RESPONSE ACTION CONTRACT

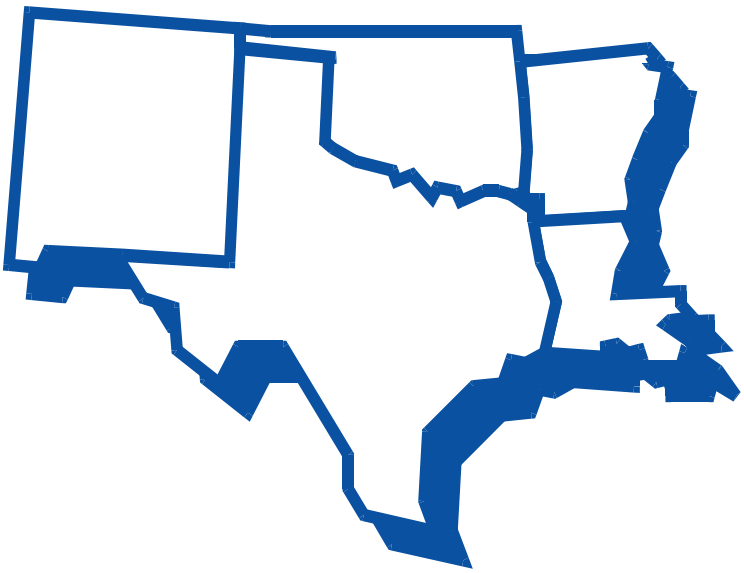
U.S. Environmental Protection Agency Region VI

Contract No. EP-W-06-021

Version 1.1
Supplemental Remedial Investigation Report
March 2008

Supplemental Remedial Investigation
Tulsa Fuel and Manufacturing Superfund Site
Collinsville, Oklahoma

Remedial Action Contract No. EP-W-06-021
Task Order No. 0030-RIRI-06FP



CH2MHILL

In Association With:
Oklahoma Department of Environmental Quality (ODEQ)
U.S. Environmental Protection Agency (USEPA)

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Version 1.1

Supplemental Remedial Investigation Report

Tulsa Fuel and Manufacturing Superfund Site
Collinsville, Tulsa County, Oklahoma

Remedial Action Contract No. EP-W-06-021
EPA Task Order No. 0030-RIRI-06FP
CH2M HILL Project No. 365672
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Prepared for:
U.S. Environmental Protection Agency

Prepared by:
CH2M HILL, INC.

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Executive Summary

This report documents the findings of the November 2007–January 2008 field investigation and summarizes the results of the supplemental remedial investigation (RI) performed for the Tulsa Fuel and Manufacturing (TFM) Superfund Site in Collinsville, Oklahoma, in Tulsa County. CH2M HILL conducted the supplemental field investigation for the U.S. Environmental Protection Agency (EPA) Region 6, under Remedial Action Contract No. EP-W-06-021, EPA Task Order No. 0030-RIRI-06FP.

The objectives of the supplemental field investigation were: 1) to obtain sufficient data to evaluate the potential soil contamination of offsite residential properties resulting from the use of smelter waste as fill material and 2) to evaluate the potential soil contamination of the area surrounding the site resulting from the release and dispersion of airborne particulates during the operation of the smelters. This report also summarizes the findings of previous investigations to provide a comprehensive source of site data for use in planning site-response actions as needed.

Field activities were conducted by CH2M HILL from November 6, 2007 to January 8, 2008 to accomplish the objectives of the supplemental remedial investigation. Field investigation activities were performed in accordance with the approved Field Investigation Work Plan (**CH2M HILL, 2007a**) and included the following:

- Developing an air dispersion model to guide in the selection of soil sample locations
- Obtaining signed access agreements to permit CH2M HILL onto residential properties to collect soil samples
- Collecting and analyzing 10 native composite surface soil samples for laboratory analysis of site-specific total analyte list (TAL) metals (arsenic, lead, cadmium, and zinc) to assess airborne dispersion of site contaminants during operation of the smelter at the site

- Collecting and analyzing 1,122 native composite surface soil samples for laboratory analysis of site-specific TAL metals (arsenic, lead, cadmium, and zinc) to assess the extent of usage of site smelter waste as fill material for offsite properties
- Collecting quality assurance/quality control (QA/QC) samples (field duplicates [FD], matrix spikes [MS] and matrix spike duplicates [MSD], and equipment rinsate blanks [ERB]) as specified in the existing field sampling plan (FSP)
- Documenting all field activities
- Managing of investigation-derived waste (IDW)
- Validating laboratory data
- Preparing a supplemental RI report

The air dispersion model indicated that the air dispersion composite samples should be collected from undisturbed areas that are north-northeast and south-southwest of the site. The residential sample locations where signed access agreements were obtained were intended to cover a 1.5-mile radial area of the site. CH2M HILL personnel obtained 184 signed access agreements from November 12 to November 17, 2007, and an additional 21 signed access agreements during the field sampling event. The locations of the signed access agreements were then submitted to the EPA for approval prior to the initiation of field work at the proposed sampling locations.

A total of 201 residential properties and 10 undisturbed air dispersion locations were sampled for site-specific TAL metals (arsenic, cadmium, lead, and zinc) during the field sampling event that began on November 26, 2007, and ended on January 8, 2008. Based on laboratory analysis of the 1,132 composite samples collected from the 201 residential properties and 10 undisturbed air dispersion locations, only 10 residential properties contained metal concentrations that exceeded the Oklahoma Department of Environmental Quality (ODEQ) residential preliminary remedial goals (PRGs). A total of 18 metal exceedances were identified at the 10 residential properties (**Table ES-1**).

TABLE ES-1
Metal Concentrations that Exceed ODEQ Residential PRGs
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Analyte	Concentration (mg/kg)
	Northing	Easting				
MF2HW7	4027373	245045	TFM003-BY-0006	0–6	LEAD	579
MF2J58	4028385	245233	TFM014-BY-0006	0–6	LEAD	509
MF2JJ5	4027039	244841	TFM029-FY-0612	6–12	ARSENIC	91.9
MF2JJ5	4027039	244841	TFM029-FY-0612	6–12	LEAD	1430
MF2HX7	4027561	244525	TFM032-OT-0006	0–6	CADMIUM	78.2
MF2HX7	4027561	244525	TFM032-OT-0006	0–6	LEAD	1400
MF2HY1	4027561	244525	TFM032-OT-0612	0–6	LEAD	599
MF2KQ7	244766	4027890	TFM085-FY-0612	6–12	LEAD	586
MF2KZ9	4024976	243944	TFM096-SY-0612	6–12	LEAD	558
MF2L02	4024965	243845	TFM097-FY-0006	0–6	LEAD	537
MF2LB6	4028975	244356	TFM115-BY-0006	0–6	ARSENIC	53.4
MF2MG9	4028667	245041	TFM175-FY-0006	0–6	LEAD	722
MF2JQ3	4026488	245040	TFM204-BY-0006	0–6	ARSENIC	114
MF2JQ3	4026488	245040	TFM204-BY-0006	0–6	LEAD	1500
MF2JW8	4026488	245040	TFM204-BY-0612	6–12	ARSENIC	45.8
MF2JW8	4026488	245040	TFM204-BY-0612	6–12	LEAD	630
MF2JX0	4026505	245048	TFM204-FY-0006	0–6	ARSENIC	41.5
MF2JX0	4026505	245048	TFM204-FY-0006	0–6	LEAD	1410

ODEQ residential PRGs: arsenic = 37 milligrams/kilograms (mg/kg), cadmium = 75 mg/kg, lead = 500 mg/kg, zinc = 23,000 mg/kg

The data collected for the supplemental RI for the TFM Superfund Site indicates that only a few offsite residential properties potentially have been impacted by site contamination and that no undisturbed air dispersion locations appears to be impacted by the release and dispersion of airborne particulates from the operating smelter in the area surrounding the site. Of the 10 residential properties impacted, two of the residential properties coincided with the observation of waste material at the property. The possible origin of contamination at the remaining eight residential properties cannot be definitively determined; however, it is likely that the origin can be attributed to historical placement of smelter waste material in

the older sections of Collinsville. Laboratory data indicates that the distribution of impacted offsite residential properties is random and that there is no discernable pattern or trend.

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Acronym List

ATSDR	Agency for Toxic Substances and Disease Registry
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLP	contract laboratory program
COC	constituent of concern
CRQL	contract-required quantitation limit
DOT	Department of Transportation
DQO	data quality objectives
EPA	U.S. Environmental Protection Agency
ERB	equipment rinsate blanks
ESAT	environmental service assistance team
FD	field duplicates
FS	feasibility study
FSP	field sampling plan
ft	foot or feet
GPS	global positioning system
gpm	gallons per minute
g/s	grams/second
IDW	investigation-derived waste
K_{oc}	high organic carbon partitioning coefficient
MDL	method detection limit
mg/kg	milligram per kilogram
mph	miles per hour
msl	mean sea level
MS	matrix spike
MSD	matrix spike duplicate
MSSL	medium-specific screening level
NPL	National Priorities List
ODEQ	Oklahoma Department of Environmental Quality
OSDH	Oklahoma State Department of Health

PA	preliminary assessment
PM	particulate matter
PRGs	preliminary remedial goals
ppm	parts per million
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RI	remedial investigation
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	site inspection
SOP	standard operating procedure
START	superfund technical assistance response team
TAL	total analyte list
TCLP	toxicity characteristic leaching procedure
TFM	Tulsa Fuel and Manufacturing
TR	traffic report
UTM	universal transverse Mercator

Section 1
Introduction

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SECTION 1

Introduction

The remedial investigation/feasibility study (RI/FS) is a process by which the nature and extent of risks posed by a hazardous waste site are quantified and potential remedial options are evaluated sufficient to support an informed risk management decision regarding remedial action for a site. The Oklahoma Department of Environmental Quality (ODEQ) completed an RI for the Tulsa Fuel and Manufacturing (TFM) Superfund Site, as documented in the RI report completed in August 2007 (**Burns & McDonnell, 2007**). ODEQ used the results of the RI to complete a baseline human health risk assessment (BHHRA) and a baseline ecological risk assessment (BERA). The RI report identified the need to collect additional data from offsite properties around the site to assess: 1) the extent of the offsite use of site waste as fill material, and 2) the potential for soil contamination due to the aerial dispersion of site contaminants from past site smelter activities. The U.S. Environmental Protection Agency (EPA) conducted this supplemental RI to address these data needs. EPA Region 6 tasked CH2M HILL with the supplemental RI, under Remedial Action Contract No. EP-W-06-021, EPA Task Order 0030-RIRI-06FP.

This introductory section provides a brief review of the site's background, a summary of previous site investigations, a concise breakdown of the scope of work and project objectives, and a description of the additional contents of this supplemental RI report.

1.1 Site Background

This section provides a description of the site and a summary of the site history. **Figure 1-1** provides a map of the site's location. Additional background information about the site, including the regulatory history of the site, is in the RI Report (**Burns & McDonnell, 2007**).

1.1.1 Site Description

The TFM site is about 1.3 miles south of downtown Collinsville, Oklahoma, in Tulsa County. The site is bordered on the east by "Old" U.S. Highway 169 and by the right of way of the Atchinson Topeka and Santa Fe railroad, on the south by a former strip mine impoundment, on the west by agricultural properties, and on the north by the Faith

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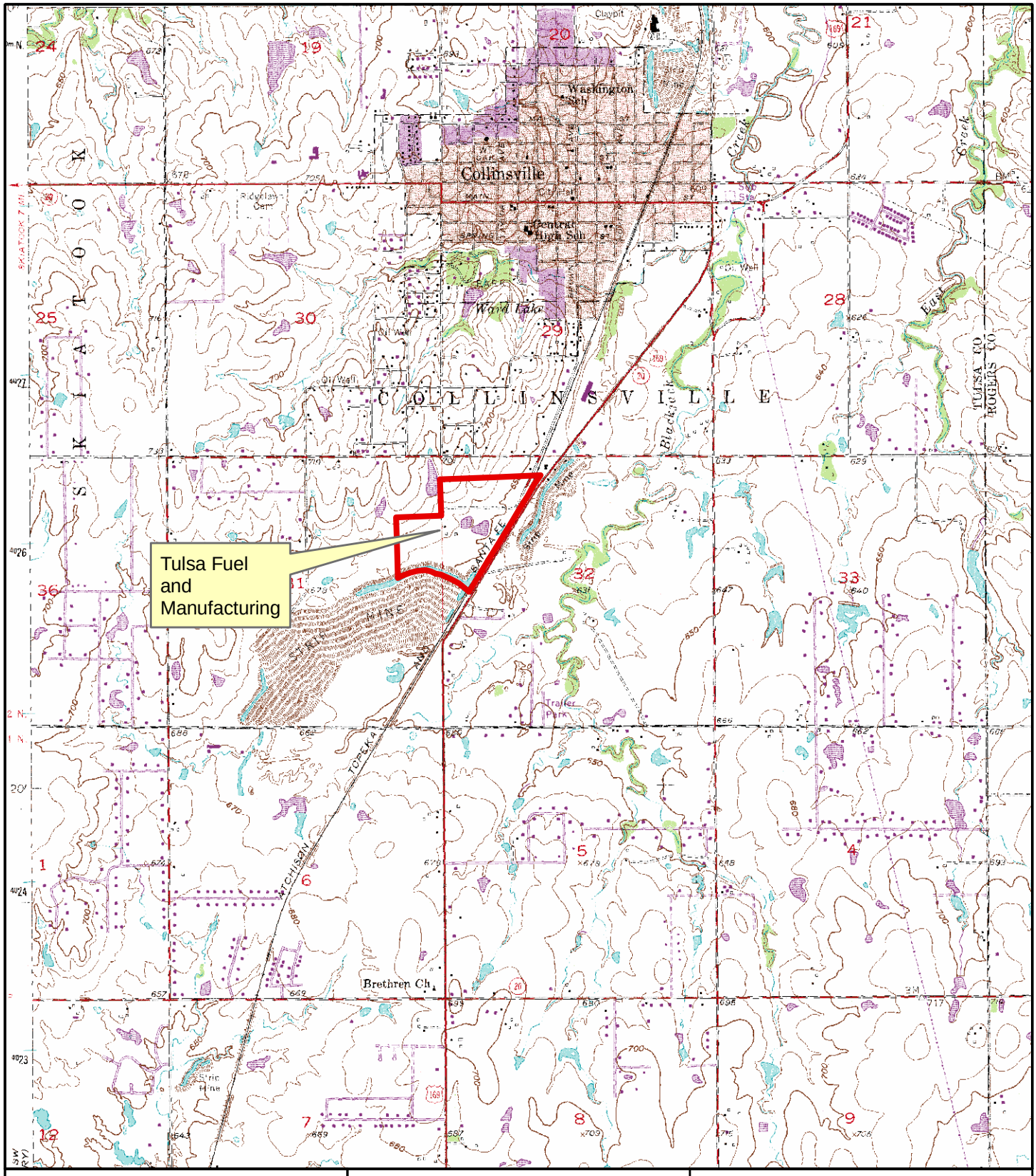
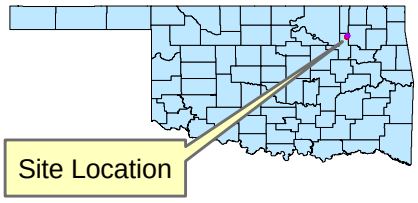


Key Map



Legend

Site Boundary

N

0 1,000 2,000
Feet

Source: USGS 7.5 Minute Topographic Map, Collinsville, Oklahoma.1980

Figure 1-1
SITE LOCATION MAP
SUPPLEMENTAL REMEDIAL INVESTIGATION

TULSA FUEL AND MANUFACTURING
Collinsville,OK

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Assembly Church. The site covers approximately 60 acres of land comprised of native grasses, open pastures, and wooded areas. A locked, chain-link fence surrounds the main entrance to the site, which is located off of N. 119th E. Ave., immediately south of the Faith Assembly Church. Although the site has a locked and gated entrance, the chain-link fence does not enclose the entire site. Visual evidence of trespassing on the site is apparent.

1.1.2 Site History

The site originated as a zinc-smelting and lead-roasting facility in 1914. It was in operation from 1914 through 1925 and helped meet the demand for zinc production during World War I. The smelting operation used nine furnaces, a mechanical kiln, condensers, an onsite laboratory, and a smokestack. A two-million gallon capacity reservoir was used with the condenser room during smelting operations (**Burns & McDonnell, 2007**). Although a majority of the site's structures have been demolished, many foundational supports and footings remain.

During operation, large amounts of ore were stored onsite, northeast of the operational area, according to historical documents. Portions of the site currently are covered with smelter waste, consisting of broken retorts and condensers, slag, building debris, ash, bricks, and other materials associated with smelting operations. An estimated 200,000 cubic yards of smelter waste remains onsite (**ODEQ, 2007**).

A residential property occupied the site from 1935 until February 2002, when a fire destroyed it. A single water well associated with the residence is still located onsite, but is no longer in use. No other residential structures are located onsite; however, a garage and a few storage sheds remain adjacent to the former residence (**Burns & McDonnell, 2007**).

The zinc-smelting and lead-roasting facility ceased operations in the late 1920s and the site has since remained relatively dormant. A local newspaper article from 1936 indicates that the only other known activity associated with the site was the temporary placement of a rock crusher onsite, which was used to manufacture road base for local area roads (**Burns & McDonnell, 2007**).

1.2 Previous Investigations

This section briefly identifies the scope, findings, and conclusions of previous investigations conducted at the site. A comprehensive explanation of each of the following investigations is provided in the final investigation report for each investigation. Previous investigations of the site include a preliminary assessment (PA) in 1992 by the former Oklahoma State Department of Health (OSDH), now known as ODEQ; a site inspection (SI) by ODEQ in 1994; an EPA removal assessment in 1999; a public health assessment by the Agency for Toxic Substances and Disease Registry (ATSDR) in 2000; and an RI by ODEQ in 2007.

1.2.1 OSDH 1992 Preliminary Assessment

In 1992, OSDH conducted a PA of the site, which at the time was identified as the Acme Brick Strip Mine. The PA was designed to determine if the waste associated with the site posed any threat to public health or the environment, and to collect sufficient information to support a decision regarding the need for further action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act of 1986 (SARA). Field work associated with the PA included a review of historical documents, an interview with existing property owners, and an onsite visit (**Burns & McDonnell, 2007**).

No environmental media samples were collected or submitted for analysis during this investigation. Based on the observations made during the onsite visit, assessments were made for groundwater, surface water, soil, and air (**OSDA, 1992**) and included the following findings:

- Because of the large amount of onsite smelter residue and waste and the unknown depth of the waste, groundwater in the vicinity of the site may have been impacted.
- Surface water has the potential for contamination because of the high potential for runoff onsite and offsite.
- Onsite soil contamination appears widespread, and human exposure to contaminated soil exists.
- Because site operations involved smelting at a time when emission standards did not exist, suspended particles may have been deposited on to areas surrounding the site.

- Onsite waste is evident at the ground surface (i.e., lack of vegetation or other cover).

Results of the PA were presented in the *Preliminary Assessment Report for Acme Brick Strip Mines – Collinsville, Oklahoma* (**OSDH, 1992**).

1.2.2 ODEQ 1994 Site Inspection

In 1994, ODEQ conducted an SI of the site. The SI was designed to characterize and evaluate the potential risks associated with possible hazardous substances and to determine whether or not ODEQ should: conduct an expanded SI; propose that the site be placed on the National Priorities List (NPL); propose that the site be assigned a "no further remedial action planned" status; or to refer the site to the EPA emergency response branch for immediate action (**Burns & McDonnell, 2007**). Field work associated with the SI included: interviewing onsite residents; collecting onsite surface soil, surface water, sediment, waste, and groundwater samples for TAL metals; and collecting background surface soil, surface water, sediment, and groundwater samples.

The aforementioned environmental media were sampled and submitted for analysis during the investigation. Based on the observations made from laboratory data, the following assessments were made for groundwater, surface water, surface soil, sediment and waste piles at the site (**ODEQ, 1994**):

- Results from the onsite groundwater well sampled by ODEQ indicate that TAL metals were below state drinking water standards. Because no metals exceeded drinking water standards, the groundwater migration pathway was not evaluated during the SI.
- Results from the surface water samples indicate that none of the TAL metals exceed raw water values for public and private water supplies listed in the Oklahoma Water Quality Standards; however, barium and cadmium exceeded the primary drinking water standards, and aluminum, iron, and manganese exceeded the recommended secondary water standards for Oklahoma.
- Results from the sediment samples indicate that antimony, arsenic, cadmium, copper, lead, mercury, silver, and zinc all had detections more than three times that of the SI background sample.

- Results from the surface soil samples indicate that arsenic, cadmium, copper, lead, and zinc all had detections more than three times that of the SI background sample.
- Results from the waste pile samples indicate that arsenic, cadmium, cobalt, copper, iron, lead, manganese, nickel, silver, and sodium all had detections more than three times that of the SI background sample. Elevated concentrations of arsenic, cadmium, and lead also indicated that these three metals would fail the toxicity characteristic leaching procedure (TCLP) test.

Results of the SI were presented in the *Site Inspection Report for Tulsa Fuel and Manufacturing* (**ODEQ, 1994**).

1.2.3 EPA 1999 Removal Assessment

In 1999, the EPA, Superfund Technical Assistance Response Team (START), conducted a removal assessment of the site. The removal assessment was designed to determine the extent of onsite contamination. Field work associated with the removal assessment included a site records review, the construction of a site location map, the collection of additional media samples, an aerial survey of the site, and an estimate of the volume of waste onsite.

Environmental media samples were collected and submitted for analysis throughout the duration of the removal assessment. Based on an analysis of the laboratory data, the following conclusions were made (**EPA, 1999**):

- Based on how deep the waste material was buried beneath the ground surface, the report concluded that an estimated 29,588 cubic yards of waste exists at the site, and that the total surface area of the site impacted by lead concentration exceeding 500 parts per million (ppm) was 41.3 acres.

Results of the removal assessment were presented in the *Removal Assessment Report for Tulsa Fuel and Manufacturing* (**EPA, 1999**).

1.2.4 ATSDR 2000 Public Health Assessment

In 2000, the ATSDR conducted a public health assessment for the site to determine if any adverse health effects were possible because of onsite waste material. The ATSDR reviewed the historical sampling data and used the data to make the following determination (**ATSDR, 2000**):

- ATSDR concluded that the site currently does not pose an apparent health hazard to the public because of the public's limited exposure to onsite soils, sediment, and surface water at the site. Results also concluded that frequent, long-term exposure to onsite soil could create a health concern.
- ATSDR did not make an evaluation of the health implications of any offsite contamination because of the limited amount of data.
- ATSDR made the following recommendations: restrict access to the site; assess the extent of the offsite contamination caused by the site; conduct remediation efforts for any future residential exposure; and perform blood-lead tests as a precautionary measure for any young children in the area.

Results of the public health assessment were presented in the *Public Health Assessment for Tulsa Fuel and Manufacturing, Collinsville, Tulsa County, Oklahoma* (**ATSDR, 2000**).

1.2.5 ODEQ 2007 Remedial Investigation

In 2005 to 2006, ODEQ, with the assistance of state contractor Burns & McDonnell, conducted an RI of the site. The RI was designed to characterize potential source areas and to evaluate the nature and extent of potential contaminants that would serve as a basis for producing a risk assessment for the site. Field work associated with the RI included the following sampling activities: collecting onsite surface and subsurface soil and waste samples, collecting a limited number of offsite surface soil samples, and collecting onsite surface water, sediment, ground water, vegetation, and air samples to evaluate current conditions for the site.

The aforementioned environmental media were sampled and submitted for analysis throughout the duration of the RI. Based on the observation made from the laboratory data, the following conclusions were made (**Burns & McDonnell, 2007**):

- Onsite surface soil samples indicate that one or more metals were detected above background levels, and that a majority of the site exhibited soil concentrations that exceeded ODEQ residential preliminary remedial goals (PRGs) in the 0 to 0.5 foot (ft) below ground surface (bgs) interval.

- Onsite subsurface soil samples indicate that one or more metals were detected above background levels. The RI report stated that the precise vertical extent of metal concentrations could not be accurately ascertained because of the high variation of the vertical extent of metal concentrations across the site.
- Waste material was generally first encountered between 0-to-1.0 ft bgs; however, waste was observed as deep as 7 ft bgs. The waste material varied in thickness between 2 to 3 ft. Waste material samples collected at these depth intervals indicated that the samples failed the TCLP test and would therefore be classified as hazardous.
- Offsite soil samples indicated that several residential properties adjacent to the site exhibited metal concentrations exceeding the residential soil screening level. Smelter waste material was also observed at some of these residential properties.
- Surface water and sediment samples for onsite and offsite areas indicate that samples exhibited elevated metal concentrations.
- Groundwater samples indicate that elevated metal concentrations were observed in only one of the eight monitoring wells sampled (that is, MW04 exceeded the screening level for cadmium). Because the groundwater lacked elevated metal concentrations, the RI report concluded that metals had limited impact on the groundwater beneath the site.
- Vegetation samples (i.e., blackberries) collected from onsite and offsite locations indicated elevated metal concentrations; however, since washed blackberries indicated a reduction of overall metal concentrations, it was determined that the blackberry contamination resulted from air dispersion of dust particles rather than from plant uptake.
- Air monitoring samples indicated that upwind and downwind samples were similar. The results indicated the TFM site is not a source of airborne contamination to offsite locations.
- With the additional data, ODEQ, with the assistance of Burns & McDonnell, prepared a BHHRA and BERA for the TFM site.

Results of the RI were presented in the *Remedial Investigation Report for Tulsa Fuel and Manufacturing* (**Burns & McDonnell, 2007**).

1.3 Project Scope and Objectives

The supplemental RI consisted of sampling activities to assess the potential for offsite soil contamination resulting from: 1) the physical transport and placement of site waste as fill material at offsite locations and 2) the dispersion of airborne constituents during the operation of the smelters at the site. The sampling activities primarily included collecting shallow surface soil samples from offsite locations within approximately 2-mile of the site. The samples were collected from residential, rural, and agricultural properties (**CH2M HILL, 2007a**).

The objective of this investigation was to obtain data supplemental to the ODEQ 2007 RI report. The supplemental data was used to assess the potential contamination of soils on offsite properties. The field activities required to support these objectives included the following activities:

- Collecting and analyzing 1,122 native composite surface soil samples to assess the extent of the usage of site smelter waste as fill material for offsite properties.
- Collecting and analyzing 10 native composite surface soil samples to assess the airborne dispersion of site contaminants during operation of the smelter at the site.

1.4 Report Overview

Section 2 of this report provides a detailed description of the data collection activities. This section includes a breakdown of the data quality objectives, an explanation of pre-sampling activities, a description of field activities and field procedures followed during the collection of soil samples, a summary of the management of investigation-derived waste (IDW), and a description of data validation activities. **Section 3** discusses the physical characteristics of the site and the surrounding investigation area. This section includes a brief description of the topography and surface water features, soils, geology and hydrogeology, meteorology, demography and land use, and ecological conditions associated with the site and surrounding investigation area. **Section 4** discusses the nature and extent of contaminants based on the results obtained from the data collected during field activities for the supplemental RI. This section identifies the contaminants and discusses the distribution of the contaminants in the vicinity of the site. **Section 5** discusses the contaminant's fate and

ability to be transported between environmental media. This section identifies the physical and chemical nature of the contaminants, identifies potential migrations routes that contaminants may take, and identifies potential contaminant exposure pathways. **Section 6** provides a summary of the report and the conclusions of the supplemental RI. **Section 7** list the references cited in this report.

Section 2
Data Collection Activities

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SECTION 2

Data Collection Activities

This section describes the objectives and procedures for the field activities associated with the supplemental RI. It also reviews the RI's data quality objectives (DQOs); addresses the various pre-sampling activities; describes the field work performed at the site; summarizes the management of the IDW; and identifies the data validation activities.

2.1 Data Quality Objectives

DQOs help ensure that that the project data collected during the field investigation will be of sufficient and adequate quality for their intended use. Project DQOs were developed following the seven-step process described in the EPA QA/G4 guidance (**EPA, 2006**) and are detailed below.

Step 1: State the Problem

Historical operation of the smelter may have distributed heavy metals into the surrounding surface soil by means of aerial deposition. Additionally, residents may have inadvertently distributed smelter waste when the material was used as fill, road base, or other uses.

Step 2: Identify the Decision

The goal of this project is to supplement the data collected in previous investigations to further characterize the extent of metals contamination in offsite soil and to support the development of a record of decision (ROD). To successfully complete these goals, several questions need to be answered:

- Are arsenic, cadmium, lead, or zinc present in soils surrounding the site a result of aerial deposition or a result of offsite transport and use of smelter waste?
- Do concentrations of the previously mentioned metals exceed background concentration values?
- Do concentrations of those metals exceed ODEQ residential PRGs, and therefore potentially pose risk to human health or the environment?

Step 3: Identify Inputs to the Decision

Inputs used to make the decisions include:

- Historical information and data obtained from previous investigations provided data regarding the site and helped focus the sampling and analysis plan.
- New analytical results for soil samples were obtained during this project to assess the extent of metals contamination.
- Results from an AERMOD dispersion model of this report were used to select sampling locations to assess aerial dispersion (**Section 2.2.1**).
- Analytical data from soil samples were compared to background metal concentrations to assess if contamination exists.
- Analytical data from soil samples were compared to ODEQ residential PRGs to assess whether escalated metal concentrations pose a potential risk to human health and/or the environment.

Step 4: Define the Boundaries of the Study

Section 1 of this report describes the geographical boundaries of the site. Sampling activities occurred within a 2-mile radius of the site in a manner consistent with the previous sampling investigations ODEQ conducted. Only soil samples were collected during this investigation.

Aerial dispersion sampling included the collection and analysis of surface soil samples collected at increasing distances from the site, along radii from the site, were based on the AERMOD dispersion model. Whenever possible, sample locations were positioned in areas likely to be undisturbed (such as old residential properties or pasture areas). Because aerial deposits would be expected to be located primarily at or near the surface, soil samples were collected from a depth interval of 0-to-3-inches bgs to evaluate the air dispersion of metal particulates.

Samples were analyzed for four TAL metals arsenic, cadmium, lead, and zinc. All analytical data were obtained using EPA-approved methods that provided detection limits below the EPA Region 6 medium-specific screening levels (MSSLs). The environmental services

assistance team (ESAT), an independent contractor overseen by the EPA, validated analytical data for quality in accordance with EPA's *National Functional Guidelines for Inorganic Data Review*.

Step 5: Develop Decision Rules

If a sample exhibited metal concentrations exceeding its respective background levels, its location was recorded as potentially contaminated. If a sample exhibited metal concentrations exceeding its respective MSSL, its location was recorded as potentially contaminated at levels that could pose a risk to human health or the environment.

Step 6: Specify Limits on Decision Errors

Random and/or systematic errors could have been introduced during sample collection, handling, storage, analysis, data reduction, and data reporting. Errors introduced during these stages of data acquisition could in turn have led to decision errors. Two types of decision errors are possible—false positive errors (Type I) and false negative errors (Type II). In this project, a false positive error would occur if it were determined that a sample location contained metals at concentrations exceeding EPA Region 6 MSSLs when in fact it did not (i.e., because of faulty data). A false negative error would occur if it were determined that a sample location did not contain metals at concentrations exceeding EPA Region 6 MSSLs when in fact it did.

While the possibility of a decision error could not be eliminated, it was minimized by adhering to the quality assurance/quality control (QA/QC) measures specified in the quality assurance project plan (QAPP) (**CH2M HILL, 2007c**) and in the standard operating procedures (SOPs) specified in the field sampling plan (FSP) (**CH2M HIL, 2007a**). Samples were properly prepared before analysis (that is, oven-dried and sieved through a number [no.] 60 mesh sieve then acid-digested) and analyzed according to EPA-approved methodology (that is, inductively coupled plasma-atomic emission spectroscopy in accordance with the EPA contract laboratory program's [CLP] Statement of Work ILM05.4). Analytical data obtained during this investigation were validated using the review criteria, and the discovered limits presented in the EPA's *National Functional Guidelines for Inorganic Data Review* to confirm that data quality achieved project DQOs and that invalid data was not used for project decisions.

Step 7: Optimize the Design

Several modifications were made to optimize the overall design of the investigation. Historical information collected in previous investigations allowed the metals TAL to be reduced to just four primary metals of concern—arsenic, cadmium, lead, and zinc. Additionally, efforts were made to sample a higher percentage of the older properties (30-to-50-year-old residential buildings) and properties close to the site (within a 1-mile radius) as these residential properties were assumed to be the most likely to exhibit metals contamination. To assess the possible aerial deposition of metal particulates, the sampling interval was confined to 0-to-3-inches bgs since metals deposited by atmospheric dispersion were expected to collect near the surface and because collecting deeper soil along with the surface soil may have resulted in the dilution of deposited metals in the sample.

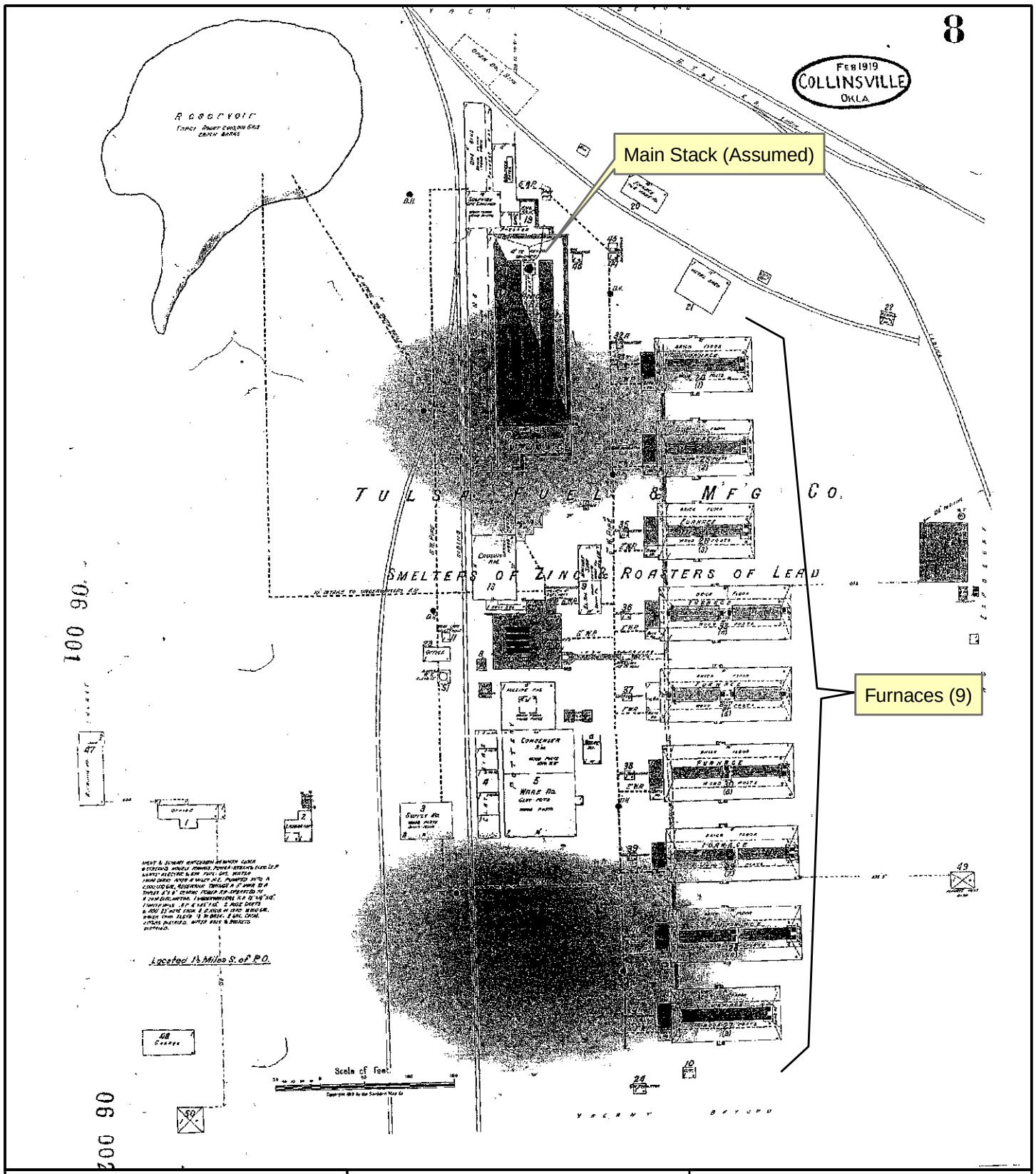
2.2 Pre-Sampling Activities

Sampling activities were initiated on November 27, 2007. Prior to the aforementioned date, two activities were performed from November 12 to 17, 2007:

- Developing an air dispersion model to guide in the selection of soil sample locations
- Collecting signed access agreements to permit CH2M HILL as EPA's representative onto residential properties for the collection of soil samples

2.2.1 Air Dispersion Modeling

A deposition modeling analysis was performed to support the identification of soil sampling locations in the vicinity of the site. This modeling analysis was described in detail in the *Technical Memorandum – Air Dispersion Modeling for Tulsa Fuel and Manufacturing* completed in November 2007 (**CH2M HILL, 2007b**). For this analysis, a review of the RI report (**Burns & McDonnell, 2007**) provided a basic site layout detailing the facility's orientation (nine furnaces, facing from east to west). The location of the smokestack was not identified in the RI report; however, other records indicated that the smokestack was 120 feet (36.57 meters) tall and 11 feet (3.35 meters) across. These dimensions correlate to a similar feature on the 1919 Sanborn fire map that indicates a stack location consistent with an operation of this type and vintage (**Burns & McDonnell, 2007**). **Figure 2-1** depicts the Sanborn fire map, annotated to illustrate the furnaces and assumed smokestack location.



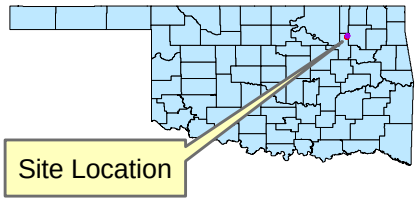


Figure 2-1
Locations of Sources
Source: Sanborn Fire Insurance Map, February 1919
SUPPLEMENTAL REMEDIAL INVESTIGATION

TULSA FUEL AND MANUFACTURING
Collinsville,OK

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Available information regarding the operational history of the facility was limited to the period of operation and approximate locations of sources. Characteristics of the smokestack (i.e, height and diameter) were identified in the RI, but details concerning furnaces (e.g., roof vent height and configuration) were not available. Other information that was not available included particle-size distribution, exhaust temperatures, velocities, and emissions rates (**CH2M HILL, 2007b**).

Given the limited amount of information available, the air dispersion model was based on the identification of the most likely areas where particulate matter (PM) emissions would be deposited proximal to the site based on (**CH2M HILL, 2007b**):

- Local meteorology (i.e., prevailing wind speeds and directions)
- Stack parameters identified in the RI (furnace building locations, smokestack height and diameter) assumed smokestack location
- Assumed variables stack parameters (i.e., temperature and velocity) based on engineering judgment and understanding of historical smelter operations
- Assumed PM particle-size distribution (based on EPA AP-42 guidance)
- Assumed relative percentage of smokestack (point) and furnace (fugitive) emissions

Because emission rates were not known for the site, nor the differences in potential operating profile (i.e., number of furnaces operating or production rate changes), the model was based on assuming a constant emission rate during the period of operation. For modeling purposes, an assumed emission rate of 1 gram per second (g/s) was assumed for both the smokestack point source and fugitive emissions from the collection of nine furnaces. The furnaces were modeled as volume sources, as it is believed the emissions from the building vented through open windows, doors, and vents on top of the building. Through this approach, the relative deposition amount (i.e., the fraction of total emissions from an assumed emission source) was estimated without having to detail the actual emission rate or amount deposited. This information was then used to identify the areas most likely to have been impacted by an emissions source (**CH2M HILL, 2007b**).

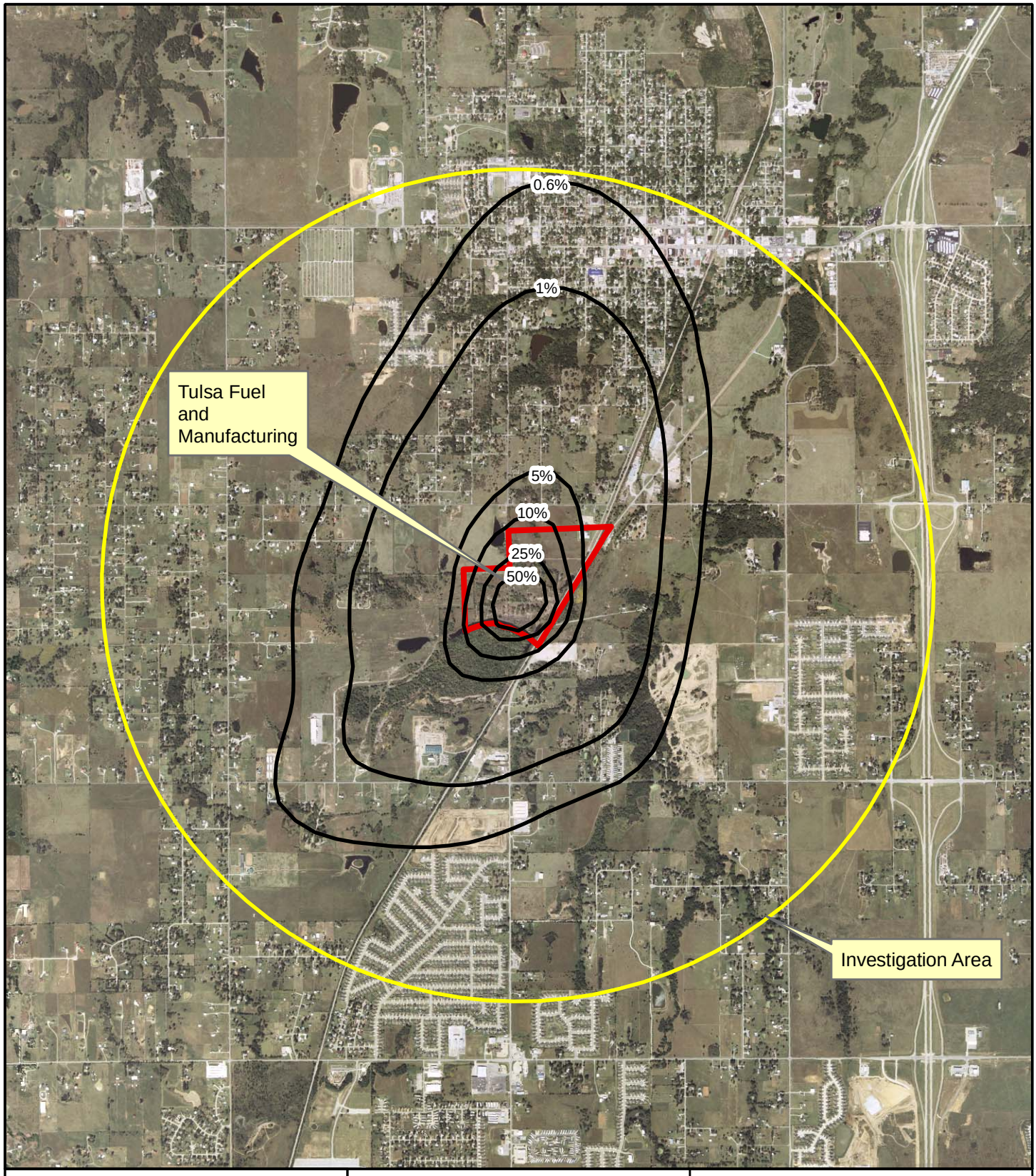
The modeling analysis included one point source and nine volume sources that represented the smokestack and nine furnace buildings. The source parameters were based on the RI

report for the smokestack's height and diameter, and the best engineering judgment for stack temperature and velocity and roof vent height and building configuration. Selection for unidentified parameters was based on comprehension of historical smelter operation.

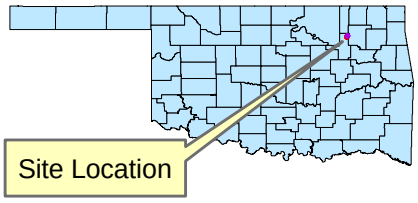
Figure 2-2 depicts the results of the air deposition analysis as contour plots. These contour plots present the expected deposition as a percentage of the maximum amount of deposition in a given area. While the plot provides equal weight to the stack and fugitive emissions, the impact from the nine furnaces occur closer to the plant site than the impacts from the smokestack occurring further downwind. As indicated by the concentric curves surrounding the former plant location, the greatest deposition expected was on or very near the plant site. The plots indicate that deposition would be most likely to occur to the north of the site. At the northern edge of the investigation area (that is, the 1.5-mile radius circle surrounding the site), modeled deposition is estimated at 0.6 percent of the maximum modeled deposition location, or the maximum location near the former facility.

This analysis was performed based on limited data concerning operation of the site. The following points should be recognized concerning the results (**CH2M HILL, 2007b**):

- Actual magnitude of deposition was not modeled; the results are intended to identify areas most likely to be impacted by deposition on a relative basis, and thus guide soil sampling efforts.
- Results are based on an assumption that the facility operated continuously (365 days per year), at a constant operating rate (constant emission rate) under weather conditions comparable to those between the years 2001 and 2005. Impacts of variations in seasonality of operations, production rates, or emission rates cannot be predicted using information available.
- The relative 50/50 split between smokestack (point source) and the nine furnaces (fugitive sources) is assumed. Variations in the split (e.g., 25/75 stack/furnace, 75/25 stack/furnace) also were considered, but indicated that the general shape of the depositional area is consistent, and that contour plots are oriented similarly, with the greatest extent to the north and south of the site.



Key Map



Legend

Site Boundary

1.5 Mile Buffer Investigation Area

Isopleth Contour

N

0 1,000 2,000 Feet

Note: Contours represent % of maximum modeled deposition.

Figure 2-2
Modeled Air Deposition Distribution
SUPPLEMENTAL REMEDIAL INVESTIGATION

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- Wet deposition associated with precipitation events was not evaluated. When it rained, pollutants would be scavenged from the plume and deposited closer to the plant site rather than be transported downwind.

The air dispersion model results, provided in **Appendix A**, indicated that a majority of air dispersion samples should be collected from properties north to northeast and south to southwest of the site.

2.2.2 Access Agreements

Access agreements were required prior to entry on to any private property for the purpose of collecting soil samples. ODEQ obtained a limited number of access agreements during previous investigation activities and the ongoing outreach program. CH2M HILL attempted to collect additional access agreements on EPA's behalf for properties within the initial 1.5-mile investigation area. Property owners who were contacted for access requests were identified primarily through either response to notices that ODEQ published in the local newspaper requesting voluntary public participation in the sampling program, or by direct contact with property owners (**CH2M HILL, 2007a**).

CH2M HILL facilitated EPA's collection of additional access agreements through phone calls or by direct contact (i.e., CH2M HILL personnel walking door to door). The properties to be sampled were selected based on proximity to the site, age of the house and/or subdivision, and accessibility to the property (i.e., absence of locked fence and/or aggressive dogs). Property owners were asked if they would consent to EPA's collection of multiple soil samples from their property. Property owners who granted access to their properties signed and dated an EPA access agreement (**Figure 2-3**). CH2M HILL then submitted the sample locations to the EPA for approval before initiating field work.

Access agreements were obtained from 184 residential property owners within and around the investigation area from November 12 to 17, 2007. As directed by the EPA, access agreements were not initially collected from residential properties east of the Atchinson Topeka and Santa Fe railroad tracks; therefore some of the 184 access agreements were obtained outside of the original 1.5-mile investigation area. **Figure 2-4** illustrates the locations of signed access agreements.

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United States Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

CONSENT FOR ENTRY AND ACCESS TO PROPERTY

Address and description of property for which consent to access is granted:

Address of Property: _____

Description of Property: _____

_____

Mailing Address of Owner _____

I hereby consent, to the officers, employees and parties authorized by the United States Environmental Protection Agency (EPA) entering and having continued access to the property described above at reasonable times for the following purposes:

- The taking of the necessary soil, water, and air samples for the purpose of investigation the degree of contamination related to historical smelting operations and the taking of photographs to record the sampling process.

I realize that these actions are undertaken pursuant to EPA's response and enforcement responsibilities under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S. C. Section 9601-9675.

I hereby agree to waive my privacy rights concerning the environmental data and associated property address as covered by the Privacy Act, 5 U.S.C 522a, gathered by the officers, employees, and parties authorized by EPA, and I permit EPA to disclose this environmental data and associated property address information to the public. I understand that my name will not be released as part of this finding.

I hereby warrant that I have the authority to make this access agreement.

This written permission is given voluntarily by me with knowledge of my right to refuse and without threats or promises of any kind.

Owner Signature	Date
Owner Printed Name	Telephone Number
Name of Signatory	Relationship of Signatory to Property
Address of Signatory	Telephone of Signatory

White Copy - EPA Property File | Yellow - CH2M HILL Copy | Pink - Owner's Copy

FORM NAME CH2MHILL PACF | REVISION NUMBER 3 | APRIL 12, 2005

Source: USEPA Region VI

Figure 2-3
ACCESS AGREEMENT FORM
SUPPLEMENTAL REMEDIAL INVESTIGATION

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Collinsville,OK

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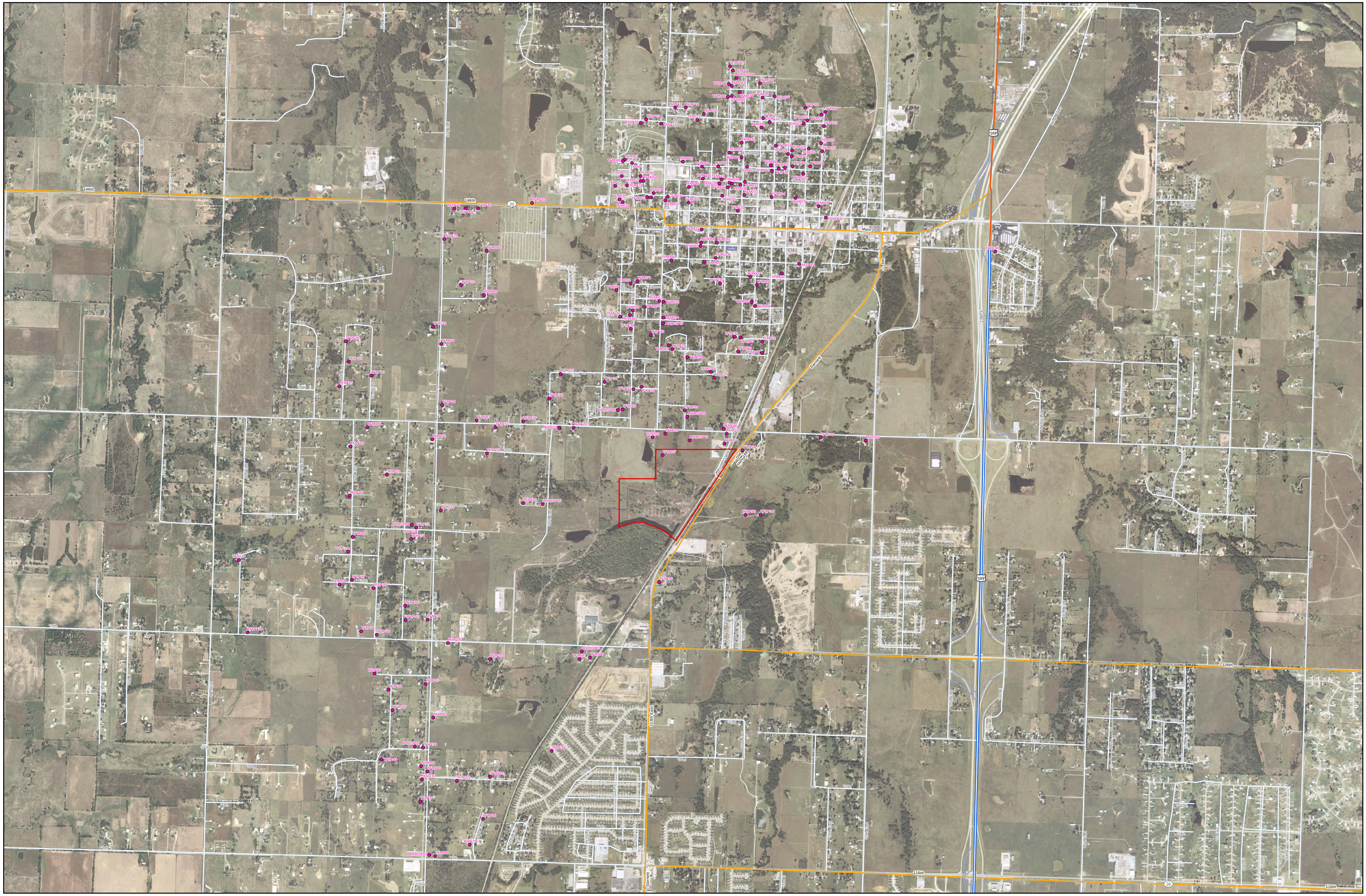

TFM Location

TFM Site Location

N

0 1,000 2,000 3,000 4,000 Feet

Figure 2-4
SIGNED ACCESS AGREEMENT LOCATIONS AND TFMS
SUPPLEMENTAL REMEDIAL INVESTIGATION

TULSA FUEL AND MANUFACTURING
Collinsville,OK

CH2MHILL

DATE: 2/13/2008

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An additional 21 signed access agreements were obtained from November 27, 2007, to January 8, 2008, while the sampling event was ongoing. Updated sampling locations were forwarded to the EPA for approval, as additional access agreements were obtained. A total of 205 property owners granted access to their properties. **Appendix C** provides a list of all offsite sampling properties and associated addresses. Inclusion of property addresses is specifically permitted by the access agreements (**Figure 2-3**).

2.3 Field Investigation Activities

This section describes the field investigation activities associated with collecting residential soil samples and air dispersion soil samples.

2.3.1 Residential Soil Sampling

Approximately 1,300 residential soil samples (native and QA/QC samples) were collected from 201 residential properties from November 26, 2007, to January 8, 2008, to assess the extent of the usage of site smelter waste as fill material for offsite properties. The following field activities were conducted during the collection of these residential soil samples.

Sampling of Residential Properties

Between one to four areas were sampled using stainless steel hand augers on each residential property. The number of sample areas depended on the layout of each property. Typically samples were collected from the front, back, or side yards, and from gravel driveways (if applicable and if possible). Each sample area was given a unique TFM number and station location identification number corresponding to the sample area on the property (i.e., TFM001-FY). The FY designation, for example, identified that the sample came from the front yard of the residential property. Some sample areas were modified or not collected at certain residential properties because of locked gates and/or aggressive dogs. As a result of these situations, some sample area labels do not adhere to the aforementioned labeling system.

Typically, soil samples were collected from two depth intervals for each sample area at any given property; only when the hand auger encountered refusal was only one sample depth collected from a sample area. The first sample was collected from the 0-to-6-inch depth interval and the second sample was collected from the 6-to-12-inch depth interval. The

composite samples were collected from an area comprising approximately 2,500 square feet. In general, the sampling areas were visually approximated at 50-by-50 feet; however, the dimensions were adjusted to match the layout of the property and maximize the number of samples that could be collected from the property. Locations adjacent to roadways or within structural drip lines were avoided whenever possible.

Each soil sample was prepared as a five-point composite. Each sample aliquot collection point was prepared by clearing vegetation, rocks, debris, and other materials from an area 3-inch square in size. If a sample aliquot collection point was within a lawn area, the grass was removed from the collection point, set aside, and replaced after sample collection.

Sample aliquots were collected from each of the collection point locations at depths of 0-to 6-inches and 6-to-12-inches bgs using a stainless steel hand auger. Soil aliquots from the same depth interval for each sample area were then placed into a stainless steel bowl that was covered with aluminum foil. Once all five sample aliquot points were collected, the soil was mixed in the stainless steel bowl to homogenize the sample.

The soil was then transferred into an appropriate laboratory-supplied sample container. The depth interval was added to the station location ID (i.e., TFM001-FY-0612), which identified that the sample was collected from the 6-to-12-inch depth interval in the front yard of TFM 001, and given a unique EPA CLP sample ID (MF2J17). The soil samples were not sieved in the field prior to placement in the containers; however, the samples were sieved in the laboratory prior to analysis. The filled sample containers were properly labeled according to EPA CLP procedures, placed into an ice-cooled chest, and shipped to a designated analytical laboratory.

After completing each soil sample collection, the excavated holes were filled to the extent possible using excess soil removed from the excavation. If additional soil was needed to fill the excavation to ground level, commercially purchased topsoil was used. The excess soil was compacted as necessary to prevent settling. In lawn areas, the grass removed during location preparation was replaced to the extent possible and tamped back into place. The stainless steel hand augers were decontaminated after each sampling depth interval, and the aluminum foil that covered the stainless steel bowl was removed and replaced with new foil to prevent cross contamination.

Sample Location Coordinates

After collecting samples at each sample area, CH2M HILL recorded the central location of the individual residential property soil composite sample points using field portable global positioning system (GPS) equipment. The universal transverse mercator (UTM) coordinates were measured from the center point of the sample collection area (i.e., the center point of the five-point composite), and recorded on to the field sampling data log sheets and in the field book.

Sample Location Photographs

Two photographs were taken for each sample area for each residential property. The first photograph identified the individual sample area within the residential property, and the second photograph identified the location of the five collection points. The specific details (i.e., photograph number, direction photo was taken, and time photograph was taken) of each photograph were recorded on to a daily photograph log sheet for one of the two digital cameras used during the field investigation. **Appendix C** provides all sample location photographs and corresponding photo log sheets.

Sample Documentation

A field sampling data log sheet (**Figure 2-5**) was completed for each residential soil sample collected during the field investigation. Information recorded on the field sample data log sheet included: name of sampler, property address, station location ID, sample ID, sample depth, GPS coordinates, date and time, media sampled, equipment used, analysis requested, collection method, number of photographs collected, and a rough sketch of the property along with sample collection points. Sample specific information—including the property address, station location ID, GPS coordinates, sample ID, sample depth, date and time, and number of photographs collected—also were recorded in the field log book. **Appendix D** provides all field sampling data log sheets collected during the field sampling event.

Sample Analysis

CH2M HILL submitted soil samples to Bonner and Chemtech, one of two offsite, fixed-base EPA CLP analysis laboratories. CLP protocols were used to ship and document the samples, and FORMS II Lite software was used to create the sample labels and traffic reports (TRs).

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Field Sampling Data Log Sheet

(Solid Media)

Tulsa Fuel and Manufacturing Site, Supplemental RI
Collinsville, OK
CH2M HILL Project No: 365672

Sampler(s): _____

Location: _____ Grid ID: _____

Station ID: _____

GPS Coordinates: Northing - _____ Easting - _____

Township/Range/Section: _____

Sample Information

Sample ID: _____ Date/Time of Sample Collection: _____

Media Sampled: _____ _____

Equipment Used: _____

Analysis Requested: TAL Metals: _____ Geotechnical: _____

Other: _____

QA/QC Samples: Duplicate MS/MSD Rinsate Other: _____

Is This Sample a Split of a PRP Sample: Yes No PRP Sample ID: _____

Sample Depth: _____

Collection Method: Composite Grab

(If sample is a composite, sketch grid with composite locations under comments below)

Other Data

Soil pH (for plant samples only): _____

Grain Size (gravel, sand, silt, or clay): _____

Texture : _____

Moisture Content (wet, moist, or dry): _____

Color: _____

Photographs collected (Yes / No): _____

Comments:

Tulsa Fuel FSP AppA_FieldForms.xls MAY 2005

Figure 2-5
FIELD SAMPLING DATA LOG SHEET
SUPPLEMENTAL REMEDIAL INVESTIGATION
TULSA FUEL AND MANUFACTURING
Collinsville,OK

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Samples were analyzed for arsenic, cadmium, lead, and zinc using CLP ILM05.4 SOW for inorganic analysis and then shipped by overnight courier according to EPA CLP shipping procedure.

Field Quality Control Sample Collection and Analysis

CH2M HILL collected QA/QC samples for residential soil samples as described in **Section 2.5.1** of the QAPP. QA/QC samples collected during the residential soil sampling event included field duplicates (FDs), equipment rinsate blanks (ERBs), and matrix spikes and matrix spike duplicates (MSs/MSDs). FD samples were collected at a rate of one for every 10 native samples, ERB samples were collected at a rate of one per every day of sampling, and MS/MSD samples were collected at a rate of one for every 20 native samples.

2.3.2 Air Dispersion Sampling

A total of 13 air dispersion soil samples (10 native and 3 QA/QC samples) were collected from 10 different undisturbed areas on January 07, 2008, to assess the airborne dispersion of site contaminants during operation of the smelter at the site. The following field activities were conducted during the collection of air dispersion samples.

Sample Collection

The objective of the aerial dispersion sampling activities was to assess the potential for surface soil impact resulting from the deposition of heavy metals from air emissions generated during the smelter's operation. Because the air dispersion modeling results indicated that the most probable areas of distribution were north-northeast and south-southwest of the site, the field team members collected five native air dispersion samples north of the site and five native air dispersion samples south of the site.

The sample areas selected were areas historically undisturbed (mainly pre-1920 residential properties and pasture areas). At each sample area, a five-point composite soil sample was collected from a maximum sampling area of 2,500 square feet. Locations adjacent to roadways or within drip lines of structures were avoided.

Each sample aliquot collection point was prepared by clearing vegetation, rocks, debris, and other materials from an approximately 3-inch square area, prior to the composite sample collection. Because of the desired shallow sampling depth interval (0-to-3-inches bgs), soil

held by the roots of the vegetation was separated and retained for inclusion in the sample. If the collection point was within a lawn area, the grass removed from the sample collection point was replaced after sample collection. Soil aliquots were then placed into a stainless steel bowl that was covered with aluminum foil. Once all five sample aliquot points were collected, the soil was mixed in the stainless steel bowl to homogenize the sample.

The soil was then transferred into an appropriate laboratory-supplied sample container. Each sample area was given a unique station location ID (such as AIRDISP01) and a unique EPA CLP sample ID (i.e., MF2J82). The soil samples were not sieved in the field prior to placement into the containers; however, the samples were sieved in the laboratory prior to analysis. The filled sample containers were then properly labeled according to EPA CLP procedures, placed into an ice-cooled chest, and shipped to a designated analytical laboratory.

After completing each soil sample collection, the excavated holes were filled to the extent possible using excess soil removed from the excavation. If additional soil was needed to fill the excavation to ground level, commercially purchased topsoil was used. The excess soil was compacted as necessary to prevent settling. In lawn areas, the grass removed during location preparation was replaced to the extent possible and tamped back into place. Additionally, the hand augers were decontaminated after each sampling depth interval, and the aluminum foil that covered the stainless steel bowl was removed and replaced with clean aluminum foil to prevent cross contamination.

Sample Location Coordinates

After collecting samples at each sample area, CH2M HILL recorded the central location of the air dispersion soil sample collection points using field portable GPS equipment. The UTM coordinates were measured from the center point of the sample collection area (that is, the center point of the five-point composite). The UTM coordinates were recorded onto the field sampling data log sheets and in the field book.

Sample Location Photographs

Two photographs were taken for each location selected for the collection of an air dispersion sample. The first photograph identified the general sample area and the second photograph identified the location of the five collection points. The specific details of each photograph—

such as ID number, direction taken, and time taken—were logged on to a daily photograph log sheet for one of the two digital cameras used during the field investigation. **Appendix C** provides all sample photographs and corresponding photo log sheets.

Sample Documentation

A field sampling data log sheet (**Figure 2-5**) was filled out for each air dispersion sample container collected during the field investigation. Information recorded on the field sample data log sheet included sampler's name, property address, station location ID, sample ID, GPS coordinates, sample depth, date and time, media sampled, equipment used, analysis requested, collection method, number of photographs collected, and a rough sketch of the property along with the sample collection points. Sample specific information including property address, station location ID, sample ID, GPS coordinates, sample depth, date and time, and number of photographs also were recorded in the field log book. **Appendix D** includes all field sampling data log sheets collect during the field sampling event.

Sample Analysis

The air dispersion samples were submitted to one of the two offsite, fixed-base laboratories for analysis. The air dispersion samples were sent to the same laboratories as the residential soil samples. CLP protocols were used for the shipment and documentation of the samples; FORMS II Lite software was used to create the sample labels and TR and then shipped by overnight courier in accordance with CLP shipping procedures. Each sample was analyzed for arsenic, cadmium, lead, and zinc using CLP ILM05.4 SOW for inorganic analysis.

Field Quality Control Sample Collection and Analysis

QA/QC samples were collected for air dispersion samples as described in **Section 2.5.1** of the QAPP. QA/QC samples collected during the soil sampling event included FD, ERB, and MS/MSD. FD samples were collected at a rate of one for every 10 native samples; ERB samples were collected at a rate of one per every day of sampling; and MS/MSD samples were collected at a rate of one for every 20 native samples.

2.4 Management of Investigation-Derived Wastes

All IDW generated during field work were placed into three Department of Transportation (DOT)-approved, steel 55-gallon drums situated on a pallet at the designated staging area

onsite. Because all unused excavated soil was used as backfill, the only IDW generated during field sampling was water, which was used to decontaminate sampling equipment. IDW drums were filled to only two-thirds of total capacity to avoid excessive weight.

To characterize the waste, one composite sample of decontamination water was collected from the three IDW drums. The composite IDW sample was then submitted to Accutest, an approved analytical laboratory, for extraction by the TCLP SW-846 Method 1311 followed by analysis for TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) by SW-846 Methods 6010B and 7470A. All analytical data relating to IDW generated during the field investigation is provided in Appendix E.

Analytical results from the approved analytical laboratory indicated that all TCLP metals were well below RCRA hazardous waste limits. The aqueous liquid inside the IDW drums was poured onto the ground onsite in accordance with the EPA's Office of Solid Waste and Emergency Response document *Guide to Management of Investigation-Derived Wastes – Publication 9345.3-03FS* dated January 1992. The drums were then properly disposed offsite.

2.5 Data Validation Activities

All samples collected by CH2M HILL for this project were analyzed by EPA CLP laboratories; ESAT validated the resulting data in accordance with the review criteria and limits presented in the EPA's *National Functional Guidelines for Inorganic Data Review* to confirm that data quality achieved project DQOs and that invalid data was not used for project decisions.

ESAT-Region 6 data qualifiers were applied during the validation process and are described below.

U The analyte was not detected at the reported quantitation limit

L The reported concentration is between the method detection limit (MDL) and the contract-required quantitation limit (CRQL).

J The result is estimated because of outlying quality control parameters such as matrix spike and serial dilution, or the result is below the CRQL.

R The result was rejected because of serious QC failure, and is therefore unusable.

F A possibility of a false negative exists.

UC The reported concentration should be used as a raised quantitation limit because of blank effects and/or laboratory or field contamination. The result should be considered a non-detect at this raised quantitation limit.

^ High biased. Actual concentration may be lower than the concentration reported.

v Low biased. Actual concentration may be higher than the concentration reported.

W The result should be used with caution. The result was reported on a dry weight basis although the sample did not conform to the EPA Office of Water definition of a soil sample because of its high water content (>70 percent moisture).

Overall, the quality of the analytical data was found to be within project DQOs. No data were rejected, giving the data set a completeness value of 100 percent. All data, including the data qualified by the ESAT data reviewers, may be used to support project decisions

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Section 3
Physical Characteristics of the Site

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SECTION 3

Physical Characteristics of the Site

This section describes the physical characteristics of the TFM site and the surrounding investigation area and includes: the topography and surface water features, soils, geology and hydrogeology, meteorology, demographics and land use, and ecological conditions. A more complete description of the physical site characteristics is provided in the 2007 ODEQ RI report.

3.1 Topography and Surface Water Features

The site and the surrounding investigation area consist of gently rolling hills, composed of a mixture of native grasses and timber with small gullies and ravines that are predominantly covered by timber. The site and surrounding investigation area topography is generally flat, with an elevation of approximately 650 ft above mean sea level (msl) elevation at the site; within a 1-mile radius of the site the elevations ranges from 620 to 740 ft msl.

The OSDH 1992 PA report indicates that the site consists of about 50 acres; however, the ODEQ 2007 RI report indicates that the site actually consists of approximately 60.7 acres (**Figure 3-1**). Of the 60.7 acres, ODEQ 2007 RI report estimates that about 25 acres of surface is covered, to varying degrees, with smelter waste material such as broken retorts, slag, building debris, ash, and brick (**ODEQ, 2007**).

Smelter waste material is located onsite, south of the access road/driveway and north of the strip mine impoundment. Portions of this smelter waste material have collapsed into the strip mine impoundment that flows into a drainage ditch, and then into an intermittent stream and finally into Blackjack Creek, located east of the site (**Burns & McDonnell, 2007**). Smelter waste material is also erratically located offsite; retorts and waste material were observed on several residential properties by field team members. Intact retorts also were observed being used as bank stabilization for several creeks that meander through downtown Collinsville (**Table 3-1**).

Three intermittent ponds are located onsite and are assumed to be remnants of the 2 million gallon reservoir located north of the former smelting operational area. The RI report notes

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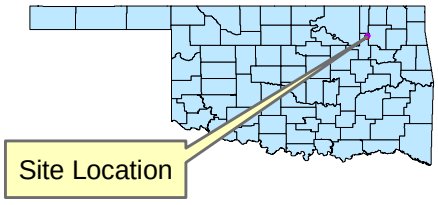
Key Map



Legend

- Residential Well
- Site Boundary
- Former Building
- Wetlands
- Barbed-Wire Fence
- Blackberry Bushes
- Former Railroad
- Hydrography
- Railroad

N

0 1,000 2,000
Feet

Figure 3-1
SITE TOPOGRAPHY AND AERIAL PHOTOGRAPH
SUPPLEMENTAL REMEDIAL INVESTIGATION
TULSA FUEL AND MANUFACTURING
Collinsville,OK

CH2MHILL

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Table 3-1
Visible Smelter Waste Material
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Location	Description
TFM032 - 527 S. 19th St.	Smelter waste used as fill material between house, barn, and lake (barren area)
TFM039 - 1369 N. 115th E. Ave	Retorts located in woods behind residential house
TFM131 - 1609 Main St.	Retorts located in back yard - Retorts used as a retention wall
TFM204 - 13501 N. Old 169	Smelter waste used as fill material all around property
1009 W. Walnut St.	Retorts located along creek - Retorts used as a retention wall
614 N. 13th St.	Retorts located along creek – Retorts used as a retention wall

that one of the intermittent ponds embankments is composed of used retorts (**Burns & McDonnell, 2007**). Two smaller ephemeral ponds are located onsite but outside the historic operational area and appears to develop only after heavy rainfalls. An assessment of surface water features, such as those of lakes and ponds, for the area surrounding the site was not conducted during this investigation or during previous investigations. Overall, the surface drainage for the site and surrounding area is to the north and east with runoff moving towards either Blackjack Creek or Cherry Creek. Both Blackjack Creek and Cherry creek flow into the Caney River, east of downtown Collinsville.

3.2 Soils

Unconsolidated overburden, consisting of silt, clay, silty loam, and shale sediments and residuum lies beneath the site. The unconsolidated overburden is relatively thin and consists of the Kanima Series, the Okemah-Parson-Carytown complex, and the Dennis-Radley complex (**USDA, 1977**).

Soils of the Okemah-Parson-Carytown complex are typically acidic, made up of silty loam to silty clay, and are typically found on slopes that are inclined between 0 to 1 percent. Soils of the Dennis-Radley complex are made up of loamy, clayey sediments that are found on gently sloping uplands and floodplains. The Kanima soils typically have moderate to low permeability, are made up of silty clay loam, and form on slopes that are inclined greater than 3 percent (**USDA, 1977**).

Geologic cross-sections of the site were prepared from boring logs and survey data. The geologic cross-sections depict the depths and locations of soil and waste material at the site, and are available in the 2007 ODEQ RI report.

3.3 Geology and Hydrogeology

The geologic stratum that underlies the site and surrounding investigation area consists of sandstone and shale, with inter-bedded coal deposits of the Pennsylvanian-aged Seminole Formation (**Miser, 1954**). The Seminole Formation is approximately 200-ft thick and is divided into an upper sandstone unit, a middle shale unit, and a basal sandstone unit (**Tulsa Geological Survey, 1972**). The upper sandstone unit is relatively shallow; typically, bedrock is encountered at extremely shallow depths. During the 2007 ODEQ RI, was encountered at a depth of 7.2 to 12.5 ft bgs, and at less than 6 inches bgs at some residential properties during the supplemental RI (rock encountered during field sampling event was presumed to represent the top of the bedrock). Underneath the Seminole Formation is the Pennsylvanian Holdenville Shale, which is composed of shale with minor sandstone and limestone strata.

No major bedrock or alluvial aquifers reside beneath the site. The Seminole Formation reportedly yields small to moderate amounts of fair-to-poor quality water. Private water wells within a 1-mile radius of the site indicate well yields ranging from 1 to 40 gallons per minute (gpm) and at depths between 32 to 200 ft bgs (**Burns & McDonnell, 2007**).

Because no well yield data was available for the onsite residential well, ODEQ installed several temporary piezometers and permanent monitoring wells during the 2007 RI. The monitoring wells and piezometers indicated that groundwater beneath the site is limited but continuous across the entire site. The potentiometric surface maps presented in the RI report indicates that groundwater flows in a south-southeasterly direction.

3.4 Meteorology

Located in northeast Oklahoma, Collinsville primarily has a continental climate, with pronounced daily and seasonal temperature changes. Summers are relatively hot and moderately humid, with average high temperatures in July and August above 90 °F and average low temperatures slightly above 70 ºF during these months. Winters are fairly short

and generally mild, with January typically being the coldest month of the year. The average high temperature in January is 46 ºF, and the average low temperature is 26 ºF (**National Weather Service, 2005**).

Severe weather storms with strong winds, hail, thunder and lightning storms, and tornadoes primarily occur between March and June; however, treacherous ice and snow storms develop between the months of November and February. Since 1888, the average annual rainfall has remained relatively constant at 42.4 inches. May is typically the wettest month of the year, with average monthly rainfall of 6.1 inches (**National Weather Service, 2005**). The record 24-hour rainfall was 9.27 inches and occurred in the month of May. Between 1950 and 2000, 68 tornadoes were reported in Tulsa County, which averages just over one tornado per year (**Oklahoma Climatological Society, 2005**).

Snowfall is infrequent for the area, with an average of approximately 9.2 inches per year. Snowfall primarily occurs from December through March. January has the highest monthly average snowfall of 3 inches (**National Weather Service, 2005**).

Prevailing surface winds, as measured at Tulsa International Airport, blow from the south and average 10.7 miles per hour (mph) (**National Water and Climate Center, 2005**). Winds are variable in the winter months with prevalent winds from the south, south-southeast, north, and north-west directions. Spring winds blow mainly from the south and south-east, and summer and fall winds prevail from the south-southwesterly direction. **Appendix A** provides the analyzed and modeled wind rose data from the Air Dispersion Model.

3.5 Demography and Land Use

The TFM site resides just outside of the city limits of Collinsville, Oklahoma, in Tulsa County, approximately 1.3 miles south of downtown Collinsville. According to the 2000 Census, Collinsville has a population of 4,077, of which 2,650 were over the age of 18 (**United States Census Bureau, 2003**). Collinsville has a total area of about 6 square miles, predominantly occupied by residential and commercial properties. The surrounding area is comprised of rural land used for agriculture, although some dispersed residential properties also reside along the outskirts of town.

3.6 Ecological Conditions

Vegetation at the site and in the investigation area surrounding it is composed of various grass species, trees, and shrubs. Onsite areas are moderately to densely vegetated, sparsely vegetated, or barren of vegetation. Species of wildlife that likely inhabit the site include the bull snake (*Pituphis melanoleucus*), eastern cottontail (*Sylvilagus floridanus*), box turtle (*Terrapene sp*.), common garter snake (*Thamnophis sirtalis*), black rat snake (*Elaphe obsoleta*), racer (*Coluber constrictor*), fox squirrel (*Sciurus niger*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes fulva*), coyote (*Canis latrans*), white-footed moose (*Peromyscus leucopus*), Wood house's toad (*Bufo woodhousei*), white-tailed deer (*Odocoileus virginianus*), killdeer (*Charadrius vociferous*), cooper's hawk (*Accipiter cooperii*), mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), red-winged blackbird (*Agelaius phoeniceus*), barn swallow (*Hirundo rustica*), and scissor-tailed flycatcher (*Tryannus forficatus*). These are common species that are typically found in the areas and that interact with the surrounding vegetation (**Burns & McDonnell, 2007**).

Based on the evidence of hunting in the area, such as bird decoys present at onsite ponds, waterfowl reside on the site at least some time during the year. Verbal testimony from local area residents given during the EPA removal assessment also indicated that catfish and bass inhabit the southern strip mine pit (**EPA, 1999**).

Section 4
Nature and Extent of Contamination

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SECTION 4

Nature and Extent of Contamination

This section discusses the nature and extent of contamination identified at residential properties surrounding the TFM site. The objective of this supplemental RI is to collect sufficient quantitative data to determine if contamination associated with the site has impacted offsite residential properties and areas surrounding the site. This section describes the vertical and horizontal extent of potential constituents of concern (COCs) in residential soil and air dispersion samples. This section also reviews the spatial and temporal trends for the COCs identified from the data.

4.1 Identification of Contaminants

Arsenic, lead, cadmium, and zinc were investigated during the field sampling event that began on November 26, 2007, and ended on January 8, 2008. Both residential soil and air dispersion samples were analyzed for all four COCs. Subsequent sub-sections discuss the laboratory data for residential soil and air dispersion samples and compare the lab data to background concentration levels and ODEQ-designated PRGs.

A literary review was conducted during the 2007 ODEQ RI to identify the background concentration levels for COCs in residential soils for the surrounding region. Background concentration levels for potential COCs for the region were determined to be:

- Arsenic at ranges from 3.4 to 25.3 milligram per kilogram (mg/kg)
- Cadmium at ranges from 0.77 to 5.9 mg/kg
- Lead at ranges from 10 to 379 mg/kg
- Zinc at ranges from 42 to 1,280 mg/kg

ODEQ designated PRGs used to analyze the laboratory data for this investigation in a risk management technical memorandum submitted to the EPA. The risk management technical memorandum indicated the following ODEQ residential PRGs for potential COCs for this project (**ODEQ, 2007**):

- Arsenic residential PRG designated at 37 mg/kg
- Cadmium residential PRG designated at 75 mg/kg
- Lead residential PRG designated at 500 mg/kg
- This report relied on the EPA Region 6 residential soil screening level of 23,000 mg/kg. Zinc was retained as a COC in this report to determine if elevated metals concentrations were related to smelter activities.

Appendix D and **Appendix F** compile the results of all laboratory data pertaining to the samples collected during the field sampling event.

4.1.1 Arsenic

Residential Soil Sampling (0–6 inches)

Samples collected from a depth interval of 0 to 6 inches were collected from 562 sample areas and analyzed for arsenic (**Figure 4-1**). Of the 562 samples, five exceeded the regional background concentration for arsenic (**Table 4-1**). Of the five samples exceeding the regional background concentration, three exceeded the ODEQ-designated PRG for arsenic.

TABLE 4-1
Exceedances for Arsenic Soil Samples (0–6 inches)
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Concentration (mg/kg)
	Northing	Easting			
MF2J36	4026036	245049	TFM195-SY-0006	0–6	26.2
MF2K57	4028528	244296	TFM056-FY-0006	0–6	27.5
MF2JX0	4026505	245048	TFM204-FY-0006	0–6	**41.5**
MF2LB6	4028975	244356	TFM115-BY-0006	0–6	**53.4**
MF2JQ3	4026488	245040	TFM204-BY-0006	0–6	**114**

Bold indicates detection above ODEQ-designated PRG of 37 mg/kg

mg/kg = milligrams/kilograms

During the sample collection of TFM204, ODEQ representative Sara Downard identified smelter waste material on the ground in multiple areas around the residential building and surrounding structures. TFM204 is located immediately east of the site, on the east side of

"Old" Highway 169. The eastern border of TFM204 is a drainage ditch that is connected to the site via a culvert pipe that passes beneath the railroad tracks and serves as a surface water drain for the site.

None of the field team members observed any smelter waste material during the sample collection of TFM115, which was the only other residential property where arsenic had been detected above the designated PRG at the 0 to 6 inch depth interval. TFM115 is located within the city limits of Collinsville on the northwest side of downtown, about 1.7 miles north-northwest of the site.

Residential Soil Sampling (6–12 inches)

Samples collected from a depth interval of 6 to 12 inches were collected from 560 sample areas and analyzed for arsenic (**Figure 4-1**). Of the 560 samples, five exceeded the regional background concentration level for arsenic (**Table 4-2**). Of those five, two samples exceeded the ODEQ-designated PRGs for arsenic.

TABLE 4-2
Exceedances for Arsenic Soil Samples (6–12 Inches)
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Concentration (mg/kg)
	Northing	Easting			
MF2HX1	4024943	4024943	TFM193-BY-0612	6–12	25.6
MF2J18	4026056	245175	TFM194-FY-0612	6–12	26.3
MF2LB7	4028528	244296	TFM115-BY-0612	6–12	26.7
MF2J26	4026046	245067	TFM195-BY-0612	6–12	28.4
MF2JW8	4028975	244356	TFM204-BY-0612	6–12	**45.8**
MF2JJ5	4027039	244841	TFM029-FY-0612	6–12	**91.9**

Bold indicates detection above ODEQ-designated PRG of 37 mg/kg

mg/kg = milligrams/kilograms

Section 4.1.1 provides a description of TFM204.

Field team members did not observe any smelter waste material during the sample collection of TFM029, which was the only other residential property where arsenic had been detected above the designated PRG at the 6-to-12-inch depth interval. TFM029 is

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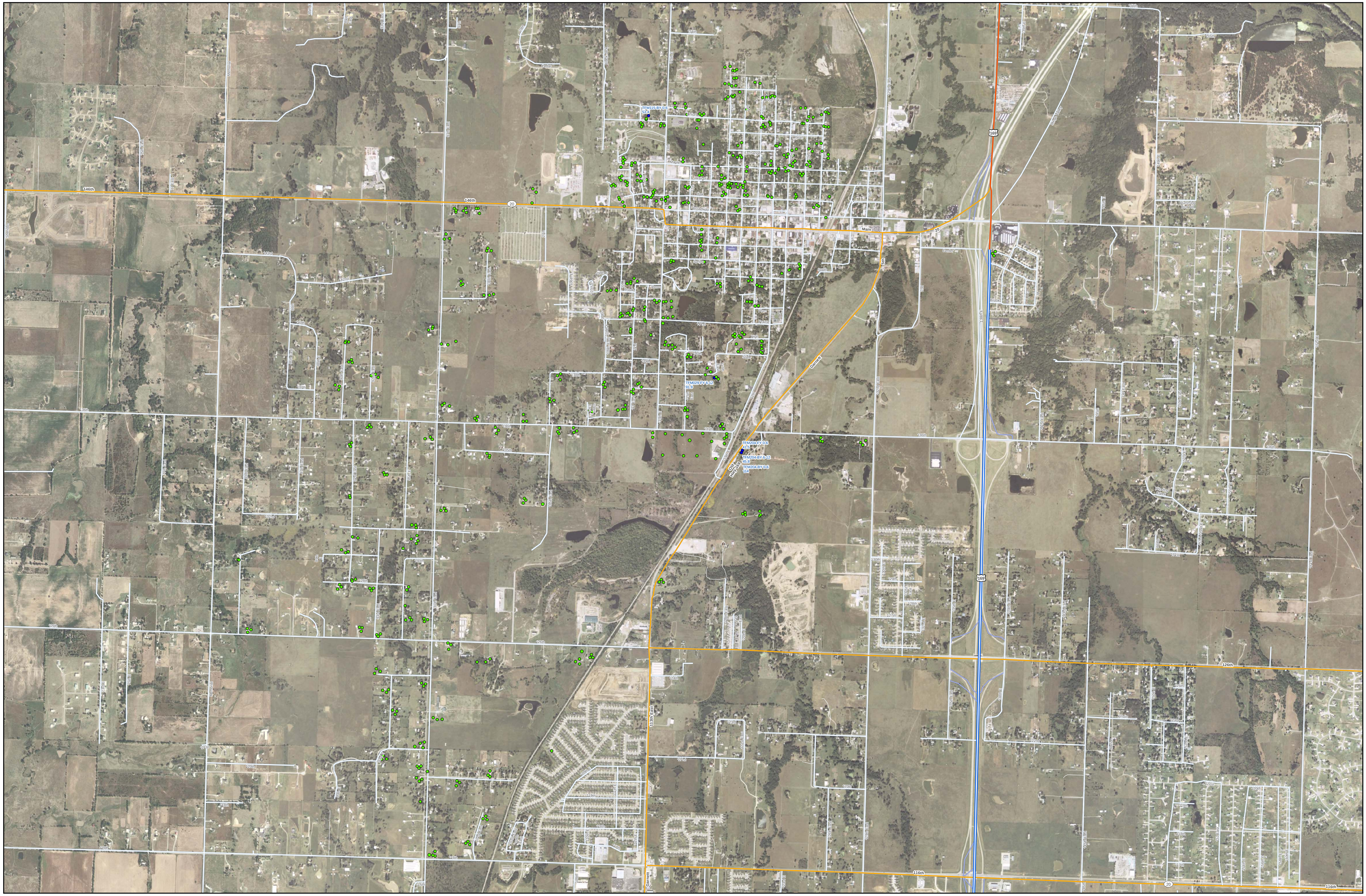

ARSENIC SAMPLE

- Concentration Less Than 37 mg/kg
- Concentration Greater Than 37 mg/kg

N

0 1,000 2,000 3,000 4,000 Feet

Legend

Figure 4-1
ARSENIC
CONCENTRATION MAP
SUPPLEMENTAL REMEDIAL INVESTIGATION

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CH2MHILL

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located along the southern city limits of Collinsville, approximately 0.4 miles north of the site, in an area known by Collinsville residents as "smelter hill."

Air Dispersion Soil Sampling (0–3 inches)

Samples collected from a depth interval of 0 to 3-inches were collected from 10 sample areas and analyzed for arsenic (**Figure 4-1**). Of these 10 samples, none exceeded the regional background concentration level or the ODEQ-designated PRG for arsenic.

4.1.2 Cadmium

Residential Soil Sampling (0–6 inches)

Samples collected from a depth interval of 0 to 6 inches were collected from 562 sample areas and analyzed for cadmium (**Figure 4-2**). Of the 562 samples, 11 exceeded the regional background concentration level for cadmium (**Table 4-3**). Of these 11, one sample exceeded the ODEQ-designated PRG for cadmium.

TABLE 4-3
Exceedances for Cadmium Soil Samples (0–6 Inches)
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Concentration (mg/kg)
	Northing	Easting			
MF2J83	4027255	245190	TFM017-BY-0006	0–6	6
MF2JF8	4028315	245596	TFM026-SY-0006	0–6	6.1
MF2KZ8	4024976	243944	TFM096-SY-0006	0–6	6.3
MF2HS9	4026443	244851	TFM001-BY-0006	0–6	6.7
MF2M17	4028289	243084	TFM149-SY-0006	0–6	7.7
MF2JJ0	4027039	244841	TFM029-FY-0006	0–6	8
MF2JH2	4026627	244479	TFM028-FY-0006	0–6	10.3
MF2JX0	4026505	245048	TFM204-FY-0006	0–6	11.6
MF2JQ3	4026488	245040	TFM204-BY-0006	0–6	12.4
MF2MS8	4028440	244959	TFM190-BY-0006	0–6	12.9
MF2HX7	4027561	244525	TFM032-OT-0006	0–6	**78.2**

Bold indicates detection above ODEQ-designated PRG of 75 mg/kg
mg/kg = milligrams/kilograms

During the sampling of TFM032, the property owner informed field team members of a barren area located between the homeowner's house and garage. Upon examination of the location, CH2M HILL field team members determined that the barren area likely occurred because of the presence of smelter waste material and therefore, collected an additional sample labeled as TFM032-OT for "other location." TFM032 is located within the city limits of Collinsville, southwest of downtown, about 0.75 miles north of the site. TFM032-OT was the only sample collected that had a concentration greater than the ODEQ residential PRG.

Residential Soil Sampling (6–12 inches)

Samples collected from a depth interval of 6 to 12 inches were collected from 560 sample areas and analyzed for cadmium (**Figure 4-2**). Of the 560, six exceeded the regional background concentration level (**Table 4-3**), and none exceeded the ODEQ-designated PRG for cadmium.

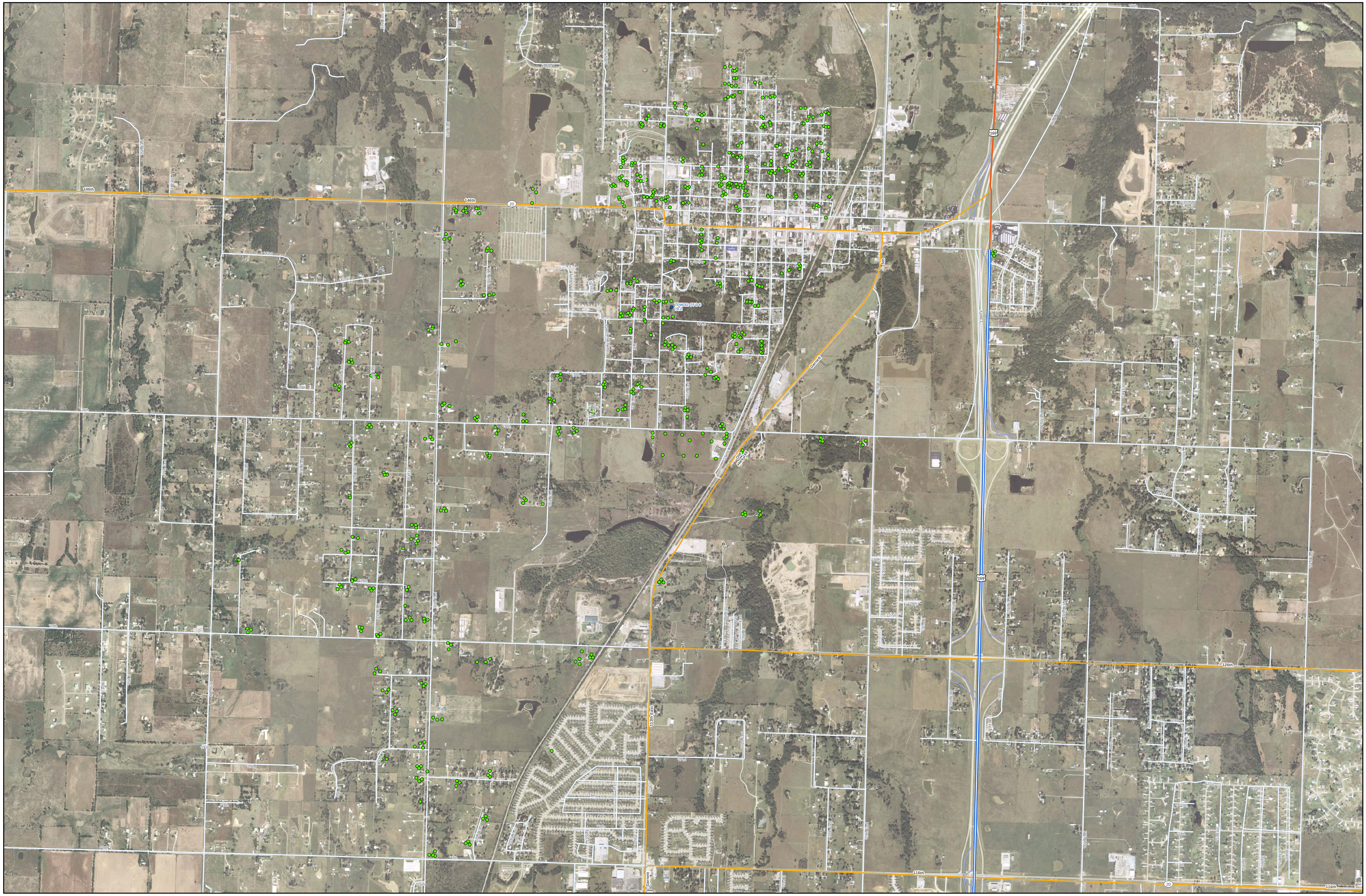
TABLE 4-4
Exceedances for Cadmium Soil Samples (6–12 Inches)
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Concentration (mg/kg)
	Northing	Easting			
MF2J87	4027255	245190	TFM017-BY-0612	6–12	6.2
MF2MG1	4027844	245469	TFM174-BY-0612	6–12	6.3
MF2JH7	4026629	244755	TFM028-BY-0612	6–12	6.9
MF2JJ5	4027039	244841	TFM029-FY-0612	6–12	9.7
MF2LB6	4028975	244356	TFM204-BY-0612	6–12	12
MF2HY1	4027561	244525	TFM032-OT-0612	6–12	47.1

Bold indicates detection above ODEQ-designated PRG of 75 mg/kg
mg/kg = milligrams/kilograms

Air Dispersion Soil Sampling (0–3 inches)

Samples collected from a depth interval of 0 to 3 inches were collected from 10 samples areas and analyzed for cadmium (**Figure 4-2**). Of these 10 samples, only one exceeded the regional background concentration level (AIRDISP10 = 9.8 mg/kg), and none exceeded the ODEQ-designated PRG. Air dispersion sample AIRDISP10 was collected from an open pasture west of the Faith of Assembly Church. The open pasture, which is owned by the



CADMIUM SAMPLE

- Concentration Less Than 75 mg/kg
- Concentration Greater Than 75 mg/kg

N

0 1,000 2,000 3,000 4,000 Feet

Legend

Figure 4-2
CADMIUM
CONCENTRATION MAP
SUPPLEMENTAL REMEDIAL INVESTIGATION

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pasture west of the Faith of Assembly Church. The open pasture, which is owned by the Faith Assembly Church, borders the TFM site to the north.

4.1.3 Lead

Residential Soil Sampling (0–6 inches)

Samples collected from a depth interval of 0 to 6 inches were collected from 562 sample areas and analyzed for lead (**Figure 4-3**). Of the 562 samples, 13 exceeded the regional background concentration level for lead (**Table 4-5**). Of these 13, seven exceeded the ODEQ-designated PRG for lead.

TABLE 4-5
Exceedances for Lead Soil Samples (0–6 inches)
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Concentration (mg/kg)
	Northing	Easting			
MF2JF8	4028315	245596	TFM026-SY-0006	0–6	387
MF2JF7	4028297	245573	TFM026-BY-0006	0–6	391
MF2J07	4026030	245182	TFM194-FY-0006	0–6	401
MF2JZ7	4028335	244622	TFM047-BY-0006	0–6	415
MF2JH2	4026627	244479	TFM028-FY-0006	0–6	439
MF2KZ3	4024998	243933	TFM096-BY-0006	0–6	456
MF2J58	4028385	245233	TFM014-BY-0006	0–6	**509**
MF2L02	4024965	243845	TFM097-FY-0006	0–6	**537**
MF2HW7	4027373	245045	TFM003-BY-0006	0–6	**579**
MF2MG9	4028667	245041	TFM175-FY-0006	0–6	**722**
MF2HX7	4027561	244525	TFM032-OT-0006	0–6	**1,400**
MF2JX0	4026505	245048	TFM204-FY-0006	0–6	**1,410**
MF2JQ3	4026488	245040	TFM204-BY-0006	0–6	**1,500**

Bold indicates detection above ODEQ-designated PRG of 500 mg/kg
mg/kg = milligrams/kilograms

Section 4.1.1 includes a description of TFM204, and **Section 4.1.2** includes a description of TFM032.

Field team members did not observe any apparent smelter waste material during the sample collection of TFM175, TFM097, TFM014, and TFM003. TFM175 is located within the city limits of Collinsville, in the middle of downtown, about 1.3 miles north of the site. TFM097 is located outside of the city limits of Collinsville, approximately 1 mile south-southwest of the site. TFM014 is located within the city limits of Collinsville, in the middle of downtown, approximately 1.5 miles north of the site. And TFM003 is located along the southern city limits of Collinsville, approximately 0.6 miles north of the site, in an area known by Collinsville residents as "smelter hill."

Residential Soil Sampling (6–12 inches)

Samples collected from a depth interval of 6 to 12 inches were collected from 560 sample areas and analyzed for lead (**Figure 4-3**). Of the 560 samples, six samples exceeded the regional background concentration level for lead (**Table 4-6**). Of these six samples, five exceeded the ODEQ-designated PRG for lead.

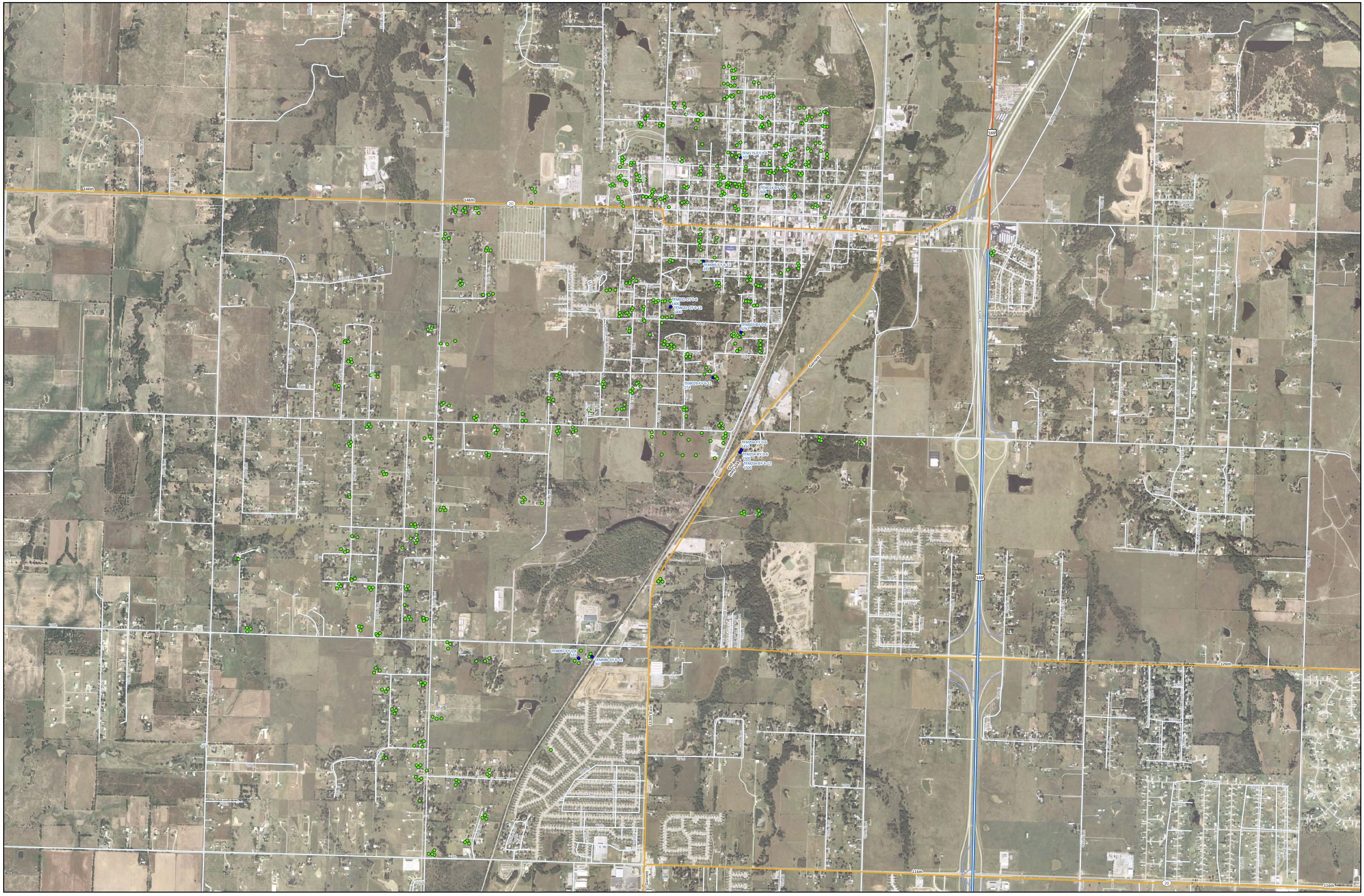
TABLE 4-6
Exceedances for Lead Soil Samples (6–12 inches)
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Concentration (mg/kg)
	Northing	Easting			
MF2JZ8	4028335	244622	TFM047-BY-0612	6–12	400
MF2KZ9	4024976	243944	TFM096-SY-0612	6–12	**558**
MF2KQ7	4027896	244766	TFM085-FY-0612	6–12	**586**
MF2HY1	4027561	244525	TFM032-OT-0612	6–12	**599**
MF2JW8	4028975	244356	TFM204-BY-0612	6–12	**630**
MF2JJ5	4027039	244841	TFM029-FY-0612	6–12	**1,430**

Bold indicates detection above ODEQ-designated PRG of 500 mg/kg
mg/kg = milligrams/kilograms

A description of TFM204 has been provided in **Section 4.1.1**, TFM032 in **Section 4.1.2**, and TFM029 in **Section 4.1.1**.

Field team members did not observe any apparent smelter waste material during the sample collection of TFM096, TFM085, and TFM029. TFM096 is located outside of the city limits of Collinsville, approximately 1 mile south-southwest of the site, and TFM085 is located within



LEAD SAMPLE

- Concentration Less Than 500 mg/kg
- Concentration Greater Than 500 mg/kg

N

0 1,000 2,000 3,000 4,000 Feet

Figure 4-3
LEAD
CONCENTRATION MAP
SUPPLEMENTAL REMEDIAL INVESTIGATION

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the city limits of Collinsville, immediately south of downtown and approximately 1 mile north of the site.

Air Dispersion Soil Sampling (0–3 inches)

Samples collected from a depth interval of 0 to 3 inches were collected from 10 samples areas and analyzed for lead (**Figure 4-3**). Of these 10 samples, none exceeded the regional background concentration level or the ODEQ-designated PRG for lead.

4.1.4 Zinc

Residential Soil Sampling (0–6 inches)

Samples collected from a depth interval of 0 to 6 inches were collected from 562 sample areas and analyzed for zinc (**Figure 4-4**). Of these 562 samples, eight exceeded the regional background concentration level (**Table 4-7**), and none exceeded the EPA Region 6 residential soil screening level for zinc.

TABLE 4-7
Exceedances for Zinc Soil Samples (0–6 inches)
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Concentration (mg/kg)
	Northing	Easting			
MF2HW7	4027373	245045	TFM003-BY-0006	0–6	1,520
MF2L02	4024965	243845	TFM097-FY-0006	0–6	1,620
MF2JF7	4028297	245573	TFM026-BY-0006	0–6	2,010
MF2J83	4027255	245190	TFM017-BY-0006	0–6	2,260[J]
MF2MS8	4028440	244959	TFM190-BY-0006	0–6	2,910
MF2HX7	4027561	244525	TFM032-OT-0006	0–6	3,020
MF2JQ3	4026488	245040	TFM204-BY-0006	0–6	4,300
MF2JX0	4026505	245048	TFM204-FY-0006	0–6	5,260

Bold indicates detection above EPA Region 6 residential soil screening level of 23,000 mg/kg
[J] = estimated concentration
mg/kg = milligrams/kilograms

Residential Soil Sampling (6–12 inches)

Samples collected from a depth interval of 6 to 12 inches were collected from 560 sample areas and analyzed for zinc (**Figure 4-4**). Of these 560 samples, eight exceeded the regional

background concentration level (**Table 4-8**), and none exceeded the EPA Region 6 residential soil screening level for zinc.

TABLE 4-8
Exceedances for Zinc Soil Samples (6–12 inches)
Supplemental RI Report: Tulsa Fuel and Manufacturing, Collinsville, OK

Sample ID Number	UTM Coordinates		Station Location ID	Depth (inches)	Concentration (mg/kg)
	Northing	Easting			
MF2KQ7	4027896	244766	TFM085-FY-0612	6–12	1,290
MF2J87	4027255	245190	TFM017-BY-0612	6–12	1,910[J]
MF2JW8	4028975	244356	TFM204-BY-0612	6–12	2,220
MF2HY1	4027561	244525	TFM032-OT-0612	6–12	2,320
MF2JJ5	4027039	244841	TFM029-FY-0612	6–12	4,140

Bold indicates detection above EPA Region 6 residential soil screening level of 23,000 mg/kg
[J] = estimated concentration
mg/kg = milligrams/kilograms

Air Dispersion Soil Sampling (0–3 inches)

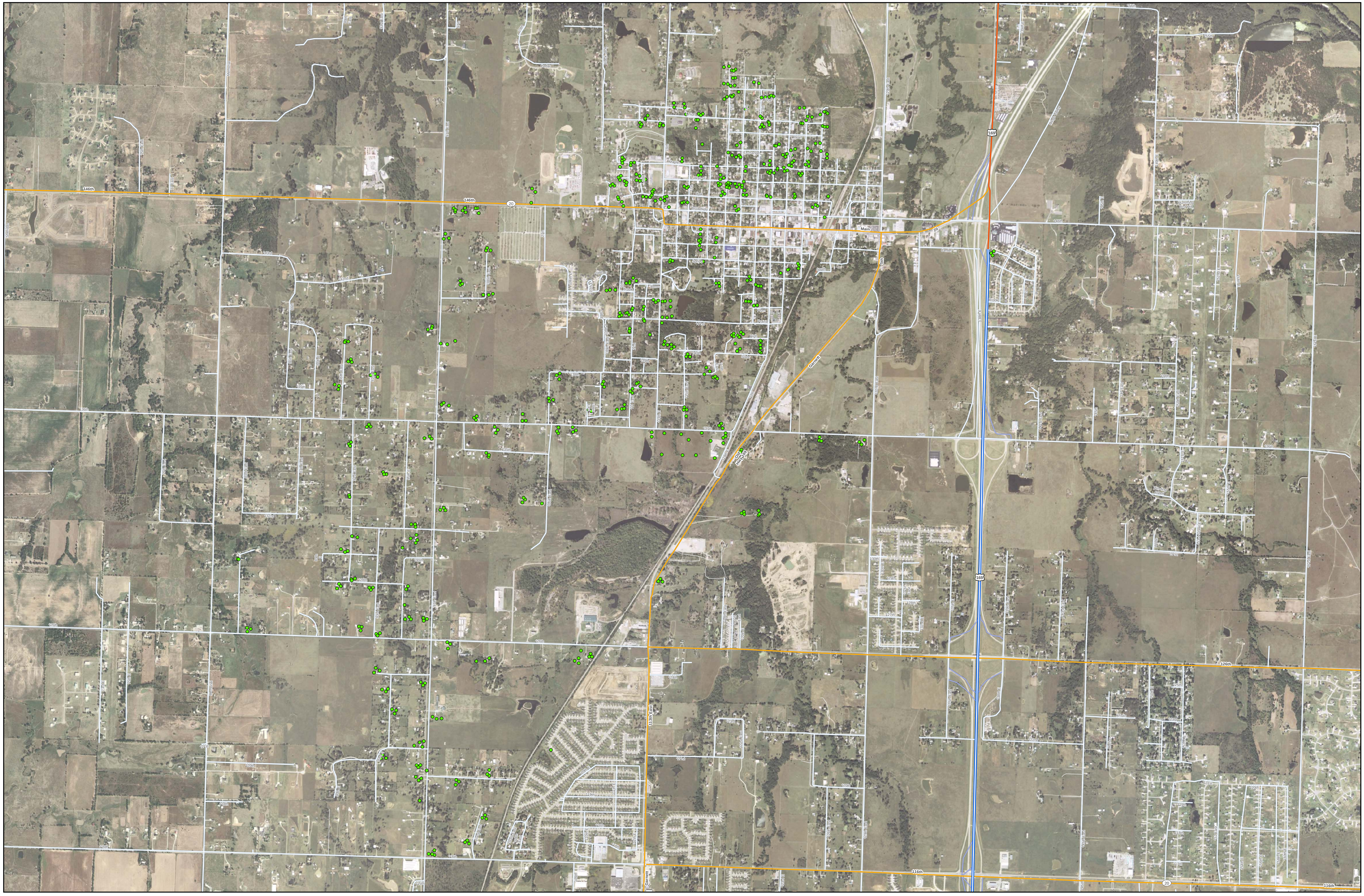
Samples collected from a depth interval of 0 to 3 inches were collected from 10 sample areas and analyzed for zinc (**Figure 4-4**). Of the 10 samples, none exceeded the regional background concentration level or the EPA Region 6 residential soil screening level for zinc.

4.2 Distribution of Contaminants

Samples were collected from a total of 201 residential properties during the field sampling event, of which 10 had at least one sample with one or more metal concentration exceeding ODEQ-designated residential PRGs for arsenic, cadmium, and lead or the EPA Region 6 residential soil screening level for zinc. A description of metal exceedances for each property is provided below and illustrated on **Figure 4-5**.

TFM003

At TFM003, lead was detected in the 0-to-6 inch back yard sample at 579 mg/kg, exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration value of 379 mg/kg. The lead concentration for the 6-to-12-inch back yard sample was 221 mg/kg, below background lead concentration values. No other metal concentrations exceeded the ODEQ-designated PRGs for any other sample areas on the property. However, zinc was



ZINC SAMPLE

- Concentration Less Than 23,000 mg/kg
- Concentration Greater Than 23,000 mg/kg

N

0 1,000 2,000 3,000 4,000 Feet

Figure 4-4
ZINC
CONCENTRATION MAP
SUPPLEMENTAL REMEDIAL INVESTIGATION

TULSA FUEL AND MANUFACTURING
Collinsville,OK

CH2MHILL

DATE: 2/13/2008

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TFM115-BY-0006
ARSENIC 53.4 mg/kg

TFM175-FY-0006
LEAD 722 mg/kg

TFM014-BY-0006
LEAD 509 mg/kg

TFM032-OT-0006
CADMIUM 78.2 mg/kg

TFM085-FY-0612
LEAD 586 mg/kg

TFM032-OT-0006
LEAD 1400 mg/kg

TFM032-OT-0612
LEAD 599 mg/kg

TFM003-BY-0006
LEAD 579 mg/kg

TFM029-FY-0612
LEAD 1430 mg/kg

TFM029-FY-0612
ARSENIC 91.9 mg/kg

TFM204-BY-0006
LEAD 1500 mg/kg

TFM204-FY-0006
ARSENIC 41.5 mg/kg

TFM204-FY-0006
LEAD 1410 mg/kg

TFM204-BY-0006
ARSENIC 114 mg/kg

TFM204-BY-0612
LEAD 630 mg/kg

TFM204-BY-0612
ARSENIC 45.8 mg/kg

TFM097-FY-0006
LEAD 537 mg/kg

TFM096-SY-0612
LEAD 558 mg/kg

Union
Black Jack
Pine
Pearl
Maple
Walnut
Oak
Broadway
Main
Center
Spring
South
Reno
Brook
Plum
High
State
146th
143rd
142nd
141st
140th
139th
138th
137th
136th
135th
130th
129th
127th
126th
124th
27th
100th East
106th E
22nd
109th East
21st
111 East
108th East
113th E
115th East
117th East
119th E
113th East
118th East
119 East
120th E
129th East
130th E
132nd East
105th East
20th
19th
18th
17th
16th
15th
13th
12th
11th
10th
9th
8th
7th
6th
Garnett
Old Hwy 169
169
20

Project Location
Tulsa
Broken Arrow
44
64
75
69

Metal Exceedances
TFM Site Boundary

N

0 500 1,000 1,500 2,000
Feet

Figure 4-5
METAL EXCEEDANCES
SUPPLEMENTAL REMEDIAL INVESTIGATION

TULSA FUEL AND MANUFACTURING
Collinsville, OK

CH2MHILL

FILENAME: \\texanlis_proj\ J:\TULSA_FUEL\Collinsville_OK\MXD\TF_Sample_PNTS.mxd

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detected in the 0-to-6-inch back yard sample at 1,520 mg/kg, exceeding the background zinc concentration value of 1,280 mg/kg.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the top-most 0 to 6 inches of the property's back yard.

TFM014

At TFM014, lead was detected in the 0-to-6-inch back yard sample at 509 mg/kg, exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration of 379 mg/kg. The lead concentration for the 6-to-12-inch back yard sample was 105 mg/kg, below background lead concentration values. No other metal concentrations exceeded the ODEQ-designated PRGs or background concentration values for any other sample area on the property.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the top-most 0 to 6 inches of the property's back yard.

TFM029

At TFM029, lead and arsenic were detected in the 6-to-12-inch front yard sample. Lead was detected in the 6-to-12-inch front yard sample at 1,430 mg/kg, exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration of 379 mg/kg. The lead concentration for the 0-to-6-inch front yard sample was 274 mg/kg, below background lead concentration values.

Arsenic was also detected in the 6-to-12-inch front yard sample at 91.9 mg/kg, exceeding the ODEQ-designated arsenic PRG of 37 mg/kg and the background arsenic concentration of 25.3 mg/kg. The arsenic concentration for the 0-to-6-inch front yard sample was 17.6 mg/kg, below background arsenic concentration values. No other metal concentrations exceeded the ODEQ-designated PRGs for any other sample areas on the property. However, zinc was detected in the 6-to-12-inch front yard sample at 4,140 mg/kg, exceeding the background zinc concentration value of 1,280 mg/kg.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the front yard of the property. The vertical extent of possible lead and arsenic contamination for the front yard could not be determined as no samples were collected below a depth of 12 inches.

TFM032

Because field team members observed smelter waste material on the ground at the additional sample area, metal concentrations were expected to exceed ODEQ-designated PRGs. The additional sample area accounts for three of the 18 ODEQ-designated PRG exceedances. No other sample areas on the property contained metal concentrations exceeding either the ODEQ-designated PRGs or background concentration values.

Lead and cadmium exceedances were detected in the additional sample area. Lead was detected in the 0-to-6-inch sample at 1,400 mg/kg and in the 6-to-12-inch sample at 599 mg/kg, with both samples exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration value of 379 mg/kg.

Cadmium also was detected in the 0-to-6-inch sample at 78.2 mg/kg, exceeding ODEQ-designated cadmium PRG of 75 mg/kg and the background cadmium concentration of 5.9 mg/kg. The cadmium concentration for the 6-to-12-inch sample was 47.1 mg/kg, which is above the background cadmium concentration values, but below the ODEQ-designated cadmium PRG. No other metal concentrations exceeded the ODEQ-designated PRGs for any other sample areas on the property. However, zinc was detected in the 0-to-6-inch sample at 3,020 mg/kg and in the 6-to-12-inch sample at 2,320 mg/kg, exceeding the background zinc concentration value of 1,280 mg/kg.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the proximal area of the waste material. The vertical extent of possible lead and cadmium contamination for the additional sample area could not be determined because no samples were collected below a depth of 12 inches.

TFM085

At TFM085, lead was detected in the 6-to-12-inch front yard sample at 586 mg/kg, exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration value of 379 mg/kg. The lead concentration for the 0-to-6-inch front yard sample was 231 mg/kg, below the background lead concentration values. No other metal concentrations exceeded ODEQ-designated PRGs for any other sample areas on the property. However, zinc was detected in the 6-to-12-inch front yard sample at 1,290 mg/kg, exceeding the background zinc concentration value of 1,280 mg/kg.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the front yard of the property. The vertical extent of possible lead contamination for the front yard sample could not be determined as no samples were collected below a depth of 12 inches.

TFM096

At TFM096, lead was detected in the 6-to-12-inch side yard sample at 558 mg/kg, exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration of 379 mg/kg. The lead concentration for the 0-to-6-inch side yard sample was 337 mg/kg, below the background lead concentration values. No other metal concentrations exceeded ODEQ-designated PRGs or background concentration values.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the property's side yard. The vertical extent of possible lead contamination for the front yard sample could not be determined as no samples were collected below a depth of 12 inches.

TFM097

At TFM097, lead was detected in the 0-to-6-inch front yard sample at 537 mg/kg, exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration of 379 mg/kg. The lead concentration for the 6-to-12-inch front yard sample was 92.9 mg/kg, below background lead concentration values. No other metal concentrations exceeded the ODEQ-designated PRGs for any other sample areas on the property. However, zinc was

detected in the 0-to-6-inch front yard sample at 1,620 mg/kg, exceeding the background zinc concentration value of 1,280 mg/kg.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the top-most 0 to 6 inches of the property's front yard.

TFM115

At TFM115, arsenic was detected in the 0-to-6-inch back yard sample at 53.4 mg/kg, exceeding the ODEQ-designated arsenic PRG of 37 mg/kg and the background arsenic concentration of 25.3 mg/kg. The arsenic concentration for the 6-to-12-inch back yard sample was 26.7 mg/kg, which is above the background arsenic concentration values, but below ODEQ-designated arsenic PRG. No other metal concentrations exceeded the ODEQ-designated PRGs or background concentration values.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the top-most 0 to 6 inches of the property's back yard.

TFM175

At TFM175, lead was detected in the 0-to-6-inch front yard sample at 722 mg/kg, exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration of 379 mg/kg. The lead concentration for the 6-to-12-inch front yard sample was 134 mg/kg, below the background lead concentration values. No other metal concentrations exceeded ODEQ-designated PRGs or background concentration values for any other sample area on the property.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely limited to the top-most 0 to 6 inches of the property's front yard.

TFM204

Because field team members observed smelter waste material on the ground around the residential building and surrounding structures, metal concentrations were expected to exceed ODEQ-designated PRGs. TFM204 accounts for six of the 18 ODEQ-designated PRG

exceedances. All sample areas on the property contained metal concentrations exceeding either the ODEQ-designated PRGs or background concentration values.

At TFM204, lead and arsenic were detected in all sample depth intervals. Lead was detected in the 0-to-6-inch front yard sample at 1,410 mg/kg, in the 0-to-6-inch back yard sample at 1,500 mg/kg, and in the 6-to-12-inch back yard sample at 630 mg/kg, all exceeding the ODEQ-designated lead PRG of 500 mg/kg and the background lead concentration of 379 mg/kg.

Arsenic also was detected in the 0-to-6-inch front yard sample at 41.5 mg/kg, in the 0-to-6-inch back yard sample at 114 mg/kg, and in the 6-to-12-inch back yard sample at 45.8 mg/kg, all exceeding the ODEQ-designated arsenic PRG of 37 mg/kg and the background arsenic concentration of 25.3 mg/kg. No other metal concentrations exceeded the ODEQ-designated PRGs for any other sample areas on the property. However zinc was detected in the 0-to-6-inch front yard sample at 5,260 mg/kg, in the 0-to-6-inch back yard sample at 4,300 mg/kg, and in the 6-to-12-inch back yard sample at 2,220 mg/kg, all exceeding the background zinc concentration value of 1,280 mg/kg.

Based on the analytical results, it is concluded that possible contamination associated with the site at levels that potentially pose a risk to human health or the environment is likely for the entire property. The vertical extent of possible lead and arsenic contamination for the residential property could not be determined as no samples were collected below a depth of 12 inches.

Taken together, the analytical results demonstrate that lead was the most frequent contaminant with 12 exceedances, followed by arsenic with five exceedances, and cadmium with one exceedance. Eleven of the 18 metal concentrations that exceeded the ODEQ-designated PRG originated from the 0-to-6-inch depth interval; the remaining 7 metal exceedances originated from the 6-to -12-inch depth interval. Seven metal exceedances were discovered from front yard samples; seven others from back yard samples; one from the side yard sample, and three from an additional sample area collected during the field sampling event.

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Section 5
Contaminant Fate and Transport

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SECTION 5

Contaminant Fate and Transport

Analysis of the fate and transport of site-related COCs is critical to developing potential remedial alternatives. Arsenic, cadmium, and lead are known contaminants that have been detected in the soil of residential properties surrounding the TFM site. **Section 5** reviews the factors affecting the migration and fate of arsenic, lead, and cadmium and their potential migration routes, the likelihood for natural attenuation of the contamination, and an evaluation of potential routes of exposure.

5.1 Physical and Chemical Nature of Contaminants

The fate of a contaminant in the environment, and the ability of that contaminant to migrate in the environment, is dependent in part on the chemical and physical properties of the contaminant. For example, the properties that can affect an organic contaminant's fate and transport are water solubility, vapor pressure, molecular weight, organic carbon partition coefficient, Henry's Law of constants, and specific gravity. These properties can determine how constituents behave under certain conditions and can be useful when evaluating the fate and transport of contaminants, and for evaluating applicable remedial technologies.

For example, the potential for movement of contaminants from one environmental medium, such as air, to another, such as groundwater, is defined by partitioning coefficients. Partitioned coefficients estimate a contaminant's propensity toward accumulating in one medium over another. The more water-soluble a compound is, the more likely it is to reside in the aqueous phase and move with percolating water through the soil column to the saturated zone and continuing its migration as a solute in groundwater flow. Water-soluble compounds generally are considered mobile in the subsurface environment. A compound with a high organic carbon partitioning coefficient (K_{oc}) value will tend to remain attached to the soil organic matter or reside principally in non-aqueous phases. These contaminants are generally considered immobile in the subsurface environment.

Henry's Law defines the partitioning of a contaminant between the gaseous and aqueous phase. A compound that has a high Henry's Law constant will prefer the gaseous phase to

either the solid, liquid, or the aqueous phase. Contaminants with this characteristic will be more mobile within the soil vapor phase, depending on the pneumatic permeability of the soil and vapor phase density of the compound.

The applicable physical and chemical properties for arsenic, cadmium, and lead—the three COCs found at several onsite locations—are discussed in the following paragraphs.

5.1.1 Arsenic

Arsenic is an odorless, nearly tasteless, brittle, silver-gray to metallic solid. It has low mobility in soil, and is affected by soil's organic content, moisture, pH, and cation-exchange capacity. In water, arsenic typically exists as As^{+5} in aerobic conditions. Arsenic generally serves as a component of alloys and in certain types of glass. It is also used in some semi-conductor devices and as a component of some herbicides, pesticides, and wood preservatives.

5.1.2 Cadmium

Cadmium is an odorless, soft, ductile, silver-white, somewhat bluish metal that is relatively rare as a naturally occurring metallic element but is widely distributed in the earth's crust. Cadmium is most widely used in batteries, pigments, coatings, platings, and stabilizers for plastics, nonferrous alloys, and electro-optical technologies. Metallic cadmium may enter the environment during the mining, ore processing, and smelting of zinc and zinc-lead ores in which cadmium is found, and during its recovery, refining, and manufacturing of cadmium compounds. Metallic cadmium also may enter the environment through the use of cadmium alloys and compounds, and their recycling and disposal. Cadmium's initial route of entry is often through the atmosphere. Cadmium metal transforms to oxide and carbonate in the atmosphere, and slowly oxidizes in both water and soil. Occupational exposure to cadmium occurs primarily during the smelting and refining of ores, the spraying of pigments, and processing scrap. The general population is exposed to metallic cadmium primarily by contact with cadmium-containing alloys, contaminated food products, and tobacco.

5.1.3 Lead

Lead is a bluish-white to silvery-gray metal that is highly lustrous when fresh but tarnishes with exposure to air. It is very soft and malleable. Lead rarely occurs in the elemental state but does occur in a number of different ores. Lead is used primarily in the manufacture of batteries, ammunition, nuclear and x-ray shielding, cable coverings, ceramic glazes, solders, pipes, and paint pigments. Primary artificial pollution sources include smelting, processing, and refining of lead ore, and the manufacture of products and materials containing lead. Common routes of human exposure are ingestion or inhalation of dust or fumes and dermal or eye contact. Organic matter content, pH, and phosphate content are the primary factors controlling the mobility of lead in soil.

5.2 Potential Routes of Migration and Exposure Pathways

This section describes the potential routes of migration and exposure pathways for site COCs with concentrations that exceed the designated PRG. **Figures 4-1, 4-2, 4-3, and 4-4** illustrate the distribution of site COCs across the investigation area.

5.2.1 Arsenic

Arsenic was detected at concentrations exceeded the designated PRGs for residential soils at three residential properties within the investigation area. Because arsenic tends to adsorb to soil particles, direct contact or ingestion of residential soil is the most likely route of exposure. Because arsenic does not volatilize, has a low solubility, and was not detected in any of the groundwater samples from previous investigations, neither volatilization and inhalation nor dissolution and migration of arsenic into groundwater would be considered complete or likely routes of exposure.

5.2.2 Cadmium

Cadmium was detected at a concentration that exceeded the designated PRG for residential soil at one residential property sampled within the investigation area. Because cadmium tends to adsorb to soil particles, direct contact or ingestion of site soils is considered the most likely route of exposure. Because cadmium is not volatile, exhibits low mobility in soil, and was not detected in groundwater samples collected during previous investigations,

neither volatilization and inhalation nor dissolution and migration of cadmium into groundwater are considered complete or likely routes of exposure.

5.2.3 Lead

Lead was detected at concentrations exceeding PRGs for residential soil at nine residential properties sampled within the investigation area. Because lead tends to adsorb to soil particles, direct contact or ingestion of site soils is considered the most likely route of exposure. Because lead is not volatile, exhibits low mobility in soil, and was not detected in groundwater samples collected during previous investigations, neither volatilization and inhalation nor dissolution and migration of lead into groundwater are considered complete or likely routes of exposure.

Section 6
Summary and Conclusions

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SECTION 6

Summary and Conclusions

The supplemental RI field investigation was implemented to evaluate the potential soil contamination of offsite residential properties resulting from the use of smelter waste as fill material and to evaluate the potential soil contamination of the area around the site resulting from the dispersion of airborne particulates during the operation of the smelters. Field activities included the collection of shallow surface soil samples from offsite residential properties and from undisturbed locations within a 2-mile radius of the TFM site. The following subsections summarize the investigation's results and present the report's final conclusions based on the data collected during the supplemental RI.

6.1 Residential Soil Sampling

A total of 201 residential properties were sampled from November 26, 2007, to January 8, 2008, for potential COCs to assess the extent of the usage of site smelter waste as fill material for offsite properties. Analysis of samples collected from the properties identified exceedances of one or more of the ODEQ-designated residential PRGs for the four analyzed metals at 10 of the residential properties. Two of these 10 properties contained visible smelter waste material. **Section 6.1.1** reviews the findings of two residential properties that contained visible smelter waste material and exceeded one or more of the ODEQ-designated residential PRGs. **Section 6.1.2** reviews the findings of the other eight residential properties that exceeded one or more of the ODEQ-designated residential PRGs but lacked visible smelter waste material.

6.1.1 Properties with Metal Exceedances and Smelter Waste Material

TFM032 and TFM204 are the two properties containing visible smelter waste material and exceeding one or more of the ODEQ-designated residential PRGs. While other residential properties sampled did contain intact retorts or other smelter waste material, only TFM32 and TFM204 contained smelter waste material that was visibly integrated into the soil. Samples collected from these two residential properties account for nine of the 18 ODEQ-designated residential PRG exceedances.

Based on the analytical results and visual observations made by field team members during the field sampling event, this report has concluded that all ODEQ-designated residential PRG exceedances for TFM032 and TFM204 are likely attributed to the presence of the smelter waste material. Because only two residential properties contained visible smelter waste material, no visible trend could be derived from the data.

6.1.2 Properties with Metal Exceedances Only

TFM003, TFM014, TFM029, TFM085, TFM096, TFM097, TFM115, and TFM175 are the eight properties that exceeded one or more of the ODEQ-designated residential PRGs but did not contain visible waste material in the soil. Five of the properties—TFM003, TFM014, TFM029, TFM085, and TFM175—are located in the older section of Collinsville, directly north of the site. Overall, the older section of Collinsville exhibited higher metal concentrations than any other area (such as newer areas of Collinsville or rural areas) sampled during the investigation. Elevated concentrations and exceedances indicate that the area directly north of the site is the only area moderately affect by contamination associated with the site.

Based on the analytical results, the 1936 local newspaper article regarding the use of onsite material for local area roads, and the verbal testimony provided by Collinsville residents to CH2M HILL field team members confirming the use of onsite material for local roads, it is concluded that the ODEQ-designated residential PRG exceedances for TFM003, TFM014, TFM029, TFM085, and TFM175 are likely attributed to the historical placement of smelter waste material in the older sections of Collinsville. TFM096, TFM097, and TFM115 are not located in the older sections of Collinsville; therefore, there is no defined source for the impact for these sample locations.

6.2 Air Dispersion Sampling

A total of 10 areas, selected on the basis of minimal historic site disturbance and the air dispersion modeling results, were sampled on January 7, 2008, for potential COCs attributable to air dispersion. Analysis of the composite samples did not identify any ODEQ-designated residential PRG exceedances. No exceedances were detected and no visible north or south trend could be derived from the data. Based on the analytical results,

it is concluded that little to no soil contamination of the area around the site resulted from the dispersion of airborne particulates during the operation of the smelter.

6.3 Summation

The data collected for the supplemental RI for the TFM Superfund Site indicates that only a small number of offsite residential sample locations—5 percent—are potentially impacted by the use of waste mass fill material, with no impact associated with the dispersion of airborne particulates on to the ground in the area surrounding the site. The residential soil that is contaminated is likely attributed to the historical placement of smelter waste material in the older sections of Collinsville. The distribution of metals impact is random and there are no discernable patterns or trend.

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Section 7
References

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SECTION 7

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Appendix A
Air Dispersion Modeling Results

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TRANSMITTAL OF DOCUMENTS FOR ACCEPTANCE BY EPA	DATE: 11-27-2007	TRANSMITTAL NO. DCN: 0030-02000
TO: Mike McAteer (6SFLP) U.S. EPA Region 6 1445 Ross Avenue 12th Floor Dallas, TX 75202	FROM: Tim McDonald CH2M HILL/DFW 502 S. Main, 4th Floor Tulsa, OK 74103-4425	X **New Transmittal** ● Resubmittal of Transmittal No. _____

SUBTASK NO.	DELIVERABLE	NO. OF COPIES	REMARKS
365672.PP.02	Technical Memo. Air Dispersion Modeling. Tulsa Fuel and Manufacturing Superfund Site, Collinsville, Oklahoma. Remedial Action Contract No. EP-W-06-21. EPA Task Order 0030-RIRI-06FP	1 electronic	via e-mail

ACCEPTANCE ACTION

DOCUMENTS FOUND ACCEPTABLE (LIST BY SUBTASK NO.)	NAME/TITLE/SIGNATURE OF REVIEWER DATE

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Air Dispersion Modeling
Tulsa Fuel and Manufacturing Superfund Site
Collinsville, Oklahoma

Remedial Action Contract No. EP-W-06-21
EPA Task Order 0030-RIRI-06FP
DCN No. 0030-02000

PREPARED FOR: U.S. EPA

PREPARED BY: CH2M HILL

DATE: November 24, 2007

Background

A deposition modeling analysis was performed to support identification of soil sampling locations in the vicinity of the Tulsa Fuel and Manufacturing (TFM) Superfund site, Collinsville, Oklahoma. The TFM site was an active zinc and lead smelter that operated from 1914 to 1925.

Review of remedial investigation (RI) documents (Burns & McDonnell, 2007) provided a general site layout detailing the facility orientation (nine furnaces oriented east-west). The main stack location was not identified, however records indicating that the stack was 120 feet (36.57 meters) tall, 11 feet (3.35 meters) in diameter[1] and a similar feature on the 1919 Sanborn fire map indicate a stack location consistent with an operation of this type and vintage. The Sanborn fire map[2], annotated to illustrate the furnaces and assumed stack location, is provided as **Figure 1**.

Operational history information regarding the facility was limited to the period of operation and approximate locations of sources. Characteristics of the main stack (height, diameter) were identified in the RI review, but details concerning furnaces (e.g., roof vent height and configuration) were not available. Other information that was not available included particle size distribution, exhaust temperatures, and velocities, and emissions rates.

General Approach

Given the limited amount of information available, the air dispersion modeling was based on identifying the most likely areas where particulate matter (PM) emissions would be deposited proximal to the site based on:

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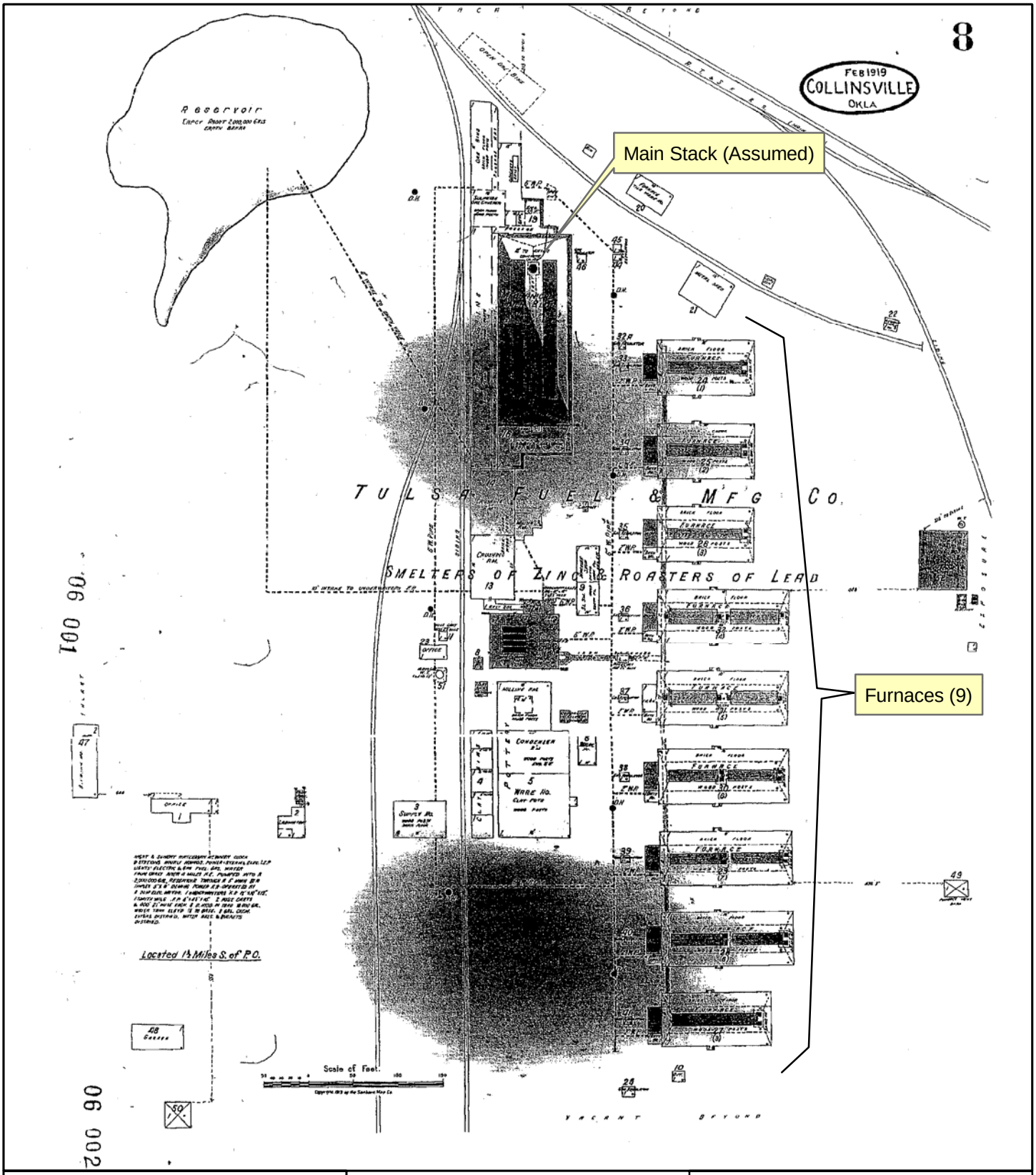
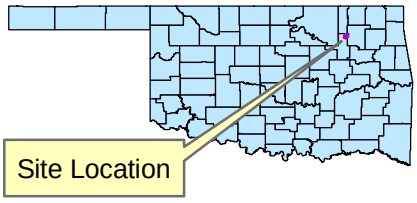
[1] Final Remedial investigation Repo4rt for Tulsa Fuel and Manufacturing, Collinsville Oklahoma, (Burns & McDonnell, August 2007), section 1.2.2.1, page 1-4

[2] Final Remedial investigation Repo4rt for Tulsa Fuel and Manufacturing, Collinsville Oklahoma, (Burns & McDonnell, August 2007), Appendix A-1



Key Map



N

Figure 1
Locations of Sources
Source: Sanborn Fire Insurance Map, February 1919

TULSA FUEL AND MANUFACTURING
Collinsville,OK

CH2MHILL

\\chuckwagon\GIS\NWOFILES\TULSA_FUEL\Collinsville_OK\MXD\Location_of_Sources.mxd. User: nbhattac Dated:11/06/07

- Local meteorology (e.g., prevailing wind speeds and directions).
- Stack parameters identified through RI review (furnace building locations, main stack height and diameter, assumed main stack location).
- Assumed variables stack parameters (i.e., temperature, velocity) based on engineering judgment and understanding of historical smelter operations.
- Assumed PM particle size distribution (based on EPA AP-42 guidance[3]).
- Assumed relative percentage of main stack (point) and furnace (fugitive) emissions.

Because emission rates were not known, nor the differences in potential operating profile (e.g., number of furnaces operating, production rate changes), the modeling was based assuming a constant emission rate during the period of operation. For modeling purposes, an assumed emission rate of 1 gram per second (g/s) was assumed for both the main stack point source and fugitive emissions from the collection of nine furnaces. Through this approach, the relative deposition amount (i.e., the fraction of total emissions from an assumed emission source) can be estimated without detailing the actual emission rate or amount deposited. The approach identifies the areas most likely to have been impacted by an emissions source.

Air Dispersion Modeling Methodology

The following paragraphs describe the modeling methodology, inputs and results of the air deposition analysis. The analysis has been prepared based on the U.S. Environmental Protection Agency (EPA) *Guidelines on Air Quality Models* (GAQM).

The EPA-approved AERMOD (Version 07026) model was used. AERMOD is a steady-state plume model that simulates air dispersion based on planetary boundary layer turbulence structure and scaling concepts. AERMOD was run with the following options.

- Regulatory default options
- Direction-specific building downwash
- Actual receptor elevations and hill height scales
- Dry Deposition
- Complex/intermediate terrain algorithms.

Sources

The modeling analysis included one point source and nine volume sources that represent the main facility stack and nine furnace buildings. The source parameters were based on the RI for the stack height and diameter, and best engineering judgment for stack temperature and velocity and roof vent height and building configuration. Selection for unknown parameters was based on understanding of historical smelter operation.

The furnaces were modeled as volume sources, as it is believed the emissions from the building vented through thin walls, open windows and doors; in addition to vents on top of

[3] EPA AP 42, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Fifth Edition, Appendix B-2, Generalized particle Size Distributions, Table B.2.2, Category 8, Process: Melting, Smelting, Refining

the building. The coordinates for the furnace are based on the approximate locations of the center of furnace building as shown in the Sanborn Map, in **Figure 1**. The coordinates for the stack are based on the feature marked on the north end of the Mechanical Building on the Sanborn fire map. The source parameters are summarized in **Tables 1 and 2**.

Table 1
Main Stack Parameters
Air Dispersion Modeling, Tulsa Fuel and Manufacturing Site, Collinsville, Oklahoma

Source ID	X (UTM m)	Y (UTM m)	Stack Height (m)	Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)	Emission Rate (g/s)
Stack	244,597	4,026,140	36.57	400	15	3.35	1

Table 2
Furnace Volume Source Parameters
Air Dispersion Modeling, Tulsa Fuel and Manufacturing Site, Collinsville, Oklahoma

Source ID	Description	X (UTM m)	Y (UTM m)	Height (m)	Sigma y (m)	Sigma z (m)	Emission Rates (g/s)
F1	Furnace 1	244,555	4,026,088	9.14	6.51	8.51	0.111
F2	Furnace 2	244,530	4,026,088	9.14	6.51	8.51	0.111
F3	Furnace 3	244,505	4,026,089	9.14	6.51	8.51	0.111
F4	Furnace 4	244,481	4,026,083	9.14	8.84	8.51	0.111
F5	Furnace 5	244,455	4,026,083	9.14	8.84	8.51	0.111
F6	Furnace 6	244,431	4,026,083	9.14	8.84	8.51	0.111
F7	Furnace 7	244,407	4,026,083	9.14	8.84	8.51	0.111
F8	Furnace 8	244,382	4,026,083	9.14	8.84	8.51	0.111
F9	Furnace 9	244,357	4,026,086	9.14	6.51	8.51	0.111

NOTES:
F1,F2 F3 AND F9 HAVE BUILDING LENGTHS OF 28 METERS
F4 THROUGH F8 HAVE BUILDING LENGTHS OF 38 METERS.
THE FURNACES WERE ASSUMED TO HAVE HEIGHTS OF 60 FEET.

Emissions and Particle Distribution

The particle distribution from the smelter emission was based on the EPA AP 42 reference[4], as detailed in **Table 3**. The point source was given an emission rate of 1g/s and a 1g/s emission rate was equally distributed between the 9 furnaces.

Table 3
Particle Size Distribution
Air Dispersion Modeling, Tulsa Fuel and Manufacturing Site, Collinsville, Oklahoma

Particle Size (µm)	Mass Fraction	Density (g/cm^3)
≤1	0.72	1
1 ≤ 2	0.08	1

[4] EPA AP 42, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Fifth Edition, Appendix B-2, Generalized particle Size Distributions, Table B.2.2, Category 8, Process: Melting, Smelting, Refining

Table 3 *Particle Size Distribution* Air Dispersion Modeling, Tulsa Fuel and Manufacturing Site, Collinsville, Oklahoma		
2 ≤ 2.5	0.02	1
2.5 ≤ 3	0.02	1
3 ≤ 4	0.02	1
4 ≤ 5	0.02	1
5 ≤ 6	0.01	1
6 ≤ 10	0.03	1
10 ≤ 30[5]	0.08	1

Building Downwash

Building influences on stacks are considered by incorporating the updated EPA Building Profile Input Program [BPIP-Prime]. The stack height used in the dispersion modeling was the actual stack height or Good Engineering Practice (GEP) stack height, whichever is less.

Building downwash was considered and the buildings included in the analysis are summarized in **Table 4**. Building heights were approximated based on understanding of similar facilities; actual building heights were not known.

Table 4 *Building Heights* Air Dispersion Modeling, Tulsa Fuel and Manufacturing Site, Collinsville, Oklahoma	
Building Name	**Height (feet)**
Mechanical Building	50
Furnace 1-9	60
Crushing Room	30
Ore Bins	30
Machine Shop	30
Supply House	30
Clay Bins	30
Blacksmith	30
Pottery	30

Meteorological Data

AERMET modeling files were created for Collinsville, Oklahoma for years 2001 to 2005. Surface data was obtained for Skiatook, Oklahoma which is located approximately 8 miles west of the project site. The source of the surface data was Oklahoma Mesonet (http://www.mesonet.org/sites/parameters.php?site=SKIA). The site characteristics were developed by CH2M HILL and assumed seasonal averages. These characteristics include albedo, surface roughness, and Bowen ratio for each season and each 30-degree wind

[5] 30 µm particle size assumed as maximum particle size; not detailed in AP 42 reference

direction sector. The upper air data station was Norman Westheimer Airport, Cleveland County, Oklahoma (WBAN- 03948).

AERMET data are processed in three steps. The first step extracts data from the archive data files and performs various quality assessment checks. The second step merges all available data. These merged data are stored together in a single file. The third step reads the merged meteorological data and surface characteristics, then estimates the boundary layer parameters needed by AERMOD. AERMET writes two files for input to AERMOD: a file of hourly boundary layer parameter estimates and a file of multiple-level (when the data are available) observations of wind speed and direction, temperature, and standard deviation of the fluctuating components of the wind direction.

Figure 2 shows the wind rose of the meteorological data, detailing 5-year (2001 to 2005) average wind direction and magnitude. Prevailing winds are from the south (with greatest wind speed) and northeast (lesser wind speed).

Receptors

The selection of receptors in AERMOD was as follows:

- The first run was a 500-meter coarse grid with a nested Cartesian grid of 100 meter-spaced receptors as follows:
  - 100-meter grid extending approximately 1 kilometer (km) around the plant location
  - 500-meter grid extending approximately 5 km
- Terrain data was calculated by AERMAP as described below.

AERMAP was run to process terrain elevation data for all sources and receptors using 7.5 minute Digital Elevation Model (DEM) files prepared by the U.S. Geologic Survey (USGS). AERMAP first determines the base elevation at each source and receptor. For complex terrain situations, AERMOD captures the physics of dispersion and creates elevation data for the surrounding terrain identified by a parameter called hill height scale. AERMAP creates hill height scale by searching for the terrain height and location that has the greatest influence on dispersion for each individual receptor. Both the base elevation and hill height scale data are produced for each receptor by AERMAP as a file or files which can be directly accessed by AERMOD.

Results

The results of the deposition analysis are presented in contour plots in **Figure 3** (aerial photography view) and **Figure 4** (identification of access rights).

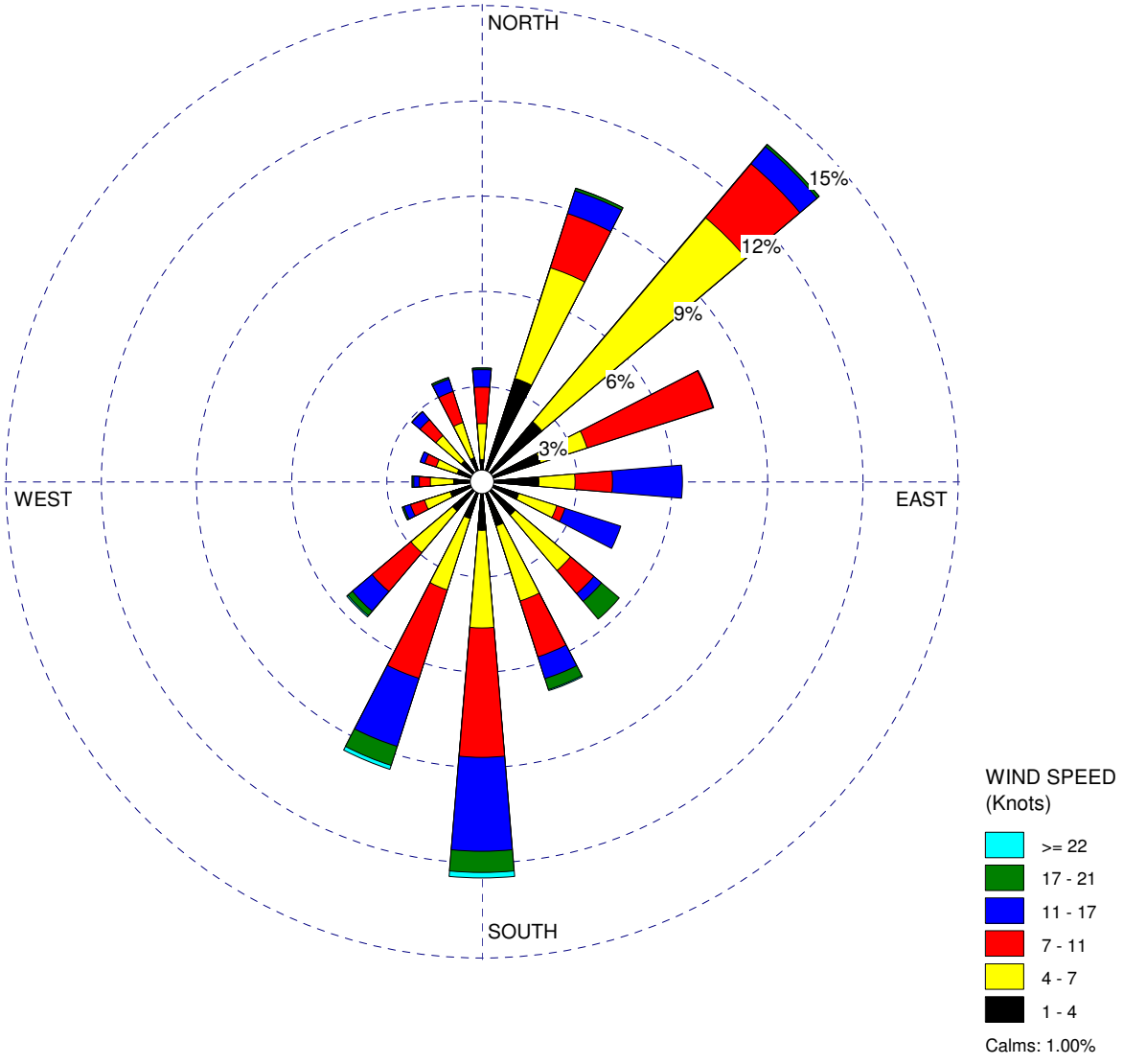
The contour plots present the expected deposition as a percentage of the maximum in a given area. While the plot give equal weighting to the stack and fugitive emissions, the impact from the nine furnaces occur closer to the plant site than the impacts from the stack which occur further downwind. As indicated by the concentric curves surrounding the former plant location, greatest deposition would be expected on or very close to the plant site. The plots indicate that deposition would be expected most likely to occur to the north of the site. At the north edge of the investigation area (1.5 mile radius circle surrounding the

WIND ROSE PLOT:

Surface Station: Skiatook, OK (2001-2005)
Upper Air Station: (03948) Norman Westheimer Airport, OK

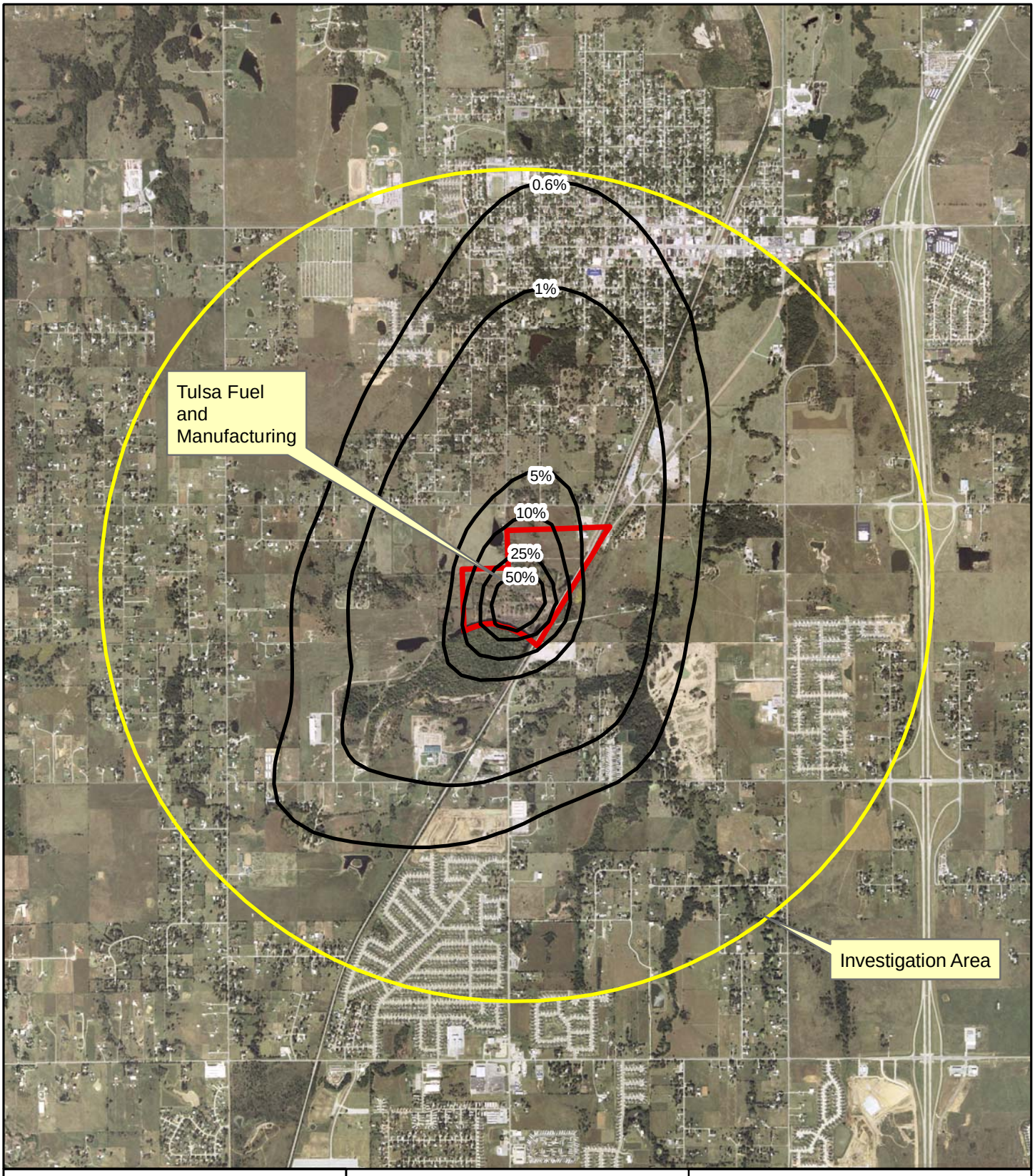
DISPLAY:

Wind Speed
Direction (blowing from)

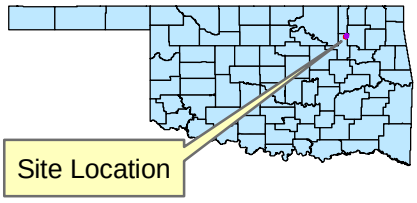


COMMENTS:	DATA PERIOD:	COMPANY NAME: Figure 2 Tulsa Wind Rose	
	2001-2005 **Jan 1 - Dec 31** **00:00 - 23:00**	MODELER:	
	CALM WINDS: **1.00%**	TOTAL COUNT: **43452 hrs.**	
	AVG. WIND SPEED: **7.51 Knots**	DATE: **11/21/2007**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software



Key Map



Legend

Site Boundary

1.5 Mile Buffer Investigation Area

Isopleth Contour

N

0 1,000 2,000
Feet

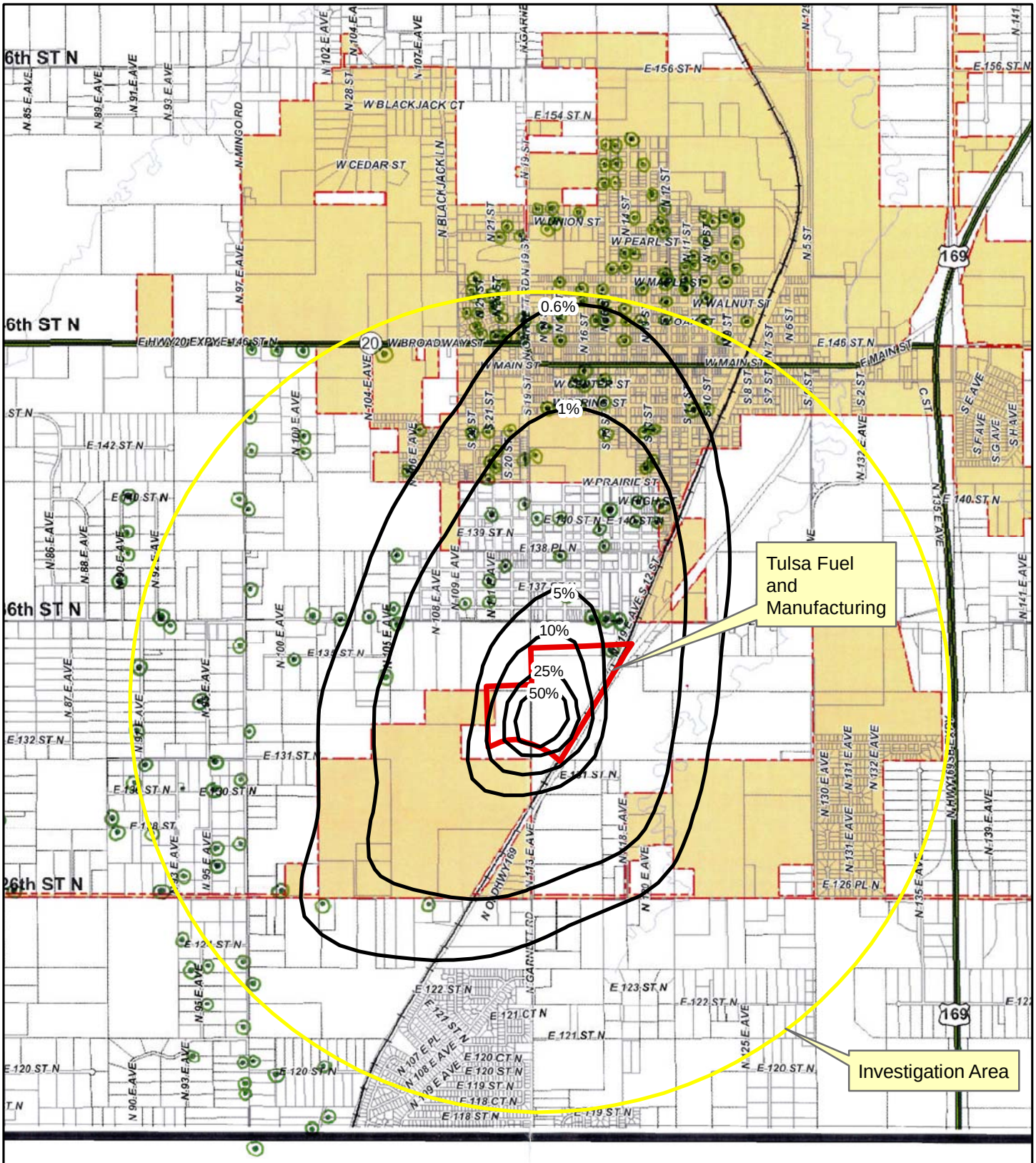
Note: Contours represent % of maximum modeled deposition.

Figure 3
Modeled Depositions Distribution

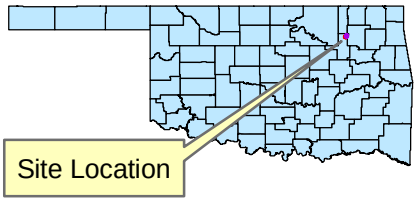
TULSA FUEL AND MANUFACTURING
Collinsville,OK

CH2MHILL

\\chuckwagon\GIS\NWOFILES\TULSA_FUEL\Collinsville_OK\MXD\Figure3.mxd. User: nbhattac Dated:11/06/07



Key Map



Legend

- Site Boundary
- 1.5 Mile Buffer Investigation Area
- Isopleth Contour

N

0 1,000 2,000
Feet

Note: Contours represent % of maximum modeled deposition.

Figure 4
Modeled Deposition Distribution

TULSA FUEL AND MANUFACTURING
Collinsville,OK

CH2MHILL

\\chuckwagon\GIS\NWOFILES\TULSA_FUEL\Collinsville_OK\MXD\Figure4.mxd. User: nbhattac Dated:11/06/07

site), modeled deposition is estimated at 0.6 percent of the maximum modeled deposition location (maximum location in close proximity to former facility).

This analysis was performed based on limited data concerning operation of the site. The following points should be recognized concerning the results:

- Actual magnitude of deposition was not modeled; the results are intended solely to indicate areas most likely to be impacted by deposition on a relative basis, and thus guide soil sampling efforts.
- Results are based on an assumption that the facility operated continuously (365 days per year), at a constant operating rate (and constant emission rate) under weather conditions comparable to those of 2001 to 2005. Impacts of variations in seasonality of operations, production rates, or emission rates can not be predicted based on the available information.
- The relative 50/50 split between main stack (point source) and the 9 furnaces (fugitive sources) is assumed. Variations in the split (e.g., 25/75 stack/furnace, 75/25 stack/furnace) were also considered, but indicated that the general shape of the depositional area is consistent; contour plots are oriented similarly, with the greatest extent to the north of the site, consistent with a southerly prevailing wind.
- Wet deposition associated with precipitation events was not evaluated. During rain events, pollutants would be scavenged from the plume and deposited closer to the plant site rather than be transported down wind.

Appendix B
Offsite Sampling Properties and Addresses
(provided on CD)

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Appendix C
Photographic Record (provided on CD)

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Appendix D
Field Sampling Data Log Sheets and Daily Field Activity Reports (provided on CD)

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Appendix E
Investigation Derived Waste Inventory

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Gulf Coast ACCUTEST Laboratories

IT'S ALL IN THE CHEMISTRY

03/13/08

Technical Report for

CH2M Hill

Tulsa Fuel & Manufacturing/365672.FI.01

Accutest Job Number: T21105

Sampling Date: 03/04/08

Report to:

CH2M Hill
7600 W. Tidwell Road Suite 400
Houston, TX 77040
John.Ynfante@CH2M.com

ATTN: John Ynfante

Total number of pages in report: 19

ACCUTEST LABORATORIES 50 YEARS 1956-2006

ACCREDITED IN ACCORDANCE WITH nelac

Test results contained within this data package meet the requirements of the National Environmental Laboratory Accreditation Conference and/or state specific certification programs as applicable.

Ron Martino
Laboratory Manager

Client Service contact: Sylvia Garza 713-271-4700

This report shall not be reproduced, except in its entirety, without the written approval of Accutest Laboratories.
Test results relate only to samples analyzed.

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Accutest Laboratories

Sample Summary

CH2M Hill

Job No: T21105

Tulsa Fuel & Manufacturing/365672.FI.01

Sample Number	Collected Date	Time By	Received	Matrix Code	Matrix Type	Client Sample ID
T21105-1	03/04/08	10:40 JB	03/05/08	AQ	Water	030408IDW

Sample Results

Report of Analysis

Accutest Laboratories

Report of Analysis

Client Sample ID:	030408IDW		
Lab Sample ID:	T21105-1	**Date Sampled:**	03/04/08
Matrix:	AQ - Water	**Date Received:**	03/05/08
		Percent Solids:	n/a
Project:	Tulsa Fuel & Manufacturing/365672.FI.01		

Metals Analysis, TCLP Leachate SW846 1311

Analyte	Result	HW#	MCL	RL	MDL	Units	DF	Prep	Analyzed	By	Method
Arsenic	0.030 B	D004	5.0	0.50	0.0010	mg/l	1	03/07/08	03/12/08	NS	SW846 6010B [2]
Barium	0.28 B	D005	100	1.0	0.00060	mg/l	1	03/07/08	03/12/08	NS	SW846 6010B [2]
Cadmium	0.0073	D006	1.0	0.0050	0.00040	mg/l	1	03/07/08	03/12/08	NS	SW846 6010B [2]
Chromium	0.018	D007	5.0	0.010	0.0010	mg/l	1	03/07/08	03/12/08	NS	SW846 6010B [2]
Lead	0.066 B	D008	5.0	0.50	0.0020	mg/l	1	03/07/08	03/12/08	NS	SW846 6010B [2]
Mercury	0.0013 U	D009	0.20	0.0020	0.0013	mg/l	1	03/11/08	03/11/08	NS	SW846 7470A [1]
Selenium	0.0032 B	D010	1.0	0.50	0.0010	mg/l	1	03/07/08	03/12/08	NS	SW846 6010B [2]
Silver	0.00070 U	D011	5.0	0.010	0.00070	mg/l	1	03/07/08	03/12/08	NS	SW846 6010B [2]

(1) Instrument QC Batch: MA3424
(2) Instrument QC Batch: MA3426
(3) Prep QC Batch: MP7440
(4) Prep QC Batch: MP7455

RL = Reporting Limit MDL = Method Detection Limit U = Indicates a result < MDL
MCL = Maximum Contamination Level (40 CFR 261 6/96) B = Indicates a result > = MDL but < RL

Misc. Forms

Custody Documents and Other Forms

Includes the following where applicable:

- Chain of Custody

CH2M HILL
CHAIN OF CUSTODY RECORD

T21105

Project/Contact Information	
Project #	365672.FI.01
Project Name	Tulsa Fuel & Manufacturing
Report Copy to	John Infante
Company Name/Contact	CH2M HILL / John Infante

Sampling Date	Time	Type Comp	Type Grab	Matrix Water	Matrix Soil	Matrix Air	Client Sample ID (9 Characters Max)	LAB QC	Total Number of Containers	Requested Analysis: TCLP Metals	Preservative: HNO3	Alternate Description	Lab ID
1 03/04/08	1040	X		X			030408IDW		1	X		IDW Sample	

THIS AREA FOR LAB USE ONLY	
Lab #	Pg 1 of 1
Lab PM	Custody Review
Log In	LIMS Verification
pH	Cust Seals Y N / Ice Y N
QC Level 1 2 3	
Cooler Temperature	

Sampled By	Jayson Burkard 03/04/08 1600	Relinquished By	Jayson Burkard 03/04/08 1600
Received By	R Montano 3/5/08 1100	Relinquished By	
Received By		Date/Time	26°C
Special Instructions			

File: Chain of Custody (blank).xls

3.1 3

T21105: Chain of Custody
Page 1 of 3

ACCUTEST.

VARIANCE MEMO
SAMPLE LOG-IN

SAMPLE(S) 1 DATE 3/5/8
PROJECT Green Hill
FILED BY RM LAB NO. T21105

VARIANCE - Check applicable items(s):

- ___ Insufficient sample sent for proper analysis; received approx. ___
- ___ Sample bottle received broken and/or cap not intact.
- ___ Samples received without paperwork; paperwork received without samples.
- ___ Samples received without proper refrigeration, when it has been deemed necessary. Temperature at receipt: ___
- ___ Illegible sample number or label missing from bottle.
- ___ Numbers on sample not the same as numbers on paper work.
- ___ Incomplete instructions received with sample(s) ie.,no request for analysis, no chain of custody, incomplete billing instructions, no due date, etc. Temperature at reciept: ___
- X Samples received in improper container or lacking proper preservation.
- ___ Physical characteristics different than those on sampling sheets; Describe: ___
- ___ Rush samples on hold because of incomplete paperwork.
- ___ Other (specify) Sample is preserved @ pH < 2. Want TCLP Analysis. Sample should be unpreserved. Must Preserve after filtration

CORRECTIVE ACTION TAKEN

- John Yotant Person Contacted
- ___ Client informed verbally.
- ___ Client informed by memo/letter.
- ___ Samples processed as is.
- ___ Samples preserved by lab.
- ___ Client will resample and resubmit.
- ✓ By phone.
- ___ Samples processed for information only and noted on report.
- ___ Samples processed with higher detection limits accepted.
- ___ Samples rejected.

Notes: ___

ROUTING

TITLE	DATE	INITIALS	CORRECTED?
Sample Manager:			
Login:			
Project Manager:	3-5-8	[illegible]	

Comments: proceed w/ analysis

Form: SM006

T21105: Chain of Custody
Page 2 of 3

ACCUTEST.

SAMPLE RECEIPT LOG

JOB #: T21105

DATE/TIME RECEIVED: 3/5/8

CLIENT: CH2M Hill

INITIALS: TM

Condition/Variance (Circle "Y" for yes and "N" for no or NA. If "N" is circled, see variance for explanation):

1. Y N Sample received in undamaged condition.
2. Y N Samples received within temp. range.
3. Y N Sample received with proper pH.
4. Y N Sample received in proper containers.
5. Y N Sample volume sufficient for analysis.
6. Y N Sample received with chain of custody.
7. Y N Chain of Custody matches **sample IDs and analysis** on containers.
8. Y N Samples Headspace acceptable
9. Y N NA Custody seal received intact and tamper not evident on cooler.
10. Y N NA Custody seal received intact and tamper not evident on bottles.

SAMPLE or FIELD ID	BOTTLE #	DATE SAMPLED	MATRIX	VOLUME	LOCATION	PRESERV.	PH
1	1	3/4/8	AQ	1L	1Q	1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA
						1,2,3,4,5,6	U, <2, >12, NA

LOCATION: WI: Walk-In VR: Volatile Refrig. SUB: Subcontract EF: Encore Freezer

PRESERVATIVES: 1: None 2: HCL 3: HNO3 4: H2SO4 5: NAOH 6: Other

Comments:

pH of waters checked excluding volatiles

pH of soils N/A

Delivery method: Courier:

COOLER TEMP: COOLER TEMP:

COOLER TEMP: COOLER TEMP:

Form: SM012, Rev.07/28/06, QAO

3.1 3

T21105: Chain of Custody

Page 3 of 3

Metals Analysis

QC Data Summaries

Includes the following where applicable:

- Method Blank Summaries
- Matrix Spike and Duplicate Summaries
- Blank Spike and Lab Control Sample Summaries
- Serial Dilution Summaries

BLANK RESULTS SUMMARY
Part 2 - Method Blanks

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7440
Matrix Type: LEACHATE

Methods: SW846 6010B
Units: mg/l

Prep Date: 03/07/08

Metal	RL	IDL	MB raw	final
Aluminum	0.20	.051		
Antimony	0.20	.0018		
Arsenic	0.50	.0014	0.00015	<0.50
Barium	1.0	.0001	0.054	<1.0
Beryllium	0.0050	.00006		
Boron	0.10	.0014		
Cadmium	0.0050	.0005	-0.00012	<0.0050
Calcium	5.0	.008		
Chromium	0.010	.0009	0.00026	<0.010
Cobalt	0.050	.00099		
Copper	0.025	.0014		
Iron	0.10	.016		
Lead	0.50	.0007	0.0020	<0.50
Magnesium	5.0	.008		
Manganese	0.015	.0002		
Molybdenum	0.0050	.00045		
Nickel	0.040	.001		
Potassium	5.0	.08		
Selenium	0.50	.0017	0.00077	<0.50
Silver	0.010	.0005	-0.00062	<0.010
Sodium	5.0	.16		
Strontium	0.010	.0005		
Thallium	0.20	.0015		
Tin	0.010	.0015		
Titanium	0.010	.0005		
Vanadium	0.050	.0004		
Zinc	0.10	.0008		

Associated samples MP7440: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(anr) Analyte not requested

MATRIX SPIKE AND DUPLICATE RESULTS SUMMARY

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7440
Matrix Type: LEACHATE

Methods: SW846 6010B
Units: mg/l

4.1.2 4

Prep Date:			03/07/08					03/07/08	
Metal	T21105-1 Original	DUP	RPD	QC Limits	T21105-1 Original	MS	Spikelot MPITCLP1	% Rec	QC Limits
Aluminum									
Antimony									
Arsenic	0.030	0.029	3.4	0-20	0.030	2.1	2.0	103.5	75-125
Barium	0.28	0.28	0.0	0-20	0.28	10.3	10.0	100.2	75-125
Beryllium									
Boron									
Cadmium	0.0073	0.0074	1.4	0-20	0.0073	0.058	0.050	101.4	75-125
Calcium									
Chromium	0.018	0.018	0.0	0-20	0.018	0.24	0.20	111.0	75-125
Cobalt									
Copper									
Iron									
Lead	0.066	0.064	3.1	0-20	0.066	2.2	2.0	106.7	75-125
Magnesium									
Manganese									
Molybdenum									
Nickel									
Potassium									
Selenium	0.0032	0.0025	24.6 (a)	0-20	0.0032	2.1	2.0	104.8	75-125
Silver	0.0	0.0	NC	0-20	0.0	0.051	0.050	102.0	75-125
Sodium									
Strontium									
Thallium									
Tin									
Titanium									
Vanadium									
Zinc									

Associated samples MP7440: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(N) Matrix Spike Rec. outside of QC limits
(anr) Analyte not requested
(a) RPD acceptable due to low duplicate and sample concentrations.

MATRIX SPIKE AND DUPLICATE RESULTS SUMMARY

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7440
Matrix Type: LEACHATE

Methods: SW846 6010B
Units: mg/l

Prep Date: 03/07/08

Metal	T21105-1 Original	MSD	Spikelot MPITCLP1	% Rec	MSD RPD	QC Limit
Aluminum						
Antimony						
Arsenic	0.030	2.1	2.0	103.5	0.0	
Barium	0.28	10.4	10.0	101.2	1.0	
Beryllium						
Boron						
Cadmium	0.0073	0.058	0.050	101.4	0.0	
Calcium						
Chromium	0.018	0.24	0.20	111.0	0.0	
Cobalt						
Copper						
Iron						
Lead	0.066	2.2	2.0	106.7	0.0	
Magnesium						
Manganese						
Molybdenum						
Nickel						
Potassium						
Selenium	0.0032	2.1	2.0	104.8	0.0	
Silver	0.0	0.051	0.050	102.0	0.0	
Sodium						
Strontium						
Thallium						
Tin						
Titanium						
Vanadium						
Zinc						

Associated samples MP7440: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(N) Matrix Spike Rec. outside of QC limits
(anr) Analyte not requested

SPIKE BLANK AND LAB CONTROL SAMPLE SUMMARY

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7440
Matrix Type: LEACHATE

Methods: SW846 6010B
Units: mg/l

Prep Date: 03/07/08

Metal	BSP Result	Spikelot MPITCLP1	% Rec	QC Limits
Aluminum				
Antimony				
Arsenic	2.0	2.0	100.0	80-120
Barium	9.7	10.	97.0	80-120
Beryllium				
Boron				
Cadmium	0.050	0.050	100.0	80-120
Calcium				
Chromium	0.22	0.20	110.0	80-120
Cobalt				
Copper				
Iron				
Lead	2.1	2.0	105.0	80-120
Magnesium				
Manganese				
Molybdenum				
Nickel				
Potassium				
Selenium	2.0	2.0	100.0	80-120
Silver	0.049	0.050	98.0	80-120
Sodium				
Strontium				
Thallium				
Tin				
Titanium				
Vanadium				
Zinc				

Associated samples MP7440: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(anr) Analyte not requested

SERIAL DILUTION RESULTS SUMMARY

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7440
Matrix Type: LEACHATE

Methods: SW846 6010B
Units: ug/l

Prep Date: 03/07/08

Metal	T21105-1 Original	SDL 1:5	RPD	QC Limits
Aluminum				
Antimony				
Arsenic	29.9	28.5	4.7	0-10
Barium	285	294	3.0	0-10
Beryllium				
Boron				
Cadmium	7.28	7.06	3.0	0-10
Calcium				
Chromium	17.6	16.9	3.7	0-10
Cobalt				
Copper				
Iron				
Lead	65.6	66.5	1.3	0-10
Magnesium				
Manganese				
Molybdenum				
Nickel				
Potassium				
Selenium	3.24	0.00	100.0(a)	0-10
Silver	0.00	0.00	NC	0-10
Sodium				
Strontium				
Thallium				
Tin				
Titanium				
Vanadium				
Zinc				

Associated samples MP7440: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(anr) Analyte not requested
(a) Percent difference acceptable due to low initial sample concentration (< 50 times IDL).

BLANK RESULTS SUMMARY
Part 2 - Method Blanks

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7455
Matrix Type: LEACHATE

Methods: SW846 7470A
Units: mg/l

Prep Date: 03/11/08

Metal	RL	IDL	MB raw	final
Mercury	0.0020	.00049	-0.00014	<0.0020

Associated samples MP7455: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(anr) Analyte not requested

MATRIX SPIKE AND DUPLICATE RESULTS SUMMARY

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7455
Matrix Type: LEACHATE

Methods: SW846 7470A
Units: mg/l

Prep Date: 03/11/08 03/11/08

Metal	T21105-1 Original	DUP	RPD	QC Limits	T21105-1 Original	MS	Spikelot HGTXAQ40	% Rec	QC Limits
Mercury	0.0	0.0	NC	0-20	0.0	0.032	0.030	106.7	75-125

Associated samples MP7455: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(N) Matrix Spike Rec. outside of QC limits
(anr) Analyte not requested

MATRIX SPIKE AND DUPLICATE RESULTS SUMMARY

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7455
Matrix Type: LEACHATE

Methods: SW846 7470A
Units: mg/l

Prep Date: 03/11/08

Metal	T21105-1 Original	MSD	Spikelot HGTXAQ40	% Rec	MSD RPD	QC Limit
Mercury	0.0	0.031	0.030	103.3	3.2	

Associated samples MP7455: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(N) Matrix Spike Rec. outside of QC limits
(anr) Analyte not requested

SPIKE BLANK AND LAB CONTROL SAMPLE SUMMARY

Login Number: T21105
Account: CHHMTXHO - CH2M Hill
Project: Tulsa Fuel & Manufacturing/365672.FI.01

QC Batch ID: MP7455
Matrix Type: LEACHATE

Methods: SW846 7470A
Units: mg/l

Prep Date: 03/11/08

Metal	BSP Result	Spikelot HGTXAQ40	% Rec	QC Limits
Mercury	0.030	0.030	100.0	80-120

Associated samples MP7455: T21105-1

Results < IDL are shown as zero for calculation purposes
(*) Outside of QC limits
(anr) Analyte not requested

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Appendix F
Data Validation Summary and Analytical Data
(provided on CD)

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