering is expected to be greater, respectively. This indicates these wells likely did not penetrate the filled quarry. A vertical cut in the slag fill at the southwest corner of the site displays "cross bedding" which dips approximately 40 degrees (from horizontal) to the west.

Shallow groundwater flow in the vicinity of the Slag Processing Area is in a radial pattern away from the slag-filled area toward the north, west and south as shown on **Figure 4.4.6-1**. Groundwater flow to the west and south is toward Wildcat Creek. The unvegetated slag covering the Slag Processing Area may permit more percolation of meteoric water to the subsurface which results in the slight mounding effect observed. The filled quarry (Chaffin Quarry) may also act like a bathtub for the accumulation of water since the bedrock bordering the quarry may be less permeable than the fill. The structure of the fill likely influences groundwater flow and contaminant transport as described above for fill at Markland Avenue Quarry in Section 4.4.6.5.2. Permeabilities parallel to "bedding planes" are likely greater than perpendicular (across) bedding

planes as is typically the case in the subsurface. Unlike Markland Avenue Quarry, little is known about patterns of disposal of slag at the Slag Processing Area. Although little is known about disposal patterns, observation of dipping beds in the vertical cut indicates similar conditions for groundwater or contaminant transport along bedding exists. Additionally, it can be postulated that filling of the quarry was likely achieved by dumping slag from ground surface down into the quarry which would produce dipping beds in the filled quarry.

Groundwater flow into the Slag Processing Area in the shallow water-bearing zone is from the vicinity of the sludge drying beds at the Lagoon Area to the east. At the time of this investigation, water levels in the Slag Processing Area were observed at elevations of approximately 770 feet MSL to 774 feet MSL Shallow groundwater, therefore, is present within the bedrock (below the bedrock surface) in the eastern part of the Slag Processing Area and occupies the slag fill in the western part of the site. Water-level elevations at the west end of the site (UA-17 and UA-25) are consistent with stream gauge elevations adjacent to the site indicating probable hydraulic communication with Wildcat Creek.

Groundwater flow in the intermediate water-bearing zone is to the west (**Figure 4.4.6-2**). Groundwater contours begin showing influence from pumping at Martin Marietta Quarry in the vicinity of the Slag Processing Area. Monitoring Well UA-17 is screened approximately at the boundary between the shallow and intermediate water-bearing zones. UA-25 is screened from an elevation of 770.5 feet MSL to 760.5 feet MSL Monitoring well LA-06A monitors the interval from 748 feet MSL to 736 feet MSL Although these intervals have a distance of only 12.5 feet between them, LA-06A and UA-25 have water levels of 749.3 feet MSL and 770.39 feet MSL, respectively. This exemplifies the affect of the pumping at Martin Marietta Quarry on the lower and intermediate water-bearing zones. This high gradient between the zones also supports the existence of a significant contrast between vertical and horizontal conductivity in this area. This may be an indication that bedding plane partings and solutioning play more of a role than vertical fracturing in this area.

Groundwater flow in the lower water-bearing zone (**Figure 4.4.6-3**) is to the west toward Martin Marietta Quarry. The hydraulic gradient in the vicinity of the Slag Processing Area is relatively flat in the lower water-bearing zone but steepens significantly to the west to a gradient of approximately 0.05 ft/ft. A strong downward vertical gradient is present in the vicinity of the Slag Processing Area with a difference in potentiometric head between the shallow and lower aquifer of 34.5 feet (LA-06) likely due to pumping at the Martin Marrietta Quarry.

4.4.6.4.6 Haynes International Defenbaugh Street Operations (DSO)

Groundwater flow in the shallow bedrock (shallow water-bearing zone) varies seasonally (see Section 3.1.4.3.3). In April 1991 groundwater flow at Haynes DSO-North Landfill was to the north in the shallow bedrock, however, in September 1991 flow was to the northwest.

Groundwater flow in the deep bedrock was to the southwest in April and September 1991. Groundwater flow at the Haynes DSO facility is significant to this investigation due to the presence of potential sources and historical analytical results indicating the presence of chlorinated organics

(e.g., tetrachloroethene at 53,100 µg/L) in samples collected from groundwater monitoring wells (see Section 3.1.4.3.3).

4.4.6.5 Analytical Results

Groundwater samples were collected by ABB-ES in August 1993 and by CDM in November and December 1995 from the shallow, intermediate and lower water-bearing zone monitoring wells. Locations of the groundwater monitoring wells from which the samples were collected are shown in **Figure 2-1**. Analytical results and their implications will be discussed in Section 4.4.6.7. A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in the groundwater samples collected from the shallow (760 feet MSL and above) water-bearing zone monitoring wells is presented in **Table 4.4.6-2**. **Table 4.4.6-3** is a summary of detections table for the groundwater samples collected by CDM (1995) in the shallow wells. Groundwater frequency of detection and range of concentrations are reported for the shallow water-bearing zone for CDM (1995) groundwater samples in **Table 4.4.6-4**. **Table 4.4.6-5** contains the frequency of detection and range of concentrations for parameters detected in groundwater samples collected by ABB-ES in the shallow water-bearing zone. All of the frequency of detection tables are for comparative summary purposes only.

The range of concentrations detected in samples collected by CDM in 1995 for each parameter are as follows [units: organics = µg/L (parts per billion) and inorganics = mg/L (parts per million)]:

Shallow Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1,1-Trichloroethane	5	28	1 - 43
1,1,2-Trichloroethane	1	28	1 - 1
1,1-Dichloroethane	5	28	1 - 5
1,1-Dichloroethene	11	28	1 - 7
1,2-Dichloroethane	1	28	2000 - 2000
1,2-Dichloroethene (total)	3	3	200 - 400
Acetone	4	28	3 - 4
Benzene	4	28	1 - 1
Chloroform	3	28	1 - 19
cis-1,2-Dichloroethene	19	25	1 - 880
m&p-Xylene	1	25	1 - 1
Methylene Chloride	3	28	1 - 1
o-Xylene	1	25	2 - 2
Tetrachloroethene	9	28	1 - 1900

Shallow Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L) (Continued)			
trans-1,2-Dichloroethene	13	25	1 - 7
Trichloroethene	17	28	1 - 2000
Vinyl Chloride	13	28	1 - 110
Group: SVOCs (µg/L)			
1,2,4-Trimethylbenzene	1	25	9 - 9
1,3,5-Trimethylbenzene	1	25	4 - 4
1,4-Dichlorobenzene	1	28	2 - 2
bis(2-Ethylhexyl)phthalate	2	3	2 - 8
di-n-Butylphthalate	1	3	2 - 2
Group: PAHs (µg/L)			
Naphthalene	2	28	1 - 16
Pyrene	1	3	.5 - .5
Group: PCBs (µg/L)			
Aroclor-1242	2	6	1.6 - 4.5
Aroclor-1248	2	6	5.8 - 6.4
Group: Pesticides (µg/L)			
alpha-Chlordane	2	3	.081 - .09
Group: Inorganics (mg/L)			
Aluminum	4	4	.344 - .775
Aluminum, Dissolved	7	29	.082 - .923
Antimony, Dissolved	2	29	.002 - .006
Arsenic	3	4	.003 - .013
Arsenic, Dissolved	8	29	.004 - .014
Barium	4	4	.099 - .169
Barium, Dissolved	28	29	.018 - .358
Cadmium	3	4	.0003 - .0031
Cadmium, Dissolved	3	29	.0004 - .0007
Calcium	4	4	131 - 235
Calcium, Dissolved	29	29	13 - 620
Chromium, Dissolved	3	29	.017 - .066

Shallow Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: Inorganics (mg/L) (Continued)			
Cobalt, Dissolved	3	29	.007 - .13
Copper	2	4	.015 - .016
Copper, Dissolved	16	29	.006 - .015
Iron	4	4	7.58 - 12.5
Iron, Dissolved	21	29	.083 - 3050
Lead	4	4	.009 - .03
Lead, Dissolved	1	29	.12 - .12
Magnesium	4	4	28 - 49
Magnesium, Dissolved	28	29	11 - 236
Manganese	4	4	.879 - 1.77
Manganese, Dissolved	29	29	.009 - 38.7
Mercury	13	29	.0001 - .0003
Nickel, Dissolved	7	29	.021 - .875
Potassium	1	4	5.24 - 5.24
Potassium, Dissolved	17	29	6 - 79
Sodium	4	4	45 - 127
Sodium, Dissolved	29	29	19 - 456
Vanadium	2	4	.009 - .011
Vanadium, Dissolved	6	29	.008 - .012
Zinc	3	4	.058 - .246
Zinc, Dissolved	7	29	.045 - .621
Group: Miscellaneous (mg/L)			
Alkalinity	4	4	310 - 620
Chloride	27	29	32 - 265
Nitrate/Nitrite Nitrogen	3	4	.65 - 4.89
Sulfate	4	4	70 - 182
Total Phosphorous	4	4	.07 - .53

Dot plots were prepared for tetrachloroethene, trichloroethene, cis-1,2-dichloroethene and vinyl chloride due to their widespread detection across the site. A dot plot indicating distribution and concentration of tetrachloroethene in the shallow water-bearing zone is shown on **Figure 4.4.6-5**. Where duplicate sample results were available, the higher value was used for the dot plots. Trichloroethene distribution and concentration in the shallow water-bearing zone are shown on dot

plot **Figure 4.4.6-6**. The distribution and concentration of cis-1,2-dichloroethene in the shallow water-bearing zone is shown on a dot plot in **Figure 4.4.6-7**. The dot plot for the shallow (**Figure 4.4.6-8**) water-bearing zone shows the distribution and concentration of vinyl chloride. **Figure 4.4.6-9** is a contour map showing the distribution of the tetrachloroethene plume in the shallow water-bearing zone. Data shown in dot plots and contour maps are from CDM sampling in November to December 1995. **Figure 4.4.6-10** is a contour map showing the distribution of the vinyl chloride plume in the shallow water-bearing zone. A contour map indicating the distribution of total VOCs is shown on **Figure 4.4.6-11**.

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in the groundwater samples collected from the intermediate water-bearing zone (700-760 feet MSL) monitoring wells is presented in **Table 4.4.6-6**. Locations of the groundwater monitoring wells from which the samples were collected are shown in **Figure 2-1**. **Table 4.4.6-7** is a summary of detections table for the groundwater samples collected by CDM (1995) in the intermediate water-bearing zone. The frequency of detection and range of concentrations for parameters detected in groundwater samples are reported for the intermediate water-bearing zone for CDM (1995) groundwater samples in **Table 4.4.6-8**. **Table 4.4.6-9** contains groundwater frequency of detection and range of concentration results for samples collected by ABB-ES in the intermediate water-bearing zone.

The range of concentrations detected in samples collected by CDM in 1995 for each parameter are as follows [units: organics = µg/L (parts per billion) and inorganics = mg/L (parts per million)]:

Intermediate Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1,1-Trichloroethane	3	33	1 - 18
1,1-Dichloroethane	9	33	1 - 55
1,1-Dichloroethene	11	33	1 - 7
1,2-Dichloroethene (total)	1	1	2000 - 2000
Acetone	3	29	5 - 14
Acrylonitrile	5	28	19 - 140
Benzene	2	33	1 - 1
Carbon Disulfide	1	29	3 - 3
Chloromethane	1	29	1 - 1
cis-1,2-Dichloroethene	31	32	1 - 1900
Ethylbenzene	1	33	1 - 1
m&p-Xylene	3	32	1 - 4
Methylene Chloride	4	33	1 - 1

Intermediate Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L) (Continued)			
o-Xylene	1	32	1 - 1
Styrene	3	29	1 - 11
Tetrachloroethene	2	33	76 - 99
Toluene	1	33	1 - 1
trans-1,2-Dichloroethene	16	32	1 - 29
Trichloroethene	18	33	1 - 5100
Vinyl Chloride	22	29	1 - 150
Group: SVOCs (µg/L)			
Hexachlorobutadiene	1	28	1 - 1
Group: Inorganics (mg/L)			
Aluminum, Dissolved	6	27	.082 - .144
Antimony, Dissolved	5	27	.002 - .004
Arsenic, Dissolved	9	27	.003 - .008
Barium, Dissolved	27	27	.012 - .278
Calcium, Dissolved	27	27	3 - 427
Chromium, Dissolved	1	27	.048 - .048
Cobalt, Dissolved	2	27	.019 - .019
Copper, Dissolved	12	27	.006 - .012
Iron, Dissolved	24	27	.213 - 13.9
Magnesium, Dissolved	26	27	3 - 248
Manganese, Dissolved	25	27	.006 - 1.04
Mercury	1	27	.0006 - .0006
Nickel, Dissolved	4	27	.032 - .272
Potassium, Dissolved	18	27	5 - 53
Sodium, Dissolved	27	27	16 - 144
Vanadium, Dissolved	2	27	.016 - .016
Zinc, Dissolved	4	27	.05 - .622
Group: Miscellaneous (mg/L)			
Chloride	27	28	24 - 211

Dot plots indicating distribution and concentration of tetrachloroethene in the intermediate water-bearing zone are shown on **Figure 4.4.6-12**. Trichloroethene distribution and concern-tration in the intermediate water-bearing zone are shown on dot plot **Figure 4.4.6-13**. The distribution and concentration of cis-1,2-dichloroethene in the intermediate water-bearing zone are shown on dot plot **Figure 4.4.6-14**. The dot plot for the intermediate (**Figure 4.4.6-15**) water-bearing zone shows the distribution and concentration of vinyl chloride. A contour map indicating the distribution of total VOCs is shown on **Figure 4.4.6-16**.

A list of organic and inorganic compounds detected at or above the laboratory quantitation limits in the groundwater samples collected from the lower water-bearing zone (660-700 feet MSL) monitoring wells is presented in **Table 4.4.6-10**. Locations of the groundwater monitoring wells from which the samples were collected are shown in **Figure 2-1**. **Table 4.4.6-11** is a summary of detections table for the groundwater samples collected by CDM (1995) in the lower water-bearing zone. The frequency of detection/range of concentration groundwater results are reported for the lower water-bearing zone for CDM (1995) groundwater samples in **Table 4.4.6-12**. **Table 4.4.6-13** contains groundwater frequency of detection/range of concentration results for samples collected by ABB-ES in the lower water-bearing zone.

The range of concentrations detected in samples collected by CDM in 1995 for each parameter are as follows [units: organics = µg/L (parts per billion) and inorganics = mg/L (parts per million)]:

Lower Water-Bearing Zone

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L)			
1,1-Dichloroethane	3	15	1 - 1
1,1-Dichloroethene	4	15	1 - 2
1,2-Dibromoethane	1	11	1 - 1
Acetone	1	11	18 - 18
Acrylonitrile	6	11	8 - 150
Carbon Disulfide	2	11	1 - 2
Chloroform	2	14	1 - 1
Chloromethane	1	14	1 - 1
cis-1,2-Dichloroethene	15	16	1 - 4700
m&p-Xylene	1	15	1 - 1
Methylene Chloride	2	16	1 - 4.5
Styrene	2	14	1 - 6
Tetrachloroethene	1	15	130 - 130
trans-1,2-Dichloroethene	6	16	1 - 4
Trichloroethene	9	16	1 - 160

Lower Water-Bearing Zone (Continued)

Parameter	No. of Detects	No. of Samples Analyzed	Range of Concentrations Detected
Group: VOCs (µg/L) (Continued)			
Vinyl Chloride	8	15	1 - 330
Group: PAHs (µg/L)			
Naphthalene	1	14	1 - 1
Group: Inorganics (mg/L)			
Aluminum, Dissolved	4	11	.081 - .147
Antimony, Dissolved	2	11	.002 - .007
Aluminum, Dissolved	4	11	.081 - .147
Antimony, Dissolved	2	11	.002 - .007
Arsenic, Dissolved	2	11	.002 - .003
Barium, Dissolved	11	11	.033 - .159
Cadmium, Dissolved	3	11	.0003 - .0003
Calcium, Dissolved	11	11	13 - 167
Chromium, Dissolved	1	11	.016 - .016
Copper, Dissolved	5	11	.007 - .014
Iron, Dissolved	9	11	.128 - 1.09
Magnesium, Dissolved	11	11	6 - 62
Manganese, Dissolved	10	11	.009 - .135
Mercury	1	11	.0001 - .0001
Potassium, Dissolved	10	11	5 - 19
Selenium, Dissolved	1	11	.027 - .027
Sodium, Dissolved	11	11	23 - 107
Zinc, Dissolved	4	11	.048 - .062
Group: Miscellaneous (mg/L)			
Chloride	11	11	22 - 139

Dot plots indicating distribution and concentration of tetrachloroethene in the lower water-bearing zone are shown on **Figure 4.4.6-17**. Trichloroethene distribution and concentration in the lower water-bearing zone are shown on dot plot **Figure 4.4.6-18**. The distribution and concentration of cis-1,2-dichloroethene in the lower water-bearing zone are shown on dot plot **Figure 4.4.6-19**. The dot plot for the lower (**Figure 4.4.6-20**) water-bearing zone shows the distribution and concentration of

vinyl chloride. A contour map indicating the distribution of total VOCs in the lower water-bearing zone is shown on **Figure 4.4.6-21**.

4.4.6.6 Discussion

4.4.6.6.1 Discussion of Water Quality Temporal Trends

Water quality results from the 1995 CDM investigation (November to December, 1995) were compared to 1993 ABB-ES (August 1993) analytical results for groundwater samples from wells completed in the shallow, intermediate and lower water-bearing zones to determine potential trends within different portions of the study area (i.e., Markland Avenue Quarry, Fence Plant, Main Plant, Lagoon Area and the Slag Processing Area). Water quality parameters for VOCs, PCBs and metals were evaluated. Water samples from two monitoring wells, UA-32 and UA-21, located in the Main Plant area, were analyzed for PCB compounds. CDM selected these two wells for PCB sampling during the 1995 investigation because of previous analytical results reported by ABB-ES. Only ABB-ES analyzed for pesticides. The Preliminary Risk Assessment conducted prior to preparation at the Work Plan (CDM 1995a) identified chemicals of concern. Monitoring parameters were selected based on the chemicals of concern to provide a focused approach for the remedial investigation.

Since a discussion of potential water quality trends requires at least two sampling events for each well, only wells sampled during both 1993 and 1995 are discussed in this section. Additional analytical information from other wells, including the wells installed by CDM during 1995, is available. The following section, Section 4.4.6.7.2 provides a discussion that includes all analytical information for groundwater.

Potential water quality trends discussed within this section are based only on the comparison of data from two sampling events. If duplicate samples were collected for a particular well during either the 1993 or the 1995 sampling events, an arithmetic average of the results is used for the trend analysis. Actual water quality trends would require additional information collected over time. In addition, sampling activities were conducted during different times of the year and under different hydrologic conditions. Constituent concentrations may vary seasonally or even daily, depending on surface water/groundwater response time. Changes in constituent concentrations (e.g., mobilization of contaminants, dilution of contaminant concentrations) result from changes in water chemistry and groundwater flow patterns due to weather and climatic variations. Also, different laboratories were used for sample analysis during the two sampling events and variations in results between laboratories are not uncommon. These items should be kept in mind with respect to the following discussion. A third sampling event was conducted for approximately 20 wells. The field measurement information has been added to the Draft Final Remedial Investigation Report and the analytical data will be added to the Final Remedial Investigation Report.

Tetrachloroethene, trichloroethene, 1,2-dichloroethene and vinyl chloride are the primary VOC constituents of concern identified during the remedial investigation. These compounds can be related to each other through degradation processes. **Figure 4.4.6-22** contains a flow chart of

degredation pathways. Tetrachloroethene is degraded under anaerobic conditions as chloride ions are removed from the chemical structure under a process known as reductive dehalagenation. According to Pankow *et. al.*, 1996, tetrachloroethene appears to biodegrade only under anaerobic conditions. TCE is also resistant to biodegradation under aerobic conditions, except in special circumstances (Pankow *el. al.*, 1996). **Table 4.4.6-17** presents dissolved oxygen values collected during the 1995 sampling event. Oxygen values ranged from 0.85 mg/L at LA-105E (lower water-bearing zone) to 15.11 mg/L at LA-06B. Values greater than 8 mg/L should be considered suspect since water at the observed temepratures is saturated with respect to oxygen at this concentration. Although the degradation pathway for tetrachloroethene can follow trichloroethene, then 1,2-dichloroethene and then vinyl chloride, each of these compounds may exist as a unique product. For example, the presence of trichloroethene may be indicative of tetrachloroethene degradation or may simply indicate the presence of a unique parent product. The reverse process, however, is not applicable to natural environmental systems, i.e., the presence of tetrachloroethene does not indicate trichloroethene degradation. For this discussion, trichloroethene and tetrachloroethene are generally considered to be parent products and 1,2,-dichloroethene and vinyl chloride are considered to be degradation products.

For the purpose of initial evaluation and as a point of reference for the reader, groundwater constituent concentrations were compared to MCLs as screening levels. For constituents where no MCL exists, IDEM Tier II guidance (October 1995, July 1996 update) may be used as a point of reference. The screening levels for groundwater are presented in **Table 4.4.1-23**. **Tables 4.4.6-14, 15 and 16** summarize all water quality parameters that exceed screening levels for the 1993 and 1995 data. The data presented in the exceedence tables is intended only to provide a point of reference for the reader. This guidance is not promulgated and may not be appropriate for use under the Superfund Program. Analytical results for Markland Avenue Quarry, the Fence Plant, the Main Plant, the Lagoon Area and the Slag Processing Area are summarized in **Tables 4.4.6-14, 15 and 16** according to each of the three water-bearing zones, shallow, intermediate and lower. An assessment of the risks associated with detected contaminants in groundwater will be provided in the risk assessment.

Markland Avenue Quarry

Monitoring wells located in the vicinity of Markland Avenue Quarry include, by water-bearing zone: Shallow - UA-01, UA-03, UA-04, UA-05, UA-22, UA-27 and LA-01A; Intermediate - LA-01B, LA-02A, LA-02B and LA-101C; Lower - LA-01C and LA-02C (see **Figure 2-1**). Monitoring wells UA-03, UA-05, UA-27 and LA-101C were not sampled during both sampling events, so information from these wells are not discussed in this section.

Shallow Water-Bearing Zone

Comparison of results for ABB-ES and CDM shallow wells shows volatile compound detections above the screening levels for monitoring well UA-22. UA-22 is located in the backfilled portion of Markland Avenue Quarry, east-southeast of the quarry pond. Well UA-22 demonstrates decreasing concentrations for trichloroethene and 1,2-dichloroethene (total), from 750 µg/L to 440 µg/L and from 980 µg/L to 155 µg/L, respectively. Vinyl chloride was not detected during 1993 by ABB-ES in

UA-22, but was detected at 4 µg/L during 1995 by CDM. No monitored parameters were detected above screening levels for samples collected from UA-01 and UA-04. Monitoring well UA-01 is located upgradient to Markland Avenue Quarry; monitoring well UA-04 is located southwest of the quarry.

Intermediate Water-Bearing Zone
For intermediate monitoring well LA-02 at zones A and B, trichloroethene concentrations remained relatively constant ranging from 11 µg/L to 15 µg/L in both LA-02 A and B. 1,2-Dichloroethene, however, increased significantly (92 µg/L to 1100 µg/L) in samples collected from LA-02B. Vinyl chloride was not detected by ABB-ES in the intermediate wells, however, further degradation of the volatile compounds has occurred and vinyl chloride was detected in LA-02B at 3 µg/L.

Lower Water-Bearing Zone
The concentration of trichloroethene in well LA-02C decreased from 130 µg/L to 62 µg/L while the concentration of 1,2-dichloroethene (total) remained relatively the same (23 µg/L to 20 µg/L). No monitored parameters were detected above screening levels for samples collected from LA-01C.

Summary
Based on available data, groundwater in all three of the water bearing zones is not contaminated upgradient from Markland Avenue Quarry. Although UA-27 exhibited very low concentrations of chloroform and chloromethane in 1993, the absence in upgradient wells of chlorinated compounds that were observed in downgradient wells indicates no significant upgradient migration has occurred at the quarry in the shallow water-bearing zone. Water quality contamination has been documented at well locations in the backfilled portion of the quarry and downgradient from the quarry pond. Based on the analytical information presented above, it appears that VOC concentrations at UA-22 in the shallow water bearing zone are decreasing. Degradation appears to be occurring as indicated by increasing concentrations of vinyl chloride and the presence of cis-1,2-dichloroethene. Degradation products cis-1,2-dichloroethene and vinyl chloride may be increasing within the intermediate zone downgradient from Markland Avenue Quarry. No water quality trends are apparent within the lower water-bearing unit.

Fence Plant

Monitoring wells located in the vicinity of the Fence Plant include, by water-bearing zone: Shallow - UA-06, UA-07, UA-28, UA-29, UA-30, UA-31, EW-14 and LA-03A; Intermediate - LA-03C, LA-102C and LA-103C; Lower - LA-03E (see **Figure 2-1**). Monitoring wells UA-07, UA-31, EW-14, LA-03C, LA-103C and LA-103E were not sampled during both sampling events. Except for LA-03C and LA-103C, information from these wells is not discussed in this section.

Shallow Water-Bearing Zone
Tetrachloroethene, trichloroethene and 1,2-dichloroethene were detected above screening levels in all of the shallow wells that were sampled (UA-06, UA-28, UA-29, UA-30 and LA-03A). Concentrations of tetrachloroethene decreased in UA-06, UA-28 and UA-29 from 1400 D µg/L to 490 E µg/L, 630 D µg/L to 600 D µg/L and 690 µg/L to 48 D µg/L, respectively. Tetrachloroethene

concen-trations increased for samples collected from UA-30 from 290 µg/L to 1900 µg/L. Tetrachloroethene concentrations in LA-03A (replaced well) of 5 µg/L are not comparable to LA-03 samples collected in 1993 (nondetect) due to a difference of 30 feet in well screen elevation although both results are low. Trichloroethene concentrations remained relatively the same for UA-28 and LA-03A, decreased in UA-06 and UA-29 from 180 µg/L to 150 µg/L and 170 µg/L to 14 µg/L, respectively and increased in UA-30 from 64 µg/L to 230 D µg/L. Concentrations for 1,2-dichloroethene (total) decreased from 530 mg/L to 200 µg/L in UA-06 and remained relatively the same in UA-28, UA-29 and UA-30. Further degradation appears to have occurred as the concentrations of vinyl chloride increased in shallow wells UA-28, UA-29, UA-30 and LA-03A. The concentrations of vinyl chloride increased from not detected in wells UA-28, UA-29 and UA-30 and from 70 µg/L in well LA-03A (1993) to up to 540 µg/L in LA-03A (1995).

Total VOC concentrations during 1995 were highest in samples collected from UA-30. UA-30 is located downgradient from the Fence Plant near Wildcat Creek. Based on the limited analytical results, it appears that concentrations at tetrachloroethene and trichloroethene are decreasing in most wells, but that vinyl chloride, is increasing. Tetrachloroethene, trichloroethene, and vinyl chloride appear to be increasing in UA-30. Samples collected from monitoring well LA-03A, which is located near UA-30, had a 20 percent decrease in tetrachloroethene, but an increase in vinyl chloride by a factor of 6.

Lead was also reported above the MCL in samples from UA-06 in 1995. The concentration reported was 0.030 mg/L (total), or about twice the MCL of 0.015 mg/L. Lead was not reported above detection limits for samples collected during 1993.

Intermediate Water-Bearing Zone

Because no intermediate wells in this area were sampled during both 1993 and 1995, CDM compared the water quality from two downgradient intermediate wells, LA-03C and LA-103C. LA-03C was sampled only by ABB-ES in 1993 while LA-103C was sampled only by CDM in 1995. LA-03C (55 feet deep), replaced the multi-port well installed by ABB-ES, which was destroyed during road and sewer construction activities conducted by the City of Kokomo; however, the well was dry and could not be sampled during 1995. Analytical results for samples collected in 1993 from LA-03C showed trichloroethene at 41 µg/L and degradation product 1,2-dichloroethene (total) at 600 µg/L. Intermediate well LA-103C (68 feet deep), installed during 1995 is located approximately 700 feet north of LA-03C. Groundwater samples collected from well LA-103C in 1995 show trichloroethene concentrations of 120 µg/L and 1,2-dichloroethene (total) concentrations of 320 µg/L, in addition to tetrachloroethene (76 µg/L) and vinyl chloride (18 µg/L). Water quality from both of these wells show higher concentrations of 1,2-dichloroethene than trichloroethene and water samples from LA-103C contained tetrachloroethene and vinyl chloride.

Lower Water-Bearing Zone

Lower well LA-03E was not sampled during 1993, but no volatile compounds above the MCLs were reported during the 1995 sampling event.

Summary
It appears that concentrations of VOCs are decreasing at the Fence Plant but are increasing downgradient from the Fence Plant. Concentration of trichloroethene and tetrachloroethene are decreasing in the shallow water-bearing zone but concentrations of 1,2-dichloroethene and vinyl chloride are increasing. Total VOC concentrations historically (1993) were the highest in samples collected from UA-06, in the shallow water-bearing zone. Currently, the highest VOC concentrations were detected in the shallow aquifer at the UA-30 well location. VOC concentrations appear to decrease with depth, i.e., highest VOC concentrations were detected in the shallow aquifer. Lead also increased in the shallow water-bearing zone at the Fence Plant (UA-06). Since none of the wells completed within the intermediate and lower water-bearing zones were sampled during both 1993 and 1995, no water quality trends are apparent within those zones.

Main Plant

Monitoring wells located and in the vicinity of the Main Plant include, by water-bearing zone: Shallow - UA-02, UA-07, UA-08, UA-09, UA-10, UA-11, UA-12, UA-13, UA-14, UA-21, UA-23, UA-24, UA-26, UA-32, EW-29, EW-30 and EW-33; Intermediate - LA-04A, LA-04B, LA-05A, LA-05B and LA-05C; Lower - LA-04C and LA-05D (see **Figure 2-1**). Only monitoring wells UA-02, UA-10, UA-13, UA-21 UA-24, UA-32, LA-04A, LA-04B, LA-04C, LA-05A, LA-05B, LA-05C and LA-05D were sampled during both sampling events. In addition, samples were collected from UA-11 for metal and water chemistry analysis.

Shallow Water-Bearing Zone
No constituents were detected above screening levels for UA-02, UA-10 and UA-13. UA-02 is located east of the Main Plant and UA-10 and UA-13 are located in the southwest portion of the Main Plant area, adjacent to Kokomo and Wildcat Creeks. UA-24 and UA-32 are located west of the Main Plant area. Volatile organic compounds were detected above the screening levels only in shallow wells UA-24 and UA-32, PCBs were detected only in shallow well UA-21 and lead (total) in shallow well UA-11.

UA-24 is located east of Wildcat Creek and UA-32 is located west of Wildcat Creek. UA-36 is a replacement well that is located approximately 50 feet to the east of the former well location. CDM collected duplicate samples for VOC analysis from UA-24. Only trichloroethene (3100 µg/L) and 1,2-dichloroethene (total) (690 µg/L) were reported for the 1993 sampling event. Trends for the monitored parameters were mixed for samples collected from UA-24; trichloroethene decreased (3100 µg/L to 2000 µg/L); vinyl chloride increased from nondetect to 46 µg/L; and 1,2-dichloroethene remained about the same (average of approximately 600 µg/L). It appears that although the initial product may be decreasing in concentration, degradation products are increasing in concentrations. At the UA-32 location, concentrations of trichloroethene, cis-1,2 dichloroethene and vinyl chloride increased from 10 µg/L(average) to 790 µg/L, from 2 µg/L (average) to 660 µg/L and from nondetect to 71 µg/L, respectively. However, UA-32 was replaced before the 1995 sampling event at a location approximately 50 feet east of the former location closer to the Main Plant. The increase in concentration may be due to the change in location rather than in water quality.

Samples from two shallow wells, UA-21 and UA-32, were analyzed for PCBs. Concentrations of PCBs increased from 1993 to 1995 in UA-21 from nondetect to 3.0 µg/L for Aroclor-1242, and for Aroclor-1248, from 5.7 µg/L to 6.4 µg/L. PCBs were not detected in the sample collected from UA-32 during 1995 and at a low level during 1993.

Lead (0.017 mg/L, total) was detected slightly above the MCL (0.015 mg/L) in samples collected from UA-11. Lead was not reported above detection limits during the 1993 sampling event.

Intermediate Water-Bearing Zone
Volatile compounds were detected above the screening levels only for intermediate well LA-04 at zones A and B; VOCs were not detected above screening levels for LA-05A, B, or C. LA-04A, located north of shallow well UA-24, also showed a very high concentration of trichloroethene (9,800 µg/L) and degradation product 1,2-dichloroethene (total) (2,400 µg/L) during 1993, which both decreased to 5,100 µg/L and 1900 µg/L, respectively, in 1995. Vinyl chloride, was not detected by ABB in 1993, but was detected by CDM in 1995 at 82 µg/L. The same volatile compounds with the same trends were detected in LA-04B, however, at lower concentrations.

Lower Water-Bearing Zone
Only lower well LA-04C had volatile compounds detected above the screening levels. The same trends as reported above for the intermediate wells apply to results for LA-04C. Both trichloroethene and 1,2-dichloroethene (total) were detected by ABB-ES at concentrations averaging 3,450 µg/L and 2,200 µg/L, respectively. Concentrations for trichloroethene and 1,2-dichloroethene dropped significantly, to 5 µg/L and 700 µg/L, respectively, at the time of CDM sampling. Vinyl chloride concentrations increased from nondetect (1993) to 330 µg/L (1995). No monitored constituents were detected above MCLs for samples collected from LA-05D.

Summary
Based on the available information, it appears that total VOC concentrations decreased with time in the shallow, intermediate and deep zones, vinyl chloride increased in all three zones at the Main Plant. VOC concentrations are increasing in the shallow water-bearing zone downgradient from the Main Plant west of Wildcat Creek, however, this may be due to relocation of UA-32. In addition, lead concentrations at shallow well UA-11, located on the western portion of the Main Plant, may have increased from 1993 to 1995.

Based on the analytical results at shallow well UA-24, it appears that trichloroethene is decreasing with time, but the concentrations of degradation products are increasing. Total VOC concentrations are lower on the west side of Wildcat Creek at the UA-32 well location, downgradient from the Main Plant. VOC concentrations, however, increased significantly at the UA-32 well location, although PCBs were no longer detected. It appears that contamination documented east of Wildcat Creek is migrating downgradient.

The decrease in trichloroethene was especially significant (factor of 600) for the lowest water-bearing zone at the Main Plant. This decrease may indicate that the initial concentration was the result of well construction and may not have represented water quality for the lower water-bearing zone.

Lagoon Area

Monitoring wells located in the vicinity of Lagoon Area include, by water-bearing zone: Shallow - UA-33, UA-34, UA-105, EW-01, EW-02, EW-03, EW-04, EW-05, EW-06, EW-07, EW-08, EW-09, EW-10, EW-11, EW-12, EW-18, EW-19, EW-20, EW-21, EW-22, EW-23, EW-28, NB-7, NB-10 and NB-11; Intermediate - LA-07A, LA-07B, LA-07C, LA-105C, LA-106C, LA-107C, EW-15, EW-16 and EW-17; Lower - LA-07D, LA-104E, LA-105E and LA-107E (see **Figure 2-1**). Only monitoring wells EW-06, EW-08, EW-11, EW-18, EW-28, LA-07A, LA-07B, LA-07C, EW-15, EW-16, EW-17 and LA-07D were included in both sampling events.

Shallow Water-Bearing Zone

Of the shallow wells within the boundary of the Lagoon Area, only, EW-08, EW-11 and EW-28 had concentrations of volatile compounds above the MCLs. EW-08 is located at the entrance of the Lagoon Area; EW-11 is located southwest of the lagoon ponds, in the area from which drums and trichloroethene-contaminated soil were removed; and EW-28 is located along Markland Avenue by the Wastewater Treatment Plant. Well EW-06, located west of the treatment ponds in the general vicinity of the treatment tanks, did not contain constituents with concentrations above MCLs.

Historically, groundwater samples collected from EW-08 contained the highest total VOC concentrations. Although total VOCs remained highest for samples collected from EW-08, the 1995 sampling data showed significant decreases in cis-1,2-dichloroethene and vinyl chloride and relatively constant concentrations of trichloroethene. Concentrations of cis-1,2-dichloroethene and vinyl chloride decreased in EW-08 from 2300 µg/L to an average of 360 µg/L and from 460 µg/L to nondetect, respectively. Trichloroethene concentrations in EW-08 remained constant with an average concentration of 630 µg/L. VOC concentrations for trichloroethene, 1,2-dichloroethene and vinyl chloride for monitoring wells EW-11 and EW-28 remained fairly constant, although VOC concentrations are slightly elevated in EW-28 and 2 µg/L of tetrachloroethene was reported for the last sampling event. Tetrachloroethene historically has not been reported for wells in this part of the Lagoon area. The presence of tetrachloroethene in EW-28 well may help identify the source of the contamination, since water quality in this well could be affected by elevated concentrations of VOCs in the vicinity of wells EW-08, LA-04 and/or UA-06 closer to source areas.

Shallow wells EW-22, EW-21, EW-18, NB-10, NB-11, EW-20, EW-23, EW-19 and NB-10 are all across the Wildcat Creek from the Lagoon Area within Haynes International Operations. Tetrachloroethene is the primary contaminant from this area. Information provided by Haynes International indicates that tetrachloroethene was detected at concentrations up to 53,100 µg/L in the past (July 1992). Unfortunately, samples from EW-19 were only field screened by ABB-ES (5100 µg/L total VOCs in May 1993) and the well has since been abandoned.

Only well EW-18 was sampled during both sampling events. The screened interval for well EW-18 (773.3 - 771.3 feet MSL) is above the elevation of surface water in Wildcat Creek (less than 770.52 feet MSL). Analytical results for this well are not consistent with water quality east of Wildcat Creek. For EW-18, tetrachloroethene and vinyl chloride concentrations remained about the same (365 µg/L and 150 µg/L, average, respectively). Concentrations of trichloroethene increased from 90 µg/L to 140 µg/L. Concentrations of 1,2-dichloroethene and vinyl chloride decreased from 480

µg/L to 380 µg/L and from 190 µg/L to 110 µg/L, respectively. As noted previously, trichloroethene, 1,2-dichloroethene and vinyl chloride can be degradation products of tetrachloroethene.

Intermediate Water-Bearing Zone

Intermediate wells within the boundary of the Lagoon Area that were sampled during both the 1993 and 1995 sampling events include LA-07 zones A, B and C. LA-07 is located near EW-11, southwest of the lagoon ponds. VOCs above the screening levels were reported for LA-07A and LA-07B. For samples collected from LA-07A, concentrations of VOCs remained quite stable, although cis 1,2-dichloroethene decreased slightly and vinyl chloride increased slightly. For samples collected from LA-07B, cis-1,2-dichloroethene increased from 4 µg/L to 120 µg/L. It appears that although total VOC concentrations remained relatively stable for samples collected from the multi-port well, LA-07, concentrations of cis 1,2-dichloroethene (LA-07B) and vinyl chloride are increasing.

Both of the intermediate wells, EW-16 and EW-17, located across Wildcat Creek just west of the Lagoon Area within Haynes International Operations, had volatile compounds at or above the screening levels. Tetrachloroethene was only detected in EW-17 (99 µg/L). Trichloroethene concentrations in EW-16 increased from 680 µg/L to 1300 µg/L and remained fairly constant for EW-17. 1,2-dichloroethene (total) concentrations increased slightly for EW-16 (570 µg/L to 1100 µg/L), decreased for EW-17 (345 µg/L to 230 µg/L). Vinyl chloride concentrations increased for EW-16 (63 µg/L to 110 µg/L) and EW-17 (35 µg/L to 150 µg/L). VOCs were only detected in EW-15 below screening levels.

Lower Water-Bearing Zone

Only well LA-07D was completed in the lower zone and was sampled during both 1993 and 1995. None of the monitoring parameters from 1993 and 1995 (VOCs, semivolatiles, PAHs, PCB, or metals) were detected above MCLs in samples collected from well LA-07D.

Summary

Historically water quality impacts were highest in the shallow water-bearing zone at the Lagoon Area entrance at the EW-08 location. Based on the available analytical data, water quality appears to be improving at this location. At other locations in the Lagoon area, water quality for wells completed in the shallow water-bearing zone is relatively unchanged. Although water quality is relatively unchanged in the shallow water-bearing zone at the EW-11 and EW-28 well locations, individual constituents at the EW-28 location may be changing. The presence of tetrachloroethene at the EW-28 well location during the 1995 sampling event may indicate that a source other than CSSS is contributing to water quality degradation.

Based on analytical information from shallow monitoring wells located south and west of Wildcat Creek in the vicinity of Haynes International, concentrations of tetrachloroethene have decreased significantly for this area. Only one shallow well, EW-18, in this area was sampled during both the 1993 and 1995 sampling events. For well EW-18, concentrations of tetrachloroethene, 1,2-dichloroethene and vinyl chloride decreased while concentrations of trichloroethene increased.

VOC concentrations in both the shallow and the intermediate water-bearing zones appear to be quite stable within the Lagoon Area boundary southwest of the lagoon ponds; however, concentrations of degradation products appear to be increasing. This trend would indicate that groundwater contaminants are naturally attenuating with time.

Water quality and water quality trends for intermediate wells located west and south of Wildcat Creek in the vicinity of Haynes International differ from those documented for the Lagoon Area property. VOC concentrations are increasing within the intermediate aquifer in this area. Concentrations of trichloroethene, 1,2-dichloroethene and vinyl chloride increased in EW-16, located west of Wildcat Creek on the east side of Haynes International facility. Concentrations of tetrachloroethene and vinyl chloride increased and trichloroethene and 1,2-dichloroethene decreased in EW-17, which is located north of the Haynes International facility. Because of the presence of tetrachloroethene in EW-17, the source of the contamination in EW-17 may be different from that of EW-16, although the increase in the VOCs observed could be the result of tetrachloroethene degradation.

Slag Processing Area

Monitoring wells located in the vicinity of the Slag Processing Area include, by water-bearing zone: Shallow - UA-15, UA-16, UA-17, UA-105 and EW-23; Intermediate - LA-06A, LA-06B, UA-25 and LA-105C; Lower - LA-06C, LA-105E and DW-282 (see **Figure 2-1**). DW-282 was assigned to the lower zone although no well log is available for the IDNR. Only wells UA-17, LA-06A, LA-06B and LA-06C were sampled during both sampling events.

Shallow Water-Bearing Zone

The sample collected from the shallow monitoring well UA-17 did not contain any of the parameters monitored during 1993 and 1995 (VOCs, semivolatile compounds, pesticides, PAHs, PCBs and metals), in exceedance of the screening criteria.

Intermediate Water-Bearing Zone

Intermediate wells, LA-06A and LA-06B, sampled during 1993 and 1995 contained VOCs in exceedence of screening levels. Total VOC concentrations were lower in LA-06A (52 feet deep) than in LA-06B (67 feet deep). VOC concentrations appear to be decreasing higher within the intermediate zone and may be increasing deeper within the intermediate zone. In LA-06A, trichloroethene, cis-1,2-dichloroethene and vinyl chloride decreased from 19 µg/L to nondetect, from 490 µg/L to 76 µg/L and from 21 µg/L to 8 µg/L, respectively. In LA-06B, trichloroethene and vinyl chloride increased, from concentrations of 52 µg/L to 125 µg/L (average) and from nondetect to 28 µg/L (average), respectively; 1,2-dichloroethene concentrations decreased slightly from 490 µg/L to 475 µg/L (average). It should be noted that for the 1995 analytical results, 1,2-dichloroethene concentration represents an average of two very different results for duplicate samples (150 µg/L and 800 µg/L).

Lower Water-Bearing Zone

Cis-1,2-dichloroethene and vinyl chloride were detected during 1993 above the screening level; however, the cis-1,2-dichloroethene concentration decreased from 310 µg/L to 2 µg/L and no vinyl

chloride was detected during 1995. This is the same trend reported for LA-06A, finished in the upper portion of the intermediate water-bearing zone.

Summary
Based on limited analytical results for 1993 and 1995 for one well installed in the Slag Processing Area, water quality in the shallow water-bearing zone is relatively unaffected by contamination. No VOCs were detected above screening criteria for either sampling event.

Based on information from one multi-port well sampled during 1993 and 1995, VOC concentrations appear to be decreasing higher within the intermediate zone, increasing deeper within the intermediate zone and decreasing within the lower water-bearing zone. Only cis-1,2-dichloroethene and vinyl chloride were detected in the lower water-bearing zone during 1993; only low levels of cis-1,2-dichloroethene were detected in the lower zone during 1995.

4.4.6.6.2 Groundwater Results Distribution and Potential Sources

This section presents a discussion of groundwater quality with respect to potential sources. This section describes primary contaminants of concern for each water-bearing zone and evaluates water quality trends based upon information collected during the CSSS remedial investigation. Analytical results for Markland Avenue Quarry, the Fence Plant, the Main Plant, the Lagoon Area and the Slag Processing Area are summarized in **Tables 4.4.6-14, 15 and 16** according to each of the three water-bearing zones, shallow, intermediate and lower. Information collected by ABB-ES during 1993 and by CDM during 1995 is included in these tables, as well as information provided by Haynes International and domestic well results provided by IDEM for DW-282.

Tables 4.4.6-14, 15 and 16 present water quality results that exceed MCLs. MCLs are listed in **Table 4.4.1-23**. **Tables 4.4.6-14, 15 and 16** list wells that exceed MCLs for volatile organic compound (VOC), metal, polychlorinated biphenol (PCB) and polynuclear aromatic hydrocarbon (PAH) parameters. For constituents with no MCL, IDEM VRP Tier II guidance may be used as a point of reference. **Figure 4.4.6-11, 16** and **21** show total VOC concentration isopleths. Except for **Figures 4.4.6-16, 21** and **13, Figures 4.4.6-5** to **Figures 4.4.6-20** show VOC (i.e., tetrachloroethene, trichloroethene, cis-1,2-dichloroethene and vinyl chloride) concentrations according to each water-bearing unit. Ground-water flow within each of the water bearing units is illustrated on **Figures 4.4.6-1, 2 and 3.** These figures should be referenced along with the **Tables 4.4.6-14, 15 and 16** to clarify the following discussions.

Markland Avenue Quarry

Shallow Water-Bearing Zone
The distribution of contaminants in the shallow water-bearing zone in the vicinity of Markland Avenue Quarry is characterized as limited to the vicinity of UA-22 (**Figure 4.4.6-5** through **4.4.6-8**). UA-22 is the only well completed in the shallow water-bearing zone in which contaminants were detected during this sampling event. The limited distribution of contaminants at Markland Avenue Quarry is due in large part to the limited number of wells completed in the fill at the quarry (only UA-22). Other shallow water-bearing zone wells in the vicinity were installed outside the fill and

are completed in bedrock. These wells (UA-01, UA-03, UA-04, UA-05 and UA-27) were installed at depths of less than 20 feet. Lack of impact in these wells is likely due to their shallow depths or the wells may not have intersected fractures. Additionally, the contaminants detected are denser than water and are like to move downward as they migrate. This coupled with the potential dip of slag "bedding" to the northwest and downward hydraulic gradients in the area make detection of these contaminants outside the filled quarry less likely.

Although analytical results indicate substantial decreases in constituent concentrations, comparison of results from two sampling rounds has several inherent problems. First, the sampling activities were conducted during different times of the year and under different hydrologic conditions. Constituent concentrations vary seasonally and with varying amounts of precipitation. Variations in groundwater elevations result in mobilization or immobilization of contaminants and/or dilution or concentration of dissolved-phase contaminants. Additionally, different laboratories were used for sample analysis for the two sampling events and variations in results between laboratories are not uncommon. These items should be kept in mind during the discussions of trends and when evaluating degradation of contaminants.

The presence of vinyl chloride indicates degradation is occurring, however, the ratio of cis-1,2-dichloroethene to trichloroethene has decreased from 0.60 to 0.30 from 1993 to 1995. This ratio should increase with time as trichloroethene degrades to cis-1,2-dichloroethene. Although concentrations have decreased in the shallow water-bearing zone, the increase in the ratio of cis-1,2-dichloroethene to trichloroethene indicates a possible continuing source of trichloroethene may be present nearby or that degradation is not proceeding rapidly and contaminant dilution and dispersion has resulted in an overall decrease in contaminant concentrations in the shallow water-bearing zone.

Intermediate Water-Bearing Zone

The distribution of contaminants in the intermediate water-bearing zone in the vicinity of Markland Avenue Quarry is characterized by elevated VOC concentrations along the west boundary of the quarry (**Figures 4.4.6-12** through **4.4.6-16**). Elevated VOC concentrations are observed at the down-gradient site boundary; however, it is likely that elevated VOC concentrations are present within the filled portion of the quarry. No wells have been completed in the intermediate or lower interval in the filled portion of the quarry.

Contaminant distributions in the intermediate water-bearing zone outside the fill at Markland Avenue Quarry indicate significant degradation occurs when impacted groundwater leaves the site. The ratio of cis-1,2-dichloroethene to trichloroethene at LA-101C and LA-02B is 61 and 100, respectively, indicating degradation is well progressed (assuming cis-1,2-dichloroethene was not disposed of in significant quantities at the quarry as waste). The presence of vinyl chloride also indicates degradation is occurring.

Lower Water-Bearing Zone

Contaminant distributions in the lower water-bearing zone outside the fill at Markland Avenue Quarry indicate low concentrations of contaminants are present at the down-gradient boundary of

the site (**Figures 4.4.6-18** and **4.4.6-19**) at LA-02 (cis-1,2-dichloroethene [19 µg/L] and trichloroethene [62 µg/L]). The upgradient well LA-01 confirms that groundwater migrating onto the site is free of contaminants (with the exception of acrylonitrile). The ratio of cis-1,2-dicloroethene to trichloroethene in the lower water-bearing zone is 0.31 indicating less degradation may be occurring.

Summary:
The primary contaminants in the groundwater in the vicinity of Markland Avenue Quarry are trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Total VOCs for the Markland Avenue Quarry area were highest in wells finished in the intermediate water-bearing zone downgradient from the quarry pond. Within each water-bearing zone, VOC concentrations are highest in backfilled area (UA-22) in the shallow water-bearing zone; highest downgradient of the quarry pond in the intermediate water-bearing zone and highest downgradient of the quarry pond in the lower water-bearing zone. The lower water-bearing zone shows the lowest groundwater impacts. Concentrations of VOCs appear to be decreasing in the shallow water-bearing zone and increasing in the intermediate zone.

Trichloroethene is the primary water quality contaminant in the filled portion of the quarry identified at the UA-22 well location. Only one shallow well, UA-22, was installed in this area. Downgradient of the quarry pond, the primary contaminant in the intermediate zone is cis-1,2-dichloroethene. Concentrations of PAHs (benzo (a) anthracene, 3 µg/L; chrysene, 4 µg/L) and pesticides (aldrin, 0.18 µg/L; dieldrin, 0.23 µg/L) were detected near screening levels during 1993 at the UA-22 well location; however, since these constituents were not primary contaminants of concern, this well was not resampled due to the relatively low mobility of these constituents. Antimony was detected above screening levels for one sample collected from the intermediate water-bearing zone (LA-02B, 0.0281 mg/L) but was not resampled for the same reasons. Generally, PAHs, PCBs, pesticides and metals, where detected, were limited to point detections at wells and plumes were not identified.

Sources
These contaminant distributions suggest that minimal degradation in the shallow water-bearing zone at Markland Avenue Quarry is occurring or the sample may have been collected in close proximity to a source. Similarly, contaminant distributions in the deep water-bearing zone are similar to those observed in the shallow zone and minimal degradation is likely due to aerobic conditions. Contaminant distributions in the intermediate water-bearing zone indicate degradation is well progressed and is likely the result of anaerobic degradation. Anaerobic conditions were observed in the bottom of the quarry pond below depths of 30 to 35 feet. However, oxygen content in water from LA-101C and LA-02B (8.41 mg/L and 10.68 mg/L) suggest aerobic conditions are currently present in these wells, therefore, anaerobic degradation may be occurring within the lower filled portion of the quarry and degredation products have migrated to these locations. The contaminants observed in the lower water-bearing zone apparently entered the lower water-bearing zone further southeast from beneath the quarry (higher cis-1,2-dichloroethene concentrations would be expected if contribution from the intermediate water-bearing zone was occurring in the vicinity of LA-101C and LA-02B.

Sources of contaminants observed in the vicinity of the quarry are postulated to include DNAPL impacted sediments in the quarry pond, leaking buried drums in the fill and possibly accumulated DNAPL within bedding and near the base of the filled quarry.

Fence Plant Area

Shallow Water-Bearing Zone

The distribution of contaminants in the shallow water-bearing zone at the Fence Plant Area is characterized as an elongate plume, trending approximately N40-45°E parallel to Wildcat Creek, of tetrachloroethene and its degradation products trichloroethene, cis- and trans-1,2-dichloroethene and vinyl chloride. The highest concentrations of tetrachloroethene and trichloroethene were detected in monitoring wells UA-30 and UA-28 (**Figures 4.4.6-5, 4.4.6-6** and **4.4.6-9**). Elevated concentrations of cis-1,2-dichloroethene and vinyl chloride were detected in shallow water-bearing zone wells throughout the area (**Figures 4.4.6-7, 4.4.6-8** and **4.4.6-10**). Tetrachloroethene and trichloroethene were detected at higher concentrations along the axis of the plume whereas cis-1,2-dichloroethene and vinyl chloride have higher concentrations along the periphery of the plume.

Concentrations of tetrachloroethene, trichloroethene and cis-1,2-dichloroethene generally decreased whereas vinyl chloride concentrations increased indicating degradation and/or plume migration is occurring. Tetrachloroethene and trichloroethene concentrations increased in UA-30 by factors of 6.5 and 3.5, respectively, indicating plume movement southwestward beyond UA-30. Samples from UA-29 and UA-06 indicated decreases of tetrachloroethene by factors of over 90 percent and 65 percent, respectively, along with similar decreases in trichloroethene (UA-29) and total 1,2-dichloroethene (UA-06). These decreases are also indicative of plume movement rather than degradation. Although plume migration is occurring, vinyl chloride concentrations increased or were detected for the first time in all the shallow water-bearing zone wells in the Fence Plant Area with the exception of LA-03A. This indicates that degradation is occurring along with plume migration. Contaminant concentrations in UA-28 remained relatively constant between sampling events and may indicate a continuous nearby source.

Intermediate Water-Bearing Zone

The distribution of contaminants in the intermediate water-bearing zone at the Fence Plant Area is difficult to characterize due to the limited number of wells completed in the area. Monitoring wells LA-03, LA-103C and LA-102C are completed in the intermediate zone, however, LA-03 failed to recharge sufficiently to enable sample collection. Tetrachloroethene and trichloroethene were only detected in LA-103C (76 µg/L and 120 µg/L, respectively) but cis-1,2-dichloroethene and vinyl chloride were detected in both wells sampled. These results are consistent with LA-103C being closer to the axis of the plume. Based on total VOC concentration distributions it appears that the plume emanating from Markland Avenue Quarry (trichloroethene parent compound) is likely co-mingling with the plume at the Fence Plant (tetrachloroethene, and possibly trichloroethene, parent compounds) with concentrations up to 100 µg/L present throughout the area.

Lower Water-Bearing Zone
The distribution of contaminants in the lower water-bearing zone at the Fence Plant Area is similarly difficult to characterized due to the limited number of wells in the area. Only one well (LA-03E) is completed in the lower water-bearing zone in the area. Trichloroethene and cis-1,2-dichloroethene were detected at concentrations of 1 µg/L and 9 µg/L , respectively. The presence of these constituents at low concentrations is consistent with the location of LA-03 near the leading edge of the plume observed in the shallow water-bearing zone.

Summary
The primary contaminants in the groundwater in the vicinity of the Fence Plant are tetrachloroethane, trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Total VOCs were highest for the Fence Plant area in well UA-30, which is completed in the upper water bearing zone downgradient from the Fence Plant and Markland Avenue Quarry. Within each water-bearing zone, VOC concentrations are highest in the vicinity of the Fence Plant (UA-06, UA-28 and UA-30) in the shallow water-bearing zone; and highest downgradient from the Fence Plant at the LA-03C location in the intermediate water-bearing zone, and in the lower water-bearing zone. Concentrations of these VOCs appear to be decreasing in the shallow water-bearing zone at the Fence Plant but are increasing in the shallow water-bearing zone downgradient from the Fence Plant. Total VOC concentrations are lowest in the lower water-bearing zone, with 10 µg/L, total VOCs, the highest concentration for samples collected from wells in this area.

Tetrachloroethane is the primary water quality contaminant in the shallow water-bearing zone in the vicinity of the Fence Plant (UA-06 and UA-30 locations). Trichloroethene concentrations also are relatively high in the shallow zone. Cis-1,2-dichloroethene is the primary contaminant in the intermediate zone, although tetrachloroethane, trichloroethene and vinyl chloride concentrations are also contaminants of concern. Lead also was reported near screening levels at UA-06 (0.03 µg/L).

Sources
Based on the distributions discussed above and the distributions observed in the soil gas survey (see Section 3 of the Remedial Investigation Report), the primary parent compound is tetrachloroethene with the source being north or northeast of the Fence Plant. Contaminant migration appears to be subparallel to Wildcat Creek with westerly migration of degradation products in the intermediate water-bearing zone. Minimal impact to the water-bearing zone was observed, however, based on a northwesterly groundwater flow direction in the lower water-bearing zone little impact would be expected at LA-03E.

Main Plant

Shallow Water-Bearing Zone
The distribution of contaminants in the shallow water-bearing zone at the Main Plant is characterized by the presence of trichloroethane in two wells (UA-24 and UA-32) along Wildcat Creek at the west boundary of the site (**Figures 4.4.6-5** through **4.4.6-8**). The highest VOC concentrations at the Main Plant are observed at these wells as shown on **Figure 4.4.6-11**. VOCs at

these two wells include trichloroethene and cis-1,2-dichloroethene at UA-24. Comparison of 1993 results to 1995 results indicates the parent compound (trichloroethene) decreased over 60 percent and degradation products either increased (vinyl chloride) or remained the same (1,2-dichloroethene). The distribution of VOCs is limited to this area with the exception of sporadic detections around the Main Plant at or near practical quantitation limits.

PCBs were detected at UA-21 but are limited to detection at this well. Nickel and lead were detected at UA-08 and UA-11, respectively, and their distribution is limited to these locations. Characterization of contaminant distributions at the Main Plant is limited due to the paucity of wells in the interior of the site.

Intermediate Water-Bearing Zone

Characterization of the distribution of contaminants in the intermediate water-bearing zone at the Main Plant is limited to the vicinity of two wells (LA-04 and LA-05) since these are the only wells installed in this zone. Trichloroethene was detected in LA-04 at a concentration of 5,100 µg/L (**Figure 4.4.6-13**). Cis-1,2-dichloroethene and vinyl chloride were detected in both LA-04 and LA-05 (**Figures 4.4.6-14** and **4.4.6-15**). The highest concentrations of both constituents were detected in LA-04. Trichloroethene and 1,2-dichloroethene decreased in concentration between 1993 and 1995 by approximately 25 to 50 percent. The ratio of 1,2-dichloroethene to trichloroethene increased from 0.24 to 0.37 indicating degradation is occurring. The VOCs in these two wells likely intermingle with the plumes identified in the Fence Plant Area and at Markland Avenue Quarry (**Figure 4.4.6-16**). Antimony and mercury were also detected at LA-05 and distribution is limited to this area.

Lower Water-Bearing Zone

Characterization of the distribution of contaminants in the lower water-bearing zone at the Main Plant is limited to the vicinity of two wells (LA-04 and LA-05) since these are the only wells installed in this zone. Trichloroethene and vinyl chloride were detected only in LA-04 at concentrations of 5 µg/L and 330 µg/L, respectively. Cis-1,2-dichloroethene was detected in both LA-04 (700 µg/L) and LA-05 (1 µg/L). Trichloroethene and 1,2-dichloroethene decreased in concentration between 1993 and 1995 by approximately 99 percent and 30 percent, respectively. This decrease is likely the result of plume movement or a change in subsurface conditions (e.g., a slight change in groundwater flow direction).

Summary

Groundwater analytical results from wells in the vicinity of the Main Plant indicate relatively few compounds detected with exception of wells along the west side of Buildings 112B, 112 and 112A. Impact in this area is likely related to operations and a reported trichloroethene spill. The relatively few detections of compounds on the Main Plant site proper is likely due in part to the paucity of monitoring wells in the interior of the site. The majority of the wells are distributed along site boundaries and are a good indication of the limited migration of constituents that has occurred in groundwater at the site.

The primary contaminants in the groundwater in the vicinity of the Main Plant are trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Total VOCs were highest in the Main Plant area in well LA-04A, which is completed in the intermediate water bearing zone downgradient from the Main

Plant, near Wildcat Creek. VOC concentrations are highest near the former spill area (LA-04, UA-11 and UA-24 well locations) on the west property boundary within the shallow, intermediate and lower water-bearing zones. These results are consistent with the reported historical spill of trichloroethene in the vicinity of Building 112 (Nail Mill). Total VOC concentrations were lowest during the 1995 sampling event in the lower water-bearing zone.

Total VOC concentrations appears to be decreasing in all three water-bearing zones, except at UA-32, located west of Wildcat Creek. Although trichloroethene concentrations appear to be decreasing, concentrations of degradation products, cis-1,2-dichloroethene and vinyl chloride, generally are increasing. This indicates that contaminant migration from the Main Plant is occurring in the shallow water bearing zone. The most significant decrease in VOC concentrations was in the lower water-bearing zone at the LA-04C well location, where trichloroethene concentrations decreased from an average from 3450 µg/L during 1993 to 5 µg/L during 1995.

Trichloroethene is the primary water quality contaminant in all three of the water-bearing zones west of the Main Plant. Cis-1,2-dichloroethene and vinyl chloride are also of concern in all three water-bearing zones in this area. In addition to the previously mentioned water quality parameters, PCBs are chemicals of concern in the shallow water-bearing zone. Concentrations of nickel and lead were reported near the MCLs at two shallow wells, but are not considered to be primary contaminants for the Main Plant area. Antimony and mercury were reported for the intermediate water-bearing zone at the LA-05 location, however, metals also are not considered to be primary contaminants of concern for the Main Plant area.

Sources

Based on distributions and trends discussed above, the primary parent compound is trichloroethene. The probable source of this contaminant is a historical spill which was reported to have occurred in the vicinity of Building 112. Based on the presence of trichloroethene in surface soils at a concentration of 5,600 µg/kg (SB-A02), the source area for the trichloroethene is believed to be in the area 200 feet south of LA-04 adjacent to and beneath Building 112. This location for the source area is also based on the presence of product tanks in this area as well as proximity to the approximate location of termination of piping from these tanks in the vicinity of pits in the building. LA-04 therefore is believed to be on the periphery of the source area.

Residual PCB soil contamination in shallow soils in the vicinity of soil borings SB-G01 and SB-H03 is believed to be the source of PCBs detected in shallow groundwater at UA-21. PCB concentrations of 9,900 µg/kg and 25,000 µg/kg were detected in SB-G01 and SB-H03, respectively. Although these are surface soil samples, their presence confirms disposal of high concentration PCBs in the area. Other sources may be present at the Main Plant and evaluation of impact to the intermediate and lower water-bearing zones is not possible for the majority of the site due to the paucity of wells in these zones at the Main Plant.

Lagoon Area

Shallow Water-Bearing Zone

The distribution of contaminants in the shallow water-bearing zone at the Lagoon Area differs for various areas of the site. Monitoring wells used for characterizing the Lagoon Area extend from locations east of the Lagoon area by well EW-28, to north of the Lagoon Area by well UA-105, to Haynes International located south and west of Wildcat Creek. The reason for the large areal extent of monitoring wells is that groundwater in the shallow water-bearing zone migrates radially from a groundwater mound resulting from the lagoon ponds. Contamination documented in wells south and west of the Wildcat Creek in the vicinity of the Haynes International facility are discussed separately.

VOC concentrations are highest in the shallow zone for the entrance to the Lagoon Area and metals concentrations are highest in the lagoon pond areas. Trichloroethene, cis-1,2-dichloroethene and vinyl chloride are the primary VOC contaminants in the shallow water-bearing zone (see **Figures 4.4.6-6, 4.4.6-7** and **4.4.6-8**). Historically, groundwater samples collected from EW-08 contained the highest total VOC concentrations. Although total VOCs remained highest for samples collected from EW-08, the 1995 sampling data showed significant decreases in cis-1,2-dichloroethene and vinyl chloride and relatively constant concentrations of trichloroethene. Concentrations of cis-1,2-dichloroethene and vinyl chloride decreased in EW-08 from 2300 µg/L to an average of 360 µg/L and from 460 µg/L to nondetect, respectively. Trichloroethene concentrations in EW-08 remained constant with an average concentration of 630 µg/L. The ratio of trichloroethene to cis-1,2-dichloroethene was approximately 2 in EW-08 during the 1995 sampling event. VOC contamination appears to migrate radially from the Lagoon entrance northwest to the UA-105 well location, where degradation product cis-1,2-dichloroethene is the primary contaminant. The ratio of trichloroethene to cis-1,2-dichloroethene at the UA-105 well location is 0.05. Contamination from the EW-08 vicinity may also migrate east to the EW-28 location; however, the presence of tetrachloroethene in EW-28 during 1995 indicates that another source is contributing to groundwater contamination at this location. The ratio of trichloroethene to cis-1,2-dichloroethene at the EW-28 location is approximately 1. As would be expected, the ratio of trichloroethene to cis-1,2-dichloroethene would decrease as degradation of the parent product progresses.

Metals were detected primarily in wells in the area of the lagoon ponds. Metals present in the Lagoon Area groundwater that exceed either the initial screening levels or U.S. EPA maximum contaminant limits include iron, manganese, nickel, chromium and antimony. Iron and manganese have secondary maximum contaminant limits established by the U.S. EPA of 0.3 and 0.05 mg/L, respectively; however, because primary MCLs and Tier II residential screening levels are not available, these compounds are not included in the exceedance tables, **Tables 4.4.6-14, 15 and 16**. Iron and manganese were consistently detected at concentrations up to 3050 mg/L and 38.7 mg/L, respectively. Nickel was detected above screening levels at seven locations within the upper water-bearing zone. The highest nickel concentration (0.818 mg/L) was detected at well EW-06, located by the treatment tanks northwest of the lagoon ponds. Antimony and chromium were detected at one location each in the shallow water-bearing zone; antimony was detected in EW-18, located west of Wildcat Creek, and chromium was detected at the EW-06 well location.

Tetrachloroethene is the primary contaminant of concern for shallow wells across Wildcat Creek from the Lagoon Area in the vicinity of Haynes International Operations. **Table 4.4.6-14** shows that a number of wells in this area exceeded water quality screening criteria for tetrachloroethene, including EW-19, EW-18, EW-20, EW-21 and EW-22. Information provided by Haynes International indicates that tetrachloroethene was detected at concentrations up to 53,100 µg/L in the past (July 1992). Unfortunately, samples from EW-19 were only field screened by ABB-ES (5100 µg/L total VOCs in May 1993) and the well has since been abandoned.

Only well EW-18 was sampled during both 1993 and 1995 sampling events. The screened interval for well EW-18 (773.3 - 771.3 feet MSL) is above the elevation of surface water in Wildcat Creek (less than 770.52 feet MSL). Analytical results for this well are not consistent with water quality east of Wildcat Creek. For EW-18, tetrachloroethene and vinyl chloride concentrations remained about the same (365 µg/L and 150 µg/L, average, respectively). Concentrations of trichloroethene increased from 90 µg/L to 140 µg/L. Concentrations of 1,2-dichloroethene and vinyl chloride decreased from 480 µg/L to 380 µg/L and from 190 µg/L to 110 µg/L, respectively. As noted previously, trichloroethene, 1,2-dichloroethene and vinyl chloride can be degradation products of tetrachloroethene.

Based on limited information, it appears that the concentrations of tetrachloroethene have decreased significantly for this area. For well EW-18, concentrations of tetrachloroethene, 1,2-dichloroethene and vinyl chloride decreased while concentrations of trichloroethene increased.

Intermediate Water-Bearing Zone

The distribution of contaminants in the intermediate water-bearing zone at the Lagoon Area also differs for various areas of the site. Monitoring wells used for characterizing the Lagoon Area extend from to north of the Lagoon Area at the well LA-105C location to southwest of Haynes International at the LA-107 well nest location. Contamination documented in wells south and west of the Wildcat Creek in the vicinity of the Haynes International facility are discussed separately.

Monitoring wells LA-07 A and B, LA-105C and LA-106C were used to characterize the Lagoon Area proper. Only VOCs, cis-1,2-dichloroethene and vinyl chloride and the metal nickel (only at LA-06A) were detected above screening levels in the Lagoon Area. Cis-1,2-dichloroethene concentrations decreased with depth within the intermediate water-bearing zone during the 1995 sampling event. The highest cis-1,2-dichloroethene concentration was detected in the intermediate well LA-106C location (630 µg/L, 72 feet in depth, screened 733-723 feet MSL). Wells LA-07A (500 µg/L, 60 feet, screened 744-732 feet MSL) and LA-07B (120 µg/L, 76 feet in depth, 729-717 feet MSL) showed decreasing contamination. Cis-1,2-dichloroethene concentrations were lower in LA-105C (320 µg/L, 73 feet deep, 741-731 feet MSL) than at LA-106C, but lower VOC concentrations would be expected in this well since the well is not located directly downgradient from the Lagoon Area, as shown on **Figure 4.4.6-2.** Well LA-105C was the only intermediate well that contained trichloroethene during the 1995 sampling event. The ratio of cis-1,2-dichloroethene to trichloroethene was 23.

The highest concentrations of VOCs were detected within the intermediate water-bearing zone in wells located in the vicinity of Haynes International. Highest VOC concentrations were detected in

EW-16, located west of Wildcat Creek on the eastern portion of the Haynes International facility. For samples for EW-16, trichloroethene (1300 µg/L, 1995) and cis-1,2-dichloroethene (1100 µg/L, 1995) and vinyl chloride (63 µg/L, 1995) were the primary contaminants. Concentrations of trichloroethene, 1,2-dichloroethene and vinyl chloride increased in EW-16, from 1993 to 1995. Concentrations of VOCs in the intermediate water-bearing zone were also high at LA-107C, located southwest of Haynes International. Only cis-1,2-dichloroethene (930 µg/L) and vinyl chloride (49 µg/L) were detected in LA-107C. Tetrachloroethene was only detected in one intermediate well, EW-17 (99 µg/L) during 1995 in the vicinity of Haynes International.

Lower Water-Bearing Zone

The distribution of contaminants in the lower water-bearing zone at the Lagoon Area is characterized by samples collected from upgradient well LA-104E and from downgradient wells LA-07, LA-106 and from LA-107E, located downgradient of Haynes International. Only VOC concentrations below screening levels were detected in LA-07 and LA-104E. The highest total VOC concentrations were detected in LA-105 E (820 µg/L). Cis-1,2-dichloroethene and to a lesser extent trichloroethene and vinyl chloride were the primary contaminants. The ratio of cis-1,2-dichloroethene to trichloroethene was 4.

Summary

The groundwater is impacted primarily by VOCs (trichloroethene, cis-1,2-dichloroethene and vinyl chloride) in the Lagoon Area and to a lesser extent by metals. Water quality for some of the monitoring wells located south and west of Wildcat Creek, in the vicinity of Haynes International, is discussed separately below.

For the Lagoon Area proper, total VOCs were highest in well EW-08, which is located at the Lagoon Area entrance and is completed in the shallow water bearing zone. This area was identified as a hot spot during the soil gas survey and is discussed in Section 4.4.3. Total VOC concentrations were similar in both the intermediate and lower water-bearing zones during the 1995 sampling event. Within each water-bearing zone, VOC concentrations are highest in the shallow water-bearing zone at the Lagoon Area entrance, in each at the intermediate water-bearing zone wells underlying the Lagoon Area and in lower water-bearing zones at the downgradient well locations (LA-105E, LA-106E and LA-107 E). Total VOC concentrations appear to be decreasing significantly in the upper water-bearing zones, but have remained about the same in the intermediate and lower water bearing zones.

Trichloroethene, cis-1,2-dichloroethene and vinyl chloride are the primary water quality contaminants in the shallow water-bearing zone. Cis-1,2-dichloroethene is primary water quality contaminant in the intermediate and lower water-bearing zone, although trichloroethene and vinyl chloride are also contaminants of concern in these zones.

Metals present in the Lagoon Area groundwater that exceed MCLs include iron, manganese, nickel, chromium and antimony. Nickel was detected above MCLs at seven locations within the upper water-bearing zone and at one location within the intermediate zone. The highest nickel concentration (0.818 mg/L) was at the EW-06 well location, located by the treatment tanks

northwest of the lagoon ponds. Antimony was detected in one sample each from the shallow water-bearing zone and from the intermediate water-bearing zone. Chromium was detected for one sample from the shallow water-bearing zone.

According to the ABB-ES data for lagoon soils and sediments (**Appendix I**), iron and manganese were consistently present in the soils at high levels. Nickel, while consistently detected was not present at as high levels; however, it may have been disposed in a more soluble form. The other metal that was present consistently in soils and sediments and at levels greater than the screening levels was lead; however, lead was not detected in the lagoon groundwater above initial screening levels.

Based on water quality information provided by Haynes International and other information collected during the remedial investigation, the elevated concentrations reported for wells located west and south of Wildcat Creek do not appear to be related to contamination from the Lagoon Area. Historic information indicates that tetrachloroethene has been the primary contaminant in this area (up to 53,000 µg/L, EW-19, 1992). Tetrachloroethene was detected in shallow well EW-18, which is screened at an elevation (773.3 feet to 771.3 feet MSL) which is above the surface water elevation in Wildcat Creek (770.52 feet). Based on groundwater flow in this area, this contamination does originate in the Lagoon area. Tetrachloroethene is the primary contaminant in the shallow water-bearing zone, but trichloroethene and cis-1,2-dichloroethene are the primary contaminants in the intermediate and lower water-bearing zones. Trichloroethene, cis-1,2-dichloroethene and vinyl chloride can be degradation products of tetrachloroethene The presence of tetrachloroethene in EW-18 and the increasing VOC concentrations in EW-16, (both wells are located adjacent to Wildcat Creek just west of the Lagoon Area) indicate another source other than CSSS contributed to groundwater contamination.

Sources

Based on the distribution and trends for contaminants in the Lagoon Area, contaminates from various sources co-mingled and/or contributed to groundwater degradation. Separate sources appear to impact various portions of the Lagoon Area including the Lagoon Area entrance, the lagoon ponds, the berm located on the southwest boundary and the vicinity of Haynes International. Soil gas data discussed in Section 4.3.3 indicates that there are near surface sources of VOCs near the Lagoon Area entrance. The primary contaminants in this area are trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Trenching or test pits may be needed to evaluate this area before remedial options are evaluated. Past drum disposal practices at the Lagoon Area are most likely the source of VOC (trichloroethene) contamination at the bermed area. Metal contamination is due to past treatment practices in the lagoon ponds. The presence of tetrachloroethene in wells located southwest of the Lagoon Area in the vicinity of Haynes International and east of the Lagoon Area near the City of Kokomo Wastewater Treatment Plant appear to indicate that another source other than CSSS contributed to groundwater degradation.

Since total VOCs may to be decreasing within each of the three water bearing zones, groundwater contamination appears to be primarily due to past practices. Increases in the concentrations of

degradation products indicates that the contamination is being degraded as contamination migrates through the water bearing-zones.

Slag Processing Area

Shallow Water-Bearing Zone
The distribution of contaminants in the shallow water-bearing zone in the vicinity of the Slag Processing Area is characterized by low levels of VOCs. VOCs were detected above screening levels for only upgradient well UA-105 in the Slag Processing Area during either the ABB-ES investigation in 1993 or the CDM investigation in 1995. Only one well, UA-17, was sampled during both of the sampling events. The limited distribution of contaminants at the Slag Processing Area may be due to the paucity number of monitoring wells in the interior of the site. None of the monitoring wells were installed into the former quarry area. The majority of the wells are distributed along site boundaries and are a good indication of the limited migration of constituents that has occurred in groundwater at the site (see **Figures 4.4.6-5, 6, 7** and **8**).

Primary contaminants in the shallow water-bearing unit in the upgradient well UA-105 are cis-1,2-dichloroethene, trichloroethene and vinyl chloride. The ratio of cis-1,2-dichloroethene to trichloroethene is 20.

Shallow monitoring wells at the Slag Processing Area are generally constructed with screened elevations comparable to the surface water elevation in Wildcat Creek. Water levels collected from these wells indicate that the shallow water-bearing zone is in hydraulic communication with the surface water. Groundwater is anticipated to move across the Slag Processing Area from the east and discharge to Wildcat Creek. Water levels in the shallow monitoring wells do not appear to be affected by large-quantity water removal at Martin Marietta Quarry.

Intermediate Water-Bearing Zone
Distribution of contaminants in the intermediate water-bearing zone is characterized by elevated VOC concentration along the west boundary of the Slag Processing Area. Characterization of the intermediate water-bearing zone is limited to one newly installed well, LA-105C, located northeast of the Slag Processing Area and one multi-port well, LA-06, located on the west boundary. The multi-port well was sampled from two ports within the intermediate water-bearing zone during 1995. All of the samples collected from the intermediate zone during 1995 showed relatively high VOC concentrations. Total VOC contamination increased with well depth within the intermediate zone; total VOC concentrations in the intermediate zone varied from 84 µg/L at LA-06A to 394 µg/L at LA-105C, to 984 µg/L at LA-06B. Elevations for well screen intervals for LA-06A, LA-105C and LA-06B decreased in elevation at approximately 10 foot intervals.

Cis-1,2-dichloroethene was primary contaminant of concern in all the intermediate well samples. Tricloroethene and vinyl chloride were detected at relatively lower concentrations. Ratios of cis-1,2-dichloroethene to trichloroethene are 23, 26 and 6 in upgradient well LA-105C and downgradient wells LA-06A and LA-06B, respectively, during 1995. Ratios for samples collected from LA-06B by ABB during 1993 varied from 1 to 10. The lower ratio of cis-1,2-dichloroethene to trichloroethene could indicate relatively "fresh" product lower in the intermediate zone with relatively degraded

product higher in the intermediate zone. This may indicate conditions favorable to degradation in the upper intermediate portion or a slug of contamination is moving through the intermediate zone and has longer to degrade in the upper intermediate zone.

Groundwater flow moves through the intermediate zone from east to west as shown on **Figure 4.4.6-2**. Water levels at LA-06 A and B are approximately 20 feet lower than at LA-105C. Water levels at LA-06 B are approximately 2 feet lower than at LA-06A. The horizontal gradient is considerable steeper west of the Slag Processing Area where water levels appear to be affected by large-quantity water removal at Martin Marietta Quarry. The horizontal gradient is more gradual over the Slag Processing Area, corresponding to increasing hydraulic conductivity values in this area. The increasing hydraulic conductivity appears to promote the migration of contamination through the intermediate water-bearing zone.

Lower Water-Bearing Zone

Contaminant distribution within the lower water-bearing zone can only be characterized at the Slag Processing Area from samples collected from the LA-06C well, located along the west boundary, and from domestic well DW-282 and monitoring well LA-105E, located north of the Slag Processing Area. A well log is not available for DW-282 and CDM assumed that the well was completed within the lower water-bearing unit. Based on lithologic logs for domestic wells located southwest of the site, DW-282 is likely finished within the Mississinewa shale with an open borehole throughout the dolomitic limestone bedrock. Comparison of data between the domestic well and the monitoring wells is difficult because the wells were sampled at different times by different parties with different sampling techniques, the samples analyzed by different laboratories, and the well construction is unknown.

Cis-1,2-dichloroethene, and to a lesser extent, trichloroethene and vinyl chloride, were the primary VOC contaminants for the lower water-bearing zone monitoring well. The highest concentration of cis-1,2-dichloroethene was detected in upgradient well LA-105E at 630 µg/L. Samples were collected from the upgradient well LA-105E only during 1995. Trichloroethene was only reported above screening levels for the upgradient well. The ratio of cis-1,2-dichloroethene to trichloroethene in the upgradient well was 4. For downgradient well LA-06, cis 1,2-dichloroethene and vinyl chloride were detected during 1993 above the screening level; however, the cis-1,2-dichloroethene concentration decreased from 310 µg/L to 2 µg/L and no vinyl chloride was detected during 1995. Concentrations of cis-1,2-dichloroethene also decreased in the domestic well from approximately 220 µg/L during 1994 to 47 µg/L during March 1995 and then increased to 200 µg/L in October 1995. Vinyl chloride concentrations in the domestic well increased during this time period from approximately 4 µg/L to 13.5 µg/L. Analytical results are available for four sampling events for the domestic well; LA-06C was sampled twice. The variance in water quality results for DW-282 shows how trends determined from two sampling events may be misleading. The domestic well results also show how water quality can vary over relatively short time periods.

Groundwater flow moves through the intermediate zone from east to west as shown on **Figure 4.4.6-3**. Water levels at LA-06C are 10 feet lower than for the intermediate zone wells and the top of the screened interval is more than 30 feet below the bottom of LA-06B. This difference in water

levels indicates poor hydraulic communication between the lower and the intermediate water-bearing zones in this localized area. This may explain why VOC contamination higher within the bedrock at LA-06B has not migrated to the lower water-bearing zone.

The horizontal gradient is considerably steeper west of the Slag Processing Area where water levels are affected by large-quantity water removal at Martin Marietta Quarry. The horizontal gradient is more gradual across the Slag Processing Area, which may correspond to increasing hydraulic conductivity values in this area as a whole, reflect recharge from the Lagoon Area, or indicate a difference in horizontal and vertical hydraulic conductivities.

Summary

Primary contaminants in the groundwater in the vicinity of the Slag Processing Area are cis-1,2-dichloroethene, and to a lesser extent, trichloroethene, and vinyl chloride. Total VOCs were highest in the Slag Processing Area in samples from well LA-06B in the intermediate water-bearing zone (984 µg/L), although total VOC concentrations are generally highest at the upgradient well location (LA-105C). Total VOC concentrations were higher deeper within the intermediate water-bearing zone; total VOC concentrations were higher in LA-06B (67 feet deep) than in LA-06A (52 feet deep). Total VOC concentration were lowest in the shallow water-bearing zone.

Samples were only collected from one shallow well (UA-17) during both 1993 and 1995. VOCs were not detected above screening levels in the shallow water-bearing zone for either the 1993 or 1995 sampling events. VOC concentrations appear to be decreasing higher within the intermediate zone and may be increasing deeper within the intermediate zone. VOC concentrations appear to be decreasing in the lower water-bearing zone.

Sources

Sample results for soil samples collected from the Slag Processing Area during the 1995 remedial investigation are presented in **Table 4.4.4-1**. This table shows that no VOCs were detected in the surface soil samples, with the exception of methylene chloride which is a common laboratory contaminant. In addition, no VOCs were detected in the soil gas samples collected from this area, with the exception of one detection of trichloroethene at the method detection limit. Although not conclusive, these results give no indication of residual contamination resulting from surface spills or leaking buried drums.

Significant VOC concentrations were reported for the intermediate water-bearing zone at well LA-06 in the Slag Processing Area. The vertical distribution of VOCs, while not conclusive, indicates groundwater impacts from VOCs likely originates from upgradient rather than from the immediate vicinity of the well in the Slag Processing Area. These results also would be consistent with leakage from drums at depth; however, compounds are consistent with those observed upgradient in the vicinity of the Lagoon Area.

4.4.6.6.3 *Groundwater Model*

Introduction

A groundwater model was constructed for use during the remedial investigation and feasibility study for CSSS. A description of the groundwater model and the modeling results is presented in **Appendix H**. Generally, objectives of the groundwater model were to determine groundwater flow paths, determine groundwater/surface water interactions, assess the influence of large quantity water removals on groundwater flow, identify potential receptors of contamination that was documented at the site, and to provide a tool for use during the feasibility study to evaluate the effectiveness of potential groundwater remedial alternatives.

Groundwater flow modeling was conducted using CDM's DYNFLOW™ model, a fully three-dimensional finite element groundwater flow model, and DYNTRACK™, a companion computer program for simulation of three-dimensional solute transport using the random walk method. The site was modeled as porous media equivalent to approximate the fractured dolomitic limestone sequence underlying the glacial drift deposits underlying the site. Use of this simplified approach allows consideration of areal flow rather than flow along individual fracture swarms.

This modeling effort is at a reconnaissance level of detail and is not intended to mathematically represent all processes active at the site, nor exactly duplicate all features of the groundwater flow system. This level of detail is adequate for the intended use of the model, for estimation of potential concentrations at receptor locations under various flow regimes, and for comparative analysis of potential remedial alternatives. Data shown on figures in the Groundwater Modeling Technical Memorandum at a particular location does not represent site-specific hydrogeology or site-specific contaminant transport results.

A brief description of the regional geology with respect to the site, a general description of how the groundwater model was developed, and a summary of the modeling conclusions are presented below. Understanding the regional setting for the model is necessary for the understanding of probable fate and transport of contamination at the CSSS.

Regional Hydrogeology

CSSS is located in Howard County, in the Upper Wabash River basin, which extends in area from the northeast portion of the state, westward along the Wabash River, to the city of Lafayette in Tippecanoe County. The Indiana Department of Natural Resources (IDNR) divided the Wabash River basin into three subbasins: an upper basin, a middle basin, and a lower basin (Fenelon *et al.* 1994). Wildcat Creek, which flows through the site along with Kokomo Creek, is the last tributary of the Wabash River in the Upper Wabash River basin. Kokomo and Wildcat Creeks join southwest of the Main Plant and flow westward through the remainder of the site as Wildcat Creek to the Wabash River.

Most physiographic features in the Upper Wabash River basin were formed by glaciers. Howard County and the CSSS are located on the Tipton Till Plain, a nearly flat glacial till plain that covers much of central Indiana. The till plain surface slopes gently to the west at a slope of less than one per cent. Till, a mixture of unsorted and unstratified clay, silt, sand and gravel deposits, is the

predominant surficial deposit (Fenelon *et al.* 1994). Incised valleys along Wildcat Creek and Kokomo Creek provide the most prominent topographic features in the vicinity of the site.

Glacial drift deposits in the vicinity of the site range in thickness from zero feet in quarries along Wildcat Creek to more than 200 feet in buried valleys that were eroded in the underlying bedrock prior to the deposition of glacial deposits (Smith *et al.* 1985). Glacial drift deposits underlying the site are generally less than 20 feet in thickness.

Bedrock underlies the glacial drift deposits. Bedrock structure is dominated by the Cincinnati Arch in this area of the state (See **Figure 8**, Fenelon *et al.* 1994). The axis of the Cincinnati Arch plunges to the northwest, at a slope of 4 to 13 feet per mile. The site is located near the axis of the Cincinnati Arch, although bedrock units in the vicinity of the site dip slightly southwest from the axis of the arch (Smith *et al.* 1985).

Silurian Period (395-435 million years ago) carbonate deposits form the uppermost bedrock underlying the site. According to "Stratigraphy of the Silurian Rock of Northern Indiana" (Shaver, 1961), Kokomo Limestone, Liston Creek Limestone and the Mississinewa Shale were identified from a core collected at Markland Avenue Quarry. The Kokomo Limestone is a thinly bedded dolomitic limestone. The Liston Creek Limestone is a cherty, fine - to medium-grained dolomitic limestone with irregular argillaceous (clayey) partings. The upper Mississinewa Shale is a dolomitic siltstone and the lower Mississinewa Shale is composed of interbedded limestone and argillaceous dolomite. The Mississinewa Shale is not a shale in the vicinity of the site. Detailed discussion of this geology is provided in Section 2 and in the Work Plan (1995a).

According to Smith *et al.* (1985), the predominant feature of the bedrock surface is a valley system cut by streams flowing from east to west. **Figure 3** in Smith *et al.* (1985) is drawn at a scale of three miles per inch and appears to indicate the presence of an ancient river channel located to the southwest of the site. The presence of an ancient river channel located southwest of the site is also suggested from lithologic logs for domestic well logs in the vicinity of the site. Lithologic logs indicate that the top of the bedrock is significantly deeper southwest of the site (50 to 100 feet) than beneath the site (5 to 20 feet).

The primary source of potable water in the site vicinity is the underlying Silurian carbonate aquifer. Groundwater flow beneath the site is primarily through open fractures, joints, bedding planes and solutional channels within the bedrock.

According to Smith *et al.* (1985), the United States Geological Survey (USGS) collected water level measurements from approximately 150 domestic and commercial wells during 1980 and from two continuous-record observation wells from 1966 to 1980. According to the study of the Wildcat and Deer Creek basins (Smith *et al.* 1985), groundwater flow within the bedrock is generally toward streams; however, reaches of Wildcat Creek near Kokomo are affected by the diversion of surface water, large-quantity groundwater withdrawals, treated wastewater discharges, and the regulation of reservoirs. Groundwater flow in lower bedrock zones may be affected by more deeply incised

rivers, such as the Wabash River, and may not be affected by shallow streams, such as Wildcat and Kokomo Creeks.

Model Construction

The model was developed using site specific and regional hydrogeologic data collected during the remedial investigation for CSSS. USGS base maps were used for topographical information. Regional information on groundwater and surface water levels and anticipated fluctuations in groundwater levels were obtained from the "Hydrogeologic Atlas of Aquifers in Indiana" (Fenelon *et al.*, 1994), and "Water Resources of Wildcat Creek and Deer Creek Basins, Howard and Parts of Adjacent Counties, Indiana, 1979-82" (Smith *et al.* 1985). Pumping rates for 1994 large quantity groundwater withdrawals for permitted wells in the vicinity of the site were obtained from Indiana state records. Information for anticipated household pumping rates was obtained from the National Ground Water Association (NGWA 1996).

For site-specific information, CDM reviewed approximately 150 lithologic logs for domestic wells to determine the principle source of groundwater for domestic wells in the vicinity of the site and to identify significant hydrologic units. The well depth, water level, depth of casing, depth of bedrock and depth of significant sand lenses within the glacial drift were tabulated for each domestic well and reviewed. Information from available lithologic logs for existing monitoring wells and monitoring wells installed for the CSSS were tabulated and reviewed to determine depth to bedrock, site-specific water levels and to determine hydrologic layers that may have significance with respect to groundwater flow pathways and contaminant transport.

Two parameters, trichloroethene and tetrachlorothene, were selected for fate and transport modeling. To help select appropriate modeling parameters, CDM reviewed water quality information collected during the remedial investigation by CDM and ABB-ES and information provided by Haynes International. Trichloroethene and tetrachloroethene were selected for modeling because elevated concentrations emanated from different locations, both parameters have low water quality standards for risk assessment, and contaminant transport properties are different for each parameter.

The groundwater model is constructed with six hydrostratigraphic layers including: the overburden; fracture Kokomo Limestone and upper Liston Creek Limestone; less fractured Kokomo Limestone and Liston Creek Limestone; massive Liston Creek Limestone; lower Liston Creek Limestone; and the Mississinewa Shale. The significance of the high hydraulic conductivity of the lower Liston Creek Limestone became apparent during the remedial investigation conducted by CDM. This hydrostratigraphic unit appears to have developed in the Liston Creek Limestone, immediately above the Mississinewa Shale. According to personal interviews with Martin Marietta Quarry staff (John Wakefield, Martin Marietta Quarry plant manager, February 6, 1996), groundwater enters the quarry primarily through this zone. The development of this zone may be attributed to the initial difference in permeability between the Liston Creek Limestone and the Mississinewa Shale and the subsequent chemical dissolution and physical erosion resulting from groundwater flow along this zone.

For general discussion of groundwater within this memorandum, the upper five hydrostratigraphic layers identified in the groundwater model are grouped into three water-bearing zones. The overburden is grouped with the highly fractured Kokomo Limestone and, to a limited extent, the upper Liston Creek Limestone in the shallow water-bearing zone at the site. The lower Kokomo Limestone and Liston Creek Limestone are less permeable and generally make up the intermediate water-bearing zone. The lower water-bearing zone consists of the lower 10 to 20 feet of the Liston Creek Limestone and the upper 5 to 20 feet of the Mississinewa Shale. The upper zone is the most permeable and the intermediate zone is the least permeable. Monitoring wells were completed up to 18 feet into the bottom hydrostratigraphic layer, the Mississinewa Shale.

Conclusions

The groundwater model succeeded in simulating the regional groundwater flow system in the vicinity of the CSSS. The model was used to simulate interactions between groundwater and surface water and to simulate influences from pumping wells (i.e., domestic wells, industrial wells, groundwater supply wells and dewatering wells at the Martin Marietta Quarry). The groundwater model was used to reach the primary conclusions presented below.

- Contaminant transport in the vicinity of the CSSS is controlled by two major hydraulic influences: (1) Martin Marietta quarry pumping and (2) Wildcat and Kokomo Creeks;

- Simulated groundwater flow path tracks and dissolved contaminants trichloroethene and tetrachloroethene are generally confined to a central contaminant transport pathway following the course of Wildcat and Kokomo Creeks in the westerly direction. Transport pathways do not diverge significantly from site source areas to the north or south of this main transport pathway; and

- Capture of contaminated groundwater originating on the CSSS by domestic wells in a subdivision located southwest of the site is unlikely under either of the quarry operational scenarios.

Additional fate and transport analyses will be performed using the model to evaluate various remedial scenarios during the feasibility study. A quantitative risk assessment will also be performed using the model during the time frame of the feasibility study. The model will prove a valuable tool in addressing these key elements of the feasibility study.

4.5 References

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Section Five

Section 5
Summary

This section provides a summary of the investigation results for each operable unit at the CSSS. The data presented in this report is used in the risk assessment report to evaluate human health and ecological risk and to develop site-specific cleanup goals.

The feasibility study will evaluate the site-specific information provided in this report and use the site-specific cleanup goals presented in the risk assessment to identify and evaluate feasible remedial alternatives for each operable unit.

5.1 Summary for Main Plant

The CSSS Phase II Investigation results indicate that the Main Plant has contributed along with other sources to the elevated metals concentrations observed in the residential soils east of the Main Plant. Higher concentrations of lead near the plant boundaries indicate the plant was a source for airborne transported particulates in the area. Air sampling results indicate that sources other than the CSSS Main Plant are currently contributing significantly to particulates being transported by wind.

Numerous basements/pits (BS-15 and BS-20) and two sewer lines are considered to be chronic sources of VOCs, PAHs, PCBs, metals and oils.

Numerous surface spills around the site have been identified based on sample analytical results. These surface spills have resulted in impact to soils of VOCs, SVOCs and PAHs, PCBs, pesticides and metals. Most significant of the releases are those involving VOCs as evidenced by impact to groundwater west of Building 112 (nail mill). Other significant surface spills include one in the vicinity of SB-F2 where VOCs, PAHs and lead were detected and the surface spill at the southeast corner of Building 71B (wire galvanizing) where PCBs, pesticides, lead and zinc were detected at elevated levels. The area east of Buildings 5 and 42 was observed to have oil saturated soils along with analytical results indicating significant concentrations of PAHs, PCBs and lead. The feasibility study will compare the concentrations of detected contaminants to the site-specific cleanup goals provided in the risk assessment to determine the volume of contaminated soils in the Main Plant.

Groundwater analytical results from wells in the vicinity of the Main Plant indicate relatively few compounds detected with exception of results from wells along the west side of Buildings 112B, 112 and 112A. Impact in this area is likely related to operations and a reported spill of trichloroethene. The relatively few detections of compounds on the Main Plant site proper is likely due in part to the paucity of monitoring wells in the interior of the site. The majority of the wells are distributed along site boundaries and are a good indication of the limited migration of constituents that has occurred in groundwater at the site.

5.2 Summary for Markland Avenue Quarry

Based on the soil gas and groundwater screening data, it appears there are sources of VOCs within the quarry fill, primarily near the abandoned concrete structure and along a line running from southwest to northeast, parallel to the pond edge and the railroad tracks. The primary VOCs detected include trichloroethene, cis-1,2-dichloroethene and vinyl chloride. The VOC contamination appears to be limited to the quarry fill area. Based on disposal history and the data collected during the RI, it is reasonable to assume that the VOC contamination extends at least to the water table, at a depth of approximately 20 feet.

The pond sediment is contaminated with VOCs, PAHs, PCBs and metals as a result of past disposal activities, and DNAPL (trichloroethene) is present within the pond sediments. The pond sediments are acting as a continuing source of contamination to the pond surface water and groundwater. The primary contaminants of concern for migration are the VOCs because they are the most mobile. Based on the distribution of the contaminants in the sediment, the parent compound, trichloroethene, is the most prevalent and was detected at the highest concentrations. The daughter, or degradation products are not as prevalent, nor are they detected at high concentrations. These results indicate that biodegradation is not very advanced in the pond sediments likely due to the high pH of the pond water. The distribution of dissolved oxygen and conductivity measurement results indicates aerobic degradation is occurring to a depth of approximately 30 feet and below this level aerobic degradation is occurring at low rates.

The pond surface water is contaminated with VOCs, primarily, trichloroethene. It is likely that VOC concentrations in the pond are being impacted by migration of contaminants from the sediments and groundwater. In turn, the pond surface water acts as a source of contamination to downgradient groundwater. VOC concentrations detected near the pond surface indicate VOC volatilization into the air is likely occurring.

The groundwater within the fill and downgradient of the quarry has been impacted by VOCs. It is noted that once the contaminant plume leaves the quarry area, the proportion of degradation products to parent compounds greatly increases. The degradation product, cis-1,2-dichloroethene is typically present at higher concentrations than trichloroethene at all downgradient wells indicating biodegredation is occurring more readily downgradient where more typical pH values are observed. This further indicates that high pH is impeding the natural degradation of VOCs in the quarry pond. Source control measures would be effective in mitigating further release of VOCs to the groundwater and will be evaluated in the feasibility study.

Surface soils within the quarry are contaminated with PAHs, PCBs, lead, arsenic and zinc. The screening level air dispersion modeling performed using the quarry surface soil data indicates that lead could potentially migrate via the air pathway at levels in excess of the Indiana air toxics standard (see **Appendix E**). Currently, the residential soil data collected downgradient does not indicate impacts from migration of lead. The isolated detections of PCBs and PAHs in the downgradient residential soils may or may not be attributable to the quarry area. The detection of PCBs in the surface soils upgradient from the quarry are likely attributable to past industrial operations in the area (see Section 3.0 Characterization of Adjacent Industrial Properties). The levels

of PCBs in these residential soils are above surface soil background as provided in the risk assessment report.

The quarry surface soils are a potential source of windborne contamination and may also impact surface water runoff which is generally handled by the city stormwater sewer system. Impact to groundwater from the types and concentrations of contaminants detected in the shallow soils is likely minimal compared to the effects from past disposal practices and potential sources buried in the fill. The surficial soil sample results at the quarry do not provide much information as to the location of past waste disposal activities.

The feasibility study will compare the concentrations of contaminants detected in the quarry pond water, sediments and surficial soil to the site-specific cleanup goals provided in the risk assessment to develop volume estimates for the contaminated media. The soil gas data will be used to provide a conservative estimate of the volume of contaminated fill material in the Markland Avenue Quarry. Due to lack of analytical data at depth in the fill area, it will be necessary to make an assumption as to the depth of contaminated materials in the feasibility study.

5.3 Summary for Lagoon and East Lagoon

Based on data collected by ABB-ES in 1993 during the first phase of the investigation there are approximately 790,000 cubic yards of material in the Lagoon Area containing elevated levels of at least one contaminant of concern. The levels of contamination presented in this report will be compared in the feasibility study to the site-specific cleanup goals presented in the risk assessment report. The volume of contaminated material in the Lagoon Area entrance will be estimated based on the soil gas data collected by CDM. The feasibility study will evaluate remedial alternatives to address contaminated material that exceeds the cleanup goals.

Based on the soil gas data, it appears there are near surface sources of VOCs near the Lagoon Area entrance. The primary contaminants in this area are trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Trenching or test pits may be needed to evaluate this area as a component of design of feasible remedial alternatives.

The groundwater is impacted primarily by VOCs in the Lagoon Area and to a lesser extent by the metals. Much of the VOC contamination is degradation products indicating an older source with the exception of wells influenced by the Lagoon Area entrance such as EW-08 and UA/LA-105. Source control would be effective in mitigating further release of the parent VOCs to the groundwater in this area and will be evaluated in the feasibility study.

5.4 Summary for Slag Processing Area

Based on soil gas and sampling results obtained by CDM in 1995, little impact to the unconsolidated sediments appears to have occurred. Impact to groundwater is limited to the intermediate and lower water-bearing zones. This impact may be from upgradient sources or from deeply buried drums.

The possibility of surface water runoff and contaminant migration off-site into Wildcat Creek exists. Similarly, the potential for windborne dispersion of dust off-site exists. Sediment/runoff fences or berms constructed along the south, east and west margins of the area would be effective measures to reduce surface water and sediment runoff to Wildcat Creek. Additionally, some form of dust control could be used to abate future off-site windborne dispersion. The feasibility study will evaluate remedial alternatives based on the site-specific cleanup goals provided in the risk assessment report.

5.5 Summary for Kokomo and Wildcat Creeks

Surface Water

Based on analytical results from this and previous investigations, constituents in surface water are generally below or slightly exceed the benchmark criteria provided in the risk assessment. Lead exceeded benchmark criteria along all six reaches of the creeks. Copper commonly exceeded benchmark criteria along Reaches 1 through 5 and zinc exceeded benchmark criteria along Reach 3. Mercury exceeded benchmark criteria in one sample collected from Reach 5. Additionally, cobalt exceeded benchmark criteria along Reach 6. These results are consistent with previous ABB-ES results with the exception that copper results are generally higher in current samples than in past samples. Cobalt and lead were detected in Reach 6 but were not previously detected in this reach. These differences in results may be due to several factors, which may include, continuing impact from active industry upstream, differences in stream flow and precipitation during and prior to sampling, variable contributions from outfalls, the wastewater treatment plant and impacted stream sediments.

Contribution of contaminants to surface water from groundwater or to groundwater from surface water was not readily determined based only on contaminant concentrations. The concentrations of VOCs and other constituents in groundwater is relatively low compared to the concentrations that would likely be required to obtain observable impacts to surface water quality. Likewise, groundwater contamination distributions observed indicate other sources (e.g., lagoons, landfills and spills) are the most substantial contributors to groundwater contamination.

The ecological assessment portion of the risk assessment will describe the impacts the detected contaminants have on the surface water and any aquatic receptors. If an impact is significant, feasible remedial options for the creek surface water will be addressed in the feasibility study.

Sediment

Based on analytical results from this and previous investigations, several constituents were consistently detected above the background and/or benchmark criteria provided in the risk assessment, in sediment samples collected from Kokomo and Wildcat Creeks. VOCs were detected above criteria in only one reach. Toluene was detected above criteria in Reach 3. SVOCs and PAHs were detected above criteria only in Reaches 3, 4, 5 and 6. PCBs, Aroclor-1248, Aroclor-1254 and Aroclor-1260, were detected above criteria in samples collected from all six reaches of the creeks. Aroclor-1016 was detected above criteria in samples collected from Reaches 3, 4, 5 and 6.

Numerous pesticides were detected above criteria in samples collected along the reaches of the creeks sampled. 4,4'-DDE, aldrin and gamma-chlordane were detected in all six reaches at 3 to 10 (plus) times the criteria (gamma-chlordane at less than three times the criteria along Reach 6). 4,4'-DDT, 44'-DDD, heptaclor, heptaclor epoxide, endrine aldehyde, dieldrine, gamma-BHC, alpha-chlordane and endosulfan II were detected in various reaches of the streams at concentrations greater than 10 times the criteria.

Numerous metals were detected above criteria in samples collected along the reaches of the creeks sampled. Cadmium, chromium, copper, nickel and zinc were detected in Reaches 1, 3 and 4 at concentrations greater than 10 times criteria. Numerous metals were detected at concentrations up to greater than 10 times criteria in various reaches of the creeks. These metals include aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, silver, thallium, zinc, mercury, selenium, manganese, antimony and vanadium.

While elevated levels of contaminants are present in all stream reaches, constituent concentrations vary significantly between sampling locations and sampling events due in large part to the heterogeneous nature of sediments. Sediment mobility and deposition vary with stream flow and also contribute to the variable nature of analytical results observed. An additional factor likely contributing to variability in results is impacts from active industries upstream.

Based on these results, it was concluded in the ecological evaluation within the risk assessment report that no critical terrestrial, semi-aquatic or aquatic habitat is present on site and that no further sampling is recommended to develop a more current bioconcentration factor. The feasibility study will evaluate the detected sediment concentrations with respect to the site-specific cleanup goals presented in the risk assessment to develop an estimate of contaminated sediment volume. Based on the data and the fact that the sediments are mobile, it is reasonable to assume that contaminated sediment is present in Wildcat Creek from Dixon Road to the Phillips Street bridge and in Kokomo Creek from Park Avenue (old Continental Steel bridge) to approximately Leeds Street. The feasibility study will present remedial alternatives for the estimated volumes of contaminated sediment.

5.6 Summary for Site-Wide Groundwater

Groundwater flow and contaminant transport in the vicinity of the CSSS is greatly influenced by preferential flow through the fractured dolomitic limestone bedrock underlying the site. For purposes of this remedial investigation, stratigraphy underlying the site is categorized into three

hydrologically significant water-bearing zones; a shallow water-bearing zone, an intermediate water-bearing zone and a lower water-bearing zone. The upper water-bearing zone at the site generally includes the overburden and the highly fractured Kokomo Limestone and, to a limited extent, the upper Liston Creek Limestone. The intermediate water-bearing zone includes the lower Kokomo and the Liston Creek Limestone. The lower water-bearing zone consists of the lower 10 to 20 feet of the Liston Creek Limestone and the upper 5 to 20 feet of the Mississinewa Shale.

The shallow water-bearing zone wells tend to be the most prolific groundwater producers of the three zones, with estimated discharge rates up to over 20 gallons per minute. Although high hydraulic conductivities (10^{-2} cm/s) are observed in the shallow water-bearing zone, hydraulic conductivities vary significantly with location and may be as low as 2×10^{-5} cm/s (UA-07, **Appendix G**). The variability in hydraulic conductivities observed in monitoring wells screened within a single water-bearing zone is dependent on whether the well intersects a water-bearing fracture, depth of the screened interval (intersection of water-bearing bedding plane or fracture, and how well the intersected fracture system is developed.

Wells completed in the intermediate water-bearing zone tend to produce less water than those completed in the shallow and lower water-bearing zones. Flow characteristics are similar to those in the shallow water-bearing zone, with flow being dependent on intersection of open fractures. Groundwater flow in the intermediate water-bearing zone on the eastern two-thirds of the site is due west with a horizontal gradient of 0.01. Hydraulic influence from large quantity water withdrawals at Martin Marietta Quarry is first observed in the vicinity of the Slag Processing Area where the hydraulic gradient steepens to 0.02.

The lower water-bearing zone consists of well-developed bedding plane fractures which have been weathered by groundwater flow along the top of the Mississinewa Shale, the underlying less permeable unit. Wells completed in this zone generally produce more water than the intermediate water-bearing zone and less than the shallow water-bearing zone. Hydraulic conductivities in the lower water-bearing zone vary from 1.6×10^{-4} cm/s (LA-104E) to 9.4×10^{-3} cm/s (LA-107E). These comparisons are of a general nature and yields from individual wells depend upon whether a fracture is encountered, the size of the fracture and how weathered and developed the secondary porosity and associated permeability has become. No communication between the lower water-bearing zone and the creeks was observed during the field investigation (comparable water-level fluctuations); however, the presence of contaminants in the lower water-bearing zone indicates that groundwater flow probably follows preferential flow pathways.

Based on water levels collected from wells screened within each of the three water-bearing zones, groundwater flow is generally to the west; however, groundwater flow within each zone may vary according to localized and regional influences. Groundwater flow in the upper-water bearing zone is toward the creeks and the water table generally follows surface topographic features, however, as indicated in Section 3.1.4.3.3 groundwater flow may vary seasonally in some areas that currently are not evident due to the lack of sufficient data. These generalities are true with the exception of the Lagoon Area where mounding of the water table is present which results in localized northerly flow along the north side of the Lagoon Area. Groundwater flow in the lower water-bearing zone appears to be to the northwest and west along the structural dip of the bedrock.

A groundwater model was constructed to simulate the regional groundwater flow system in the vicinity of the CSSS. The model was used to simulate interactions between groundwater and surface water and to simulate influences from pumping wells (i.e., domestic wells, industrial wells, groundwater supply wells and dewatering wells at the Martin Marietta Quarry). The groundwater model was used to reach the following conclusions:

- Contaminant transport in the vicinity of the CSSS is controlled by Martin Marietta quarry pumping and Wildcat and Kokomo Creeks;
- Groundwater flow pathways are confined to a central contaminant transport pathway following the course of Wildcat and Kokomo Creeks in the westerly direction. Transport pathways do not diverge significantly from site source areas to the north or south of this main transport pathway; and
- Capture of contaminated groundwater originating on the CSSS by domestic wells in a subdivision located southwest of the site is unlikely under either of the quarry operational scenarios. The model is used in the feasibility study in the fate and transport analysis and to evaluate the effectiveness of various remedial alternatives.

The primary contaminants detected at the highest concentrations observed impacting the largest areas at the CSSS are VOCs. Generally, PAHs, PCBs, pesticides and metals, where detected, were limited to point detections at wells and plumes were not identified. This is expected due to the relatively low mobility of these constituents and their method of introduction to the subsurface - usually disposal on the ground surface. As a result, the preponderance of discussion and evaluation of VOCs is required due to their mobility and, as a result, greater extent of impact to the subsurface in the vicinity of the CSSS.

It should be noted that potential water quality trends within each area discussed below are based only on the comparison of data from two sampling events. The data from the second round of groundwater sampling conducted by CDM in September 1996 will be included in the Final RI Report. If duplicate samples were collected for a particular well during either the 1993 or the 1995 sampling events, an average of the results is used for the trend analysis. Actual water quality trends would require additional information collected over time. In addition, sampling activities were conducted during different times of the year and under different hydrologic conditions. Constituent concentrations may vary seasonally or even daily, depending on surface water/groundwater response time. Changes in constituent concentrations (e.g., mobilization of contaminants, dilution of contaminant concentrations) result from changes in water chemistry and groundwater flow patterns due to weather and climatic variations. Also, different laboratories were used for sample analysis during the two sampling events and variations in results between laboratories are not uncommon.

Markland Avenue Quarry

The primary contaminants in groundwater in the vicinity of Markland Avenue Quarry are trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Total VOCs for the Markland Avenue Quarry area were highest in wells finished in the intermediate water-bearing zone downgradient from the quarry pond. VOC concentrations are highest in the backfilled area (UA-22) in the shallow water-bearing zone; highest downgradient of the quarry pond in the intermediate water-bearing zone, and highest downgradient of the quarry pond in the lower water-bearing zone. The lower water-bearing zone shows the lowest groundwater impacts. It should be noted that the intermediate and lower water-bearing zone wells (three total) are installed only downgradient of the quarry pond. Concentrations of these VOCs appear to be decreasing in the shallow water-bearing zone and increasing in the intermediate zone.

Evaluation of contaminant distributions is limited due to the paucity of wells completed in and around the quarry. VOCs have migrated to the site boundary on the west side of the site in the intermediate and lower water-bearing zones.

Results indicate degradation in the intermediate zone is well progressed. Shallow and lower water-bearing zones have similar daughter to parent compound ratios indicating lower zone contaminants are not entering this zone from the vicinity of degredation in the intermediate zone. This indicates degredation in the intermediate water-bearing zone may be localized. Anaerobic degredation appears to be occurring in the lower portion of the Quarry pond (low DO - see **Table 4.4.6-17**) and the presence of high concentrations of degredation products downgradient in LA-101C at depths of 80 to 90 feet indicate it may be occurring near the base of the quarry in the vicinity of the pond.

The extent of impact has not been determined horizontally or vertically. Partial horizontal extent has been determined to the southeast (LA-01, UA-01) in all three zones and to the southwest (UA-02) in the shallow zone. Extent has not been determined to the south for the intermediate and lower zones and has not been determined in all three zones to the west, north and east. It is not known if contaminants from Markland Avenue Quarry have co-mingled with the tetrachloroethene plume west of the Fence Plant. Extent of impact, therefore, is poorly defined and contaminant concentrations may not represent maximums since wells are completed at site boundaries rather than in close proximity to sources in the fill and the quarry pond.

Vertical extent of groundwater contamination has not been defined. LA-02 is the only lower water-bearing zone well in a down-gradient position at the quarry. Total VOCs of 194 µg/L are present in LA-02 in the lower water-bearing zone. Contaminants are likely present at higher concentrations and potentially deeper near the source area. The presence of DNAPL in the Quarry pond also indicates the potential for DNAPL migration vertically and laterally in directions which do not coincide with groundwater flow directions - especially considering the stratified and fractured nature of the bedrock. Additionally, DNAPL is likely to migrate along the base of the quarry in the direction the quarry floor dips.

The high pH of water in the quarry pond indicates there may be a potential contaminant of a very basic nature which has not yet been identified in the quarry fill. The high pH potentially affects the degredation of organic constituents in groundwater.

Concentrations of PAHs (benzo(a)anthracene, 3 µg/L; chrysene, 4 µg/L) and pesticides (aldrin, 0.18 µg/L; dieldrin, 0.23 µg/L) were detected near screening levels during 1993 at the UA-22 well location; however, since these constituents were not primary contaminants of concern and distribution is likely limited, this well was not resampled.

Fence Plant

The primary contaminants in groundwater in the vicinity of the Fence Plant are tetra-chloroethene, trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Total VOCs were highest for the Fence Plant area in well UA-30, which is completed in the upper water bearing zone downgradient from the Fence Plant and Markland Avenue Quarry. Within each water-bearing zone, VOC concentrations are highest west of the Fence Plant (UA-06, UA-28 and UA-30) in the shallow water-bearing zone; and highest west of the Fence Plant at the LA-03C location in the intermediate water-bearing zone, and in the lower water-bearing zone. Concentrations of these VOCs appear to be decreasing in the shallow water-bearing zone at the Fence Plant but are increasing in the shallow water-bearing zone west of the Fence Plant. Total VOC concentrations are lowest in the lower water-bearing zone for samples collected from wells in this area.

Evaluation of contaminant distributions is limited due to the paucity of wells completed in and around the Fence Plant. The shallow water-bearing zone is most impacted and has tetrachloroethene at concentrations up to one percent of its solubility (UA-30). Dissolved chlorinated compound concentrations detected at one percent of compound solubility is considered evidence of the presence of DNAPL (Pankow and Cherry 1996). The intermediate and lower water-bearing zones have higher concentrations of degradation products. Based on the concentrations and distributions of degradation products it appears anaerobic degredation is occurring around the periphery of the plume with cis-1,2-dichloroethene and vinyl chloride increasing as degradation proceeds.

Based on results from the five shallow wells, a well-developed plume is present and results at UA-28 appear relatively constant for parent compounds suggesting a continuing source may be present north or northeast of the Fence Plant. High concentrations of tetrachloroethene at UA-06 in 1993 suggest the Fence Plant could have been a potential source, however, current contaminant distributions and soil gas survey results indicate a source north or northeast of the Fence Plant. The nose of the tetrachloroethene plume appears to have recently moved through the vicinity of UA-30.

The horizontal extent of contamination in the shallow water-bearing zone is bounded to the west by Wildcat Creek (assuming minimal migration beneath the creek), to the east by Markland Avenue Quarry and to the south by UA-11. The extent of contamination to the north and northeast is not known.

The extent of contamination in the intermediate and lower water-bearing zones is not known. Based on groundwater flow in the intermediate and lower water-bearing zones, monitoring wells LA-03C and E are present along the edge of the area covered by the plume in the shallow zone. LA-103C and LA-102C are located downgradient of the plume. Concentrations are likely higher closer to the axis of the plume so results from these wells are considered as downgradient concentrations.

Vertical extent of groundwater contamination is not known. As indicated above, LA-03E is located at the edge of the plume if the groundwater flow direction in the lower aquifer is considered. Low concentrations of VOCs were detected in the lower water-bearing zone. Higher concentrations at greater depths are expected proximal to the source and likely along the axis of the plume and west of the plume and source.

Main Plant

Groundwater analytical results from wells in the vicinity of the Main Plant indicate relatively few compounds detected with exception of wells along the west side of Buildings 112B, 112 and 112A. Impact in this area is likely related to past operations at the Main Plant and a reported trichloroethene spill. The relatively few detections of compounds on the Main Plant site proper is likely due in part to the paucity of monitoring wells in the interior of the site. The majority of the wells are distributed along site boundaries and are a good indication of the limited migration of constituents that has occurred in groundwater at the site.

The primary contaminants in groundwater in the vicinity of the Main Plant are trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Total VOCs were highest in the Main Plant area in well LA-04A, which is completed in the intermediate water-bearing zone downgradient from the Main Plant, near Wildcat Creek. VOC concentrations are highest in the former spill area near the LA-04, UA-11 and UA-24 well locations on the west boundary of the Main Plant within the shallow, intermediate and lower water-bearing zones. These results are consistent with the reported historical spill of trichloroethene in the vicinity of Building 112 (nail mill). Total VOC concentrations were lowest during the 1995 sampling event in the lower water-bearing zone.

Total VOC concentrations appear to be decreasing in all three water-bearing zones, except at UA-32, located west of Wildcat Creek. The increase in VOC concentrations in UA-32 could be attributed to replacement of the well 50 to 70 feet closer to the Main Plant. Although trichloroethene concentrations appear to be decreasing, concentrations of cis-1,2-dichloroethene and vinyl chloride, generally are increasing. VOC concentrations at the UA-32 location indicate a plume is migrating downgradient from the Main Plant. The presence of chlorinated VOCs in UA-32 indicates that migration of contaminants in the shallow water-bearing zone can occur beneath the creek beds.

The most significant decrease in VOC concentrations was in the lower water-bearing zone at the LA-04C well location, where trichloroethene concentrations decreased from an average of 3450 µg/L during 1993 to 5 µg/L during 1995. The decrease in concentration may indicate that the 1993 sample was contaminated due to well construction methodology or the decrease in concentrations may indicate that a slug of contamination moved through the lower water-bearing zone. Since VOC concentrations at other intervals also varied, this may indicate a series of plumes, resulting from leaching at the spill location due to precipitation events.

Vertical extent of groundwater contamination in the Main Plant area is poorly defined. Although water quality at LA-04 is impacted, the location of the spill is thought to be 200 feet south of the well location and contaminant concentrations may be higher closer to the source. Wells LA-04 and 05 are the only lower water-bearing zone wells in a down-gradient position at the Main Plant. Contaminants are likely present at higher concentrations and potentially deeper near the source

area. The presence of DNAPL as the spill product and historical trichloroethene concentrations near one percent of its solubility indicates the potential for DNAPL migration vertically and laterally in directions which do not coincide with groundwater flow directions - especially considering the stratified and fractured nature of the bedrock.

Residual PCB soil contamination in shallow soils in the vicinity of soil borings SB-G01 and SB-H03 is believed to be the source of PCBs detected in shallow groundwater at UA-21. PCB concentrations of 9,900 µg/kg and 25,000 µg/kg were detected in SB-G01 and SB-H03, respectively. Although these are surface soil samples, their presence confirms disposal of high concentration PCBs in the area. Other sources may be present at the Main Plant and evaluation of impact to the intermediate and lower water-bearing zones within the Main Plant boundaries is not possible for the majority of the site due to the paucity of wells in these zones at the Main Plant.

Lagoon Area

The groundwater is impacted primarily by VOCs (trichloroethene, cis-1,2-dichloroethene and vinyl chloride) in the Lagoon Area and to a lesser extent by metals. Within each water-bearing zone, VOC concentrations are highest in the shallow water-bearing zone at the Lagoon Area entrance, at the intermediate water-bearing zone well locations at the Lagoon Area, and in lower water-bearing zone at the downgradient well locations (LA-105E, LA-106E and LA-107 E). Total VOC concentrations appear to be decreasing significantly in the upper water-bearing zones, but have remained relatively constant in the intermediate and lower water bearing zones.

Trichloroethene, cis-1,2-dichloroethene and vinyl chloride are the primary water quality contaminants in the shallow water-bearing zone. Cis-1,2-dichloroethene is the primary water quality contaminants in the intermediate and lower water-bearing zone, although trichloroethene and vinyl chloride are also contaminants of concern in these zones.

Metals present in the Lagoon Area groundwater that exceed MCLs include iron, manganese, nickel, chromium and antimony. Nickel was detected at elevated levels at seven locations within the upper water-bearing zone and at one location within the intermediate zone. The highest nickel concentration (0.818 mg/L)was detected at the EW-06, located by the treatment tanks northwest of the lagoon ponds. Antimony was detected in one sample each from the shallow water-bearing zone and from the intermediate water-bearing zone. Chromium was detected for one sample from the shallow water-bearing zone.

According to the ABB-ES data for lagoon soils and sediments (**Appendix I**), iron and manganese were consistently present in the soils at high levels. Nickel, while consistently detected was not present at as high levels; however, it may have been disposed in a more soluble form. The other metal that was present consistently and at elevated levels was lead; however, lead was not detected in the lagoon groundwater above MCLs.

Based on water quality information for Haynes International and other information collected during the remedial investigation, the elevated concentrations reported for wells located west and south of Wildcat Creek do not appear to be related to contamination from the Lagoon Area. Historic information indicates that tetrachloroethene has been the primary contaminant in this area (up to

53,000 µg/L, EW-19, 1992). Tetrachloroethene was detected in shallow well EW-18, which is screened at an elevation (773.3 feet to 771.3 feet MSL) above the surface water elevation in Wildcat Creek (770.52 feet). Based on groundwater flow in this area, this contamination cannot originate in the Lagoon Area. Tetrachloroethene is the primary contaminant in the shallow water-bearing zone, but trichloroethene and cis-1,2-dichloroethene are the primary contaminants in the intermediate and lower water-bearing zones. Trichloroethene, cis-1,2-dichloroethene and vinyl chloride are degradation products of tetrachloroethene. The presence of tetrachloroethene in EW-18 and the increasing VOC concentrations in EW-16, (both wells are located adjacent to Wildcat Creek just west of the Lagoon Area) indicate another source other than CSSS contributed to groundwater contamination.

Based on the distribution and trends for contaminants in the Lagoon Area, contaminants from various sources co-mingled and/or contributed to groundwater degradation. Separate sources appear to impact various portions of the Lagoon Area including the Lagoon Area entrance, the lagoon ponds, the berm located at the southwest boundary and the vicinity of Haynes International. Soil gas data discussed in Section 4.3.3 indicates there are near surface sources of VOCs near the Lagoon Area entrance. The primary contaminants in this area are trichloroethene, cis-1,2-dichloroethene and vinyl chloride. Trenching or test pits may be needed to evaluate this area before remedial options are evaluated. Past drum disposal practices at the Lagoon Area are most likely the source of VOC (trichloroethene) contamination at the bermed area. Metal contamination is due to past treatment practices in the lagoon ponds. The presence of tetrachloroethene in wells located southwest of the Lagoon Area in the vicinity of Haynes International and east of the Lagoon Area near the City of Kokomo Wastewater Treatment Plant indicates that a source other than the CSSS contributed to groundwater contamination. The presence of VOCs in the lower water-bearing zone of wells LA-105E and LA-107E shows that the extent of groundwater contamination in the vicinity of the CSSS is poorly defined.

Slag Processing Area

No VOCs were detected in the shallow water-bearing zone, except at the upgradient UA-105 well location. Primary contaminants in groundwater in the vicinity of the Slag Processing Area are cis-1,2-dichloroethene, and to a lesser extent, trichloroethene, and vinyl chloride. Total VOCs were highest at the Slag Processing Area in samples from well LA-06B in the intermediate water bearing zone (984 µg/L), although total VOC concentrations are generally highest at an upgradient well location (LA-105C). Total VOC concentrations were higher at lower intervals within the intermediate water-bearing zone; total VOC concentrations were higher in LA-06B (67 feet deep) than in LA-06A (52 feet deep). Total VOC concentrations were lowest in the shallow water-bearing zone.

VOC concentrations appear to be decreasing higher within the intermediate zone but may be increasing deeper within the intermediate zone. VOC concentrations appear to be decreasing in the lower water-bearing zone as well.

Significant VOC concentrations were reported for the intermediate water-bearing zone at well LA-06 in the Slag Processing Area. The vertical distribution of VOCs, while not conclusive, indicates groundwater impacts from VOCs likely originates from upgradient rather than from the immediate vicinity of the well in the Slag Processing Area. These results would also be consistent with leakage

from drums at depth; however, contaminant compounds are consistent with those observed upgradient in the vicinity of the Lagoon Area.

Second Round Groundwater Monitoring

As indicated in CDM's Work Plan (CDM 1995a) the following wells were sampled during the second CDM groundwater monitoring event in September of 1996:

Second Round Groundwater Monitoring

Monitoring Well I.D. MW	Parameters	Justification
UA-05	RDO VOA, RDM Metals, Chloride and Mercury	Confirm ABB Data and evaluate trends.
UA-11	RDO VOA, RDM Metals, Chloride and Mercury	"
LA-03C	RDO VOA	"
LA-101C	RDO VOA, RDM Metals, Chloride and Mercury	Confirm CDM (1995) data and establish baseline concentrations.
LA-102C	RDO VOA, RDM Metals, Chloride and Mercury	"
LA-103C	RDO VOA, RDM Metals, Chloride and Mercury	"
LA-104E	RDO VOA, RDM Metals, Chloride and Mercury	"
UA-105A	RDO VOA, RDM Metals, Chloride and Mercury	"
LA-105C	RDO VOA, RDM Metals, Chloride and Mercury	"
LA-105E	RDO VOA, RDM Metals, Chloride and Mercury	"
LA-106C	RDO VOA, RDM Metals, Chloride and Mercury	"
LA-107C	RDO VOA, RDM Metals, Chloride and Mercury	"

Second Round Groundwater Monitoring

Monitoring Well I.D. MW	Parameters	Justification
LA-107E	RDO VOA, RDM Metals, Chloride and Mercury	Confirm CDM (1995) data and establish baseline concentrations.
UA-32	RDO VOA, PCBs, RDM Metals and Chloride	"
LA-03A	RDO VOA, RDM Metals, Chloride and Mercury	"
LA-03E	RDO VOA, RDM Metals, Chloride and Mercury	"
UA-24	RDO VOA, RDM Metals, Chloride and Mercury	"
EW-08	RDO VOA, RDM Metals, Chloride and Mercury	"
UA-30	RDO VOA, RDM Metals, Chloride and Mercury	Confirm ABB, CDM (1995) Data
UA-06	RDO VOA, RDM Metals, Chloride and Mercury	Confirm ABB, CDM (1995) Data
EW-28	RDO VOA, RDM Metals, Chloride and Mercury	Confirm ABB, CDM (1995) Data

Monitoring wells UA-27 and UA-03 were not sampled because they were dry. Due to lack of sufficient recharge, only the VOA fraction was collected from LA-03C. All three alternate wells proposed in the work plan were sampled. The field data collected from these was evaluated in this Draft Final RI report and the field readings of pH, temperature and conductivity are consistent with the previous sampling rounds. The September 1996 dissolved oxygen data was considered unuseable due to equipment malfunction. The feasibility study will evaluate the source area and groundwater data presented in this report and will use the groundwater flow model to develop and evaluate feasible remedial alternatives for groundwater. Major factors the feasibility study will take into account include residual DNAPL areas throughout the site, predicted impacts of source area contamination on groundwater, and the fractured bedrock flow regime.

5.7 References

Camp Dresser & McKee Inc. (CDM). 1995a. *Continental Steel Superfund Site Focused Remedial Investigation/Feasibility Study Work Plan.*