FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
SAMPLING AND ANALYSIS PLAN
TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA

VOLUME I
FIELD SAMPLING PLAN

VOLUME II
QUALITY ASSURANCE PROJECT PLAN

July 2005

Prepared for

Oklahoma
Department of Environmental Quality

Burns & McDonnell Project No. 36478
Burns & McDonnell Engineering Company
Engineers-Architects-Consultants
Kansas City, Missouri

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
BMcD	Burns & McDonnell Engineering Company, Inc.
^{o}C	degrees Celsius
CCE	CC Environmental
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
CIH	Certified Industrial Hygienist
CLP	Contract Laboratory Program
COC	chain of custody
COPC	chemical of potential concern
DEQ	Department of Environmental Quality
DO	Dissolved Oxygen
DOT	United States Department of Transportation
DQO	data quality objective
ESB	USEPA Region 6 Environmental Services Branch
^{o}F	degrees Fahrenheit
FS	Feasibility Study
FSM	Field Site Manager
FSP	Field Sampling Plan
ft	feet
gpm	gallons per minute
GPS	Global Positioning System
HAS	hollow stem auger
HSM	Health and Safety Manager
HSP	Health and Safety Plan
IDW	investigation-derived waste
ITEC	Inter-Tribal Environmental Council
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
mph	miles per hour
MSDS	material safety data sheets
msl	mean sea level
MS/MSD	matrix spike/matrix spike duplicate

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LIST OF ACRONYMS AND ABBREVIATIONS (continued)

NAVD 88	North American Vertical Datum 88
NCP	National Contingency Plan
NELAP	National Environmental Laboratory Accreditation Program
NWCC	National Water and Climate Center
NWS	National Weather Service
OAC	Oklahoma Administrative Code
OCS	Oklahoma Climatological Survey
ONHI	Oklahoma Natural Heritage Inventory
OSDH	Oklahoma State Department of Health
PCB	polychlorinated biphenyl
PID	photoionization detector
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RLS	Registered Land Surveyor
ROD	Record of Decision
RPM	Remedial Project Manager
RSCC	Regional Sample Control Center
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCM	Sample Control Manager
SDG	sample delivery group
SEL	Oklahoma State Environmental Laboratory
SHSS	Site Health and Safety Supervisor
SMO	Sample Management Office
SOP	standard operating procedure
SVOC	semivolatile organic compound
SW-846	*Test Methods for Evaluating Solid Waste, Physical and Chemical Methods*
TAL	Target Analyte List
TBC	to-be-considered
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TFM	Tulsa Fuel and Manufacturing
TGS	Tulsa Geological Survey
TR	traffic report
TSCA	Toxic Substances Control Act

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LIST OF ACRONYMS AND ABBREVIATIONS (continued)

USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VOC	volatile organic compound

* * * * *

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1.0 PROJECT DESCRIPTION

1.1 SITE HISTORY AND DESCRIPTION

1.1.1 Introduction

Burns & McDonnell Engineering Company, Inc. (BMcD), under contract with the Oklahoma Department of Central Services Construction and Properties Division on behalf of the Oklahoma Department of Environmental Quality (DEQ), will conduct a remedial investigation (RI) and feasibility study (FS) of the Tulsa Fuel and Manufacturing site (TFM) in Collinsville, Oklahoma (See Figure 1-1). The RI/FS is 100% federally funded through a Cooperative Agreement between the DEQ and the United States Environmental Protection Agency (USEPA).

This RI/FS Field Sampling Plan (FSP) has been prepared by BMcD as part of the Sampling and Analysis Plan (SAP) for TFM. The SAP is presented in the following volumes:

- Volume I, FSP
- Volume II, Quality Assurance Project Plan (QAPP) (BMcD, 2005a)

This FSP presents the requirements and procedures for conducting RI/FS field operations and investigations. Included in this FSP is the envisioned scope of field activities for the RI/FS at the TFM. The organization of this FSP is as follows:

Section 2.0 Organization and Responsibilities

Section 3.0 Scope and Objectives

Section 4.0 Field Operations and Sampling Procedures

Section 5.0 Sample Chain of Custody/Documentation

Section 6.0 Sample Packaging and Shipping Requirements

Section 7.0 Investigation-Derived Wastes

Section 8.0 Corrective Action

Section 9.0 Project Schedule

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Section 10.0 References

1.1.2 Summary of Environmental History

During World War I, zinc was in great demand. It was used to galvanize armaments to prevent rust. A zinc smelter and lead roaster were at the TFM location from 1914 through 1925. Historically, the smelter was known as the Prime Western Smelter. The TFM was also misnamed as Acme Brick Strip Mines site, since it was immediately adjacent to a strip mine on its southern boundary (DEQ, 2005b). Use of the land prior to the smelting operation is unknown (Oklahoma State Department of Health [OSDH], 1992).

The smelting operation utilized nine furnaces, approximately 150 feet (ft) in length by 60 ft wide, which were believed to be fueled by nearby natural gas wells. Other main structures of the smelter included a mechanical kiln building approximately 240 ft by 80 ft in size, a condenser room approximately 75 ft by 50 ft in size, and a laboratory (See Figure 1-2). A 2-million gallon capacity reservoir was used in conjunction with the condenser room during smelting operations. In addition, large amounts of ore were stored on the site in the area northeast of the waste piles (Figure 1-2). Little is known about waste management at the smelter during its operation. Due to the time period in which the smelter operated, it is unlikely that air emission control devices were used (DEQ, 1994 and OSDH, 1992). A copy of the Sanborn Fire Insurance Map is provided in Appendix B-1 to the *Remedial Investigation/Feasibility Study Work Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma* (RI/FS Work Plan, BMcD, 2005c).

Strip mining occurred in the surrounding area. Immediately south of the site was a strip mining operation approximately 40 acres in size, which was known as the Acme Brick Strip Mine (OSDH, 1992). A water-filled surface impoundment (i.e., strip mine pit), which acts as a southern boundary to the TFM, is currently associated with the former strip mine. It has been reported that this impoundment serves as a local fishery (DEQ, 2005b). Another strip mine area operated just east of the TFM, and one was located in northeast Collinsville (Figure 1-1).

The Collinsville Smelter, which is being evaluated through DEQ's Voluntary Cleanup Program, is located approximately ¼ mile to the east-northeast of the TFM (Figure 1-1). The Bartlesville Zinc Company owned and operated this zinc smelter between 1911 and 1918. The Bartlesville Zinc Company owned 220 acres of land surrounding the smelter area, but only 40 of those acres are currently under review. In 1987, the Collinsville Smelter was reclaimed and regraded by the Oklahoma Conservation Commission in conjunction with reclamation of the adjacent coal strip mine (Exponent, 2001).

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The majority of the structures have been demolished, but several foundations and building footings remain on the TFM. On September 28, 1928, the 120-foot tall and 11-foot diameter smokestack was imploded. A residence (Figures 1-2 and 1-3), which was occupied from 1935 through February 2002, was located on the TFM near the former office building (paymaster hut). The on-site residence was destroyed by a fire and is currently unoccupied. The residence has a water well that was used in the past for drinking water but is no longer in use. No other residential structures are located on the site; however, a garage and a few storage sheds remain in place adjacent to the former residence.

Although the TFM is partially fenced, there is evidence of trespassing. There is abundant evidence of fishing and hunting activity around the ponds on the TFM, and fishing in the ponds has been reported on several occasions. In addition, individuals have been observed picking blackberries along the eastern fenced boundary and evidence of off-road vehicle traffic is present. The area in the vicinity of the on-site residence, including the garage and storage sheds and along the access road/driveway, has become a trash dump. Broken appliances, used exercise equipment, junked cars, and assorted trash/debris were observed during the March 29, 2005 site tour.

At other smelter sites in Oklahoma, slag or waste material was transported off the site and used as fill in driveways, gardens, and school running tracks. Since the TFM was abandoned in the 1920s and large amounts of slag material were left behind, this could have occurred in the past. Other than an investigation of the former Collinsville Strip Mine (Fluor Daniel, Inc., 1997), no sampling data have been taken to evaluate that possibility. During a February 14, 2001 DEQ site visit, DEQ located what appears to be a slag-based parking lot at 123 W. 5th Street in Collinsville, Oklahoma. Additionally, a local newspaper article from 1936 states that a rock crusher was placed at the TFM for the manufacturing of road base for area roads (DEQ, 2005b).

1.1.3 Summary of Environmental Setting

This section discusses the physical setting of the site including topography, local ecology, climatology, and hydrogeology.

1.1.3.1 Physical Setting

As indicated in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), the location for the TFM is approximately 1 1/3 miles south of downtown, Collinsville in Tulsa County, Oklahoma. The TFM is located in the NE1/4 SE1/4 NE1/4 Section 31 and SW1/4 NW1/4 Section 32 Township 22 North Range 14 East in Tulsa County, Oklahoma, and has the

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coordinates of 36° 20’ 45.59” north latitude and 95° 50’ 51.28” west longitude. As shown on Figures 1-1 through 1-3, the TFM consists of approximately 50 acres and is bounded by “Old” U.S. Highway 169 and the Atchinson Topeka Sante Fe railroad tracks to the east, an impoundment (i.e., strip mine pit) that comprises the boundary of a former strip mining operation to the south, and agricultural lots to the north and west (OSDH, 1992). Additionally, the Faith Assembly Church property directly bounds the TFM to the north (Figures 1-2 and 1-3). The Collinsville Smelter, which is a former zinc smelter, is located approximately ¼ mile to the east-northeast of the TFM (Figure 1-1).

In 2004, a 6-foot chain link fence was installed across the access road/driveway entrance into the TFM (DEQ, 2005a). The location of the fence is shown on Figures 1-2 and 1-3. Barbed-wire fencing is also located along the western boundary (Figures 1-2 and 1-3). The southern boundary is comprised of the strip mine pit, which is the only unfenced boundary (Figures 1-2 and 1-3).

1.1.3.2 Surface Features

The TFM consists of approximately 50 acres (OSDH, 1992). The majority of the facility structures have been demolished. Previous studies have indicated that approximately seven (7) acres of the site are covered with approximately 30,000 cubic yards of waste consisting of broken retorts and condensers, slag, building debris, ash, bricks, and other materials from the former smelting operations (DEQ, 2005b). This waste area is located to the south of the access road/driveway (Figure 1-3). The waste varies in thickness from 2-ft to greater than 6-ft. The waste piles are not covered, and run-off is uncontrolled. The waste borders the southern strip mine impoundment, and portions of the waste have collapsed into the impoundment. This impoundment, which receives surface water runoff from the TFM, is reportedly a local fishery and flows into an intermittent drainage ditch (eastern wetlands, Figures 1-2 and 1-3) that borders on the eastern edge of the waste (DEQ, 2005b). An intermittent stream originates in this area and flows approximately ¾ mile before draining into Blackjack Creek, which is located east of the TFM (Figure 1-1). It has been reported that the southern impoundment is connected hydraulically with the intermittent stream and that the stream receives surface water runoff from the site (OSDH, 1992). Three ponds, which are assumed to be remnants of the 2-million gallon reservoir, are located north of the waste piles (DEQ, 2005b). In addition, two smaller ponds are located on the TFM (Figures 1-2 and 1-3). The area north of the access road/driveway is vegetated with grasses (Figures 1-2 and 1-3).

A residence (Figures 1-2 and 1-3), which was occupied from 1935 through February 2002, was located on the site near the former office building (paymaster hut). The on-site residence was destroyed by a fire and is currently unoccupied. The residence has a water well, which was used in the past for drinking water

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(DEQ, 2005b). A cistern is located just north of the intermittent drainage that travels west to east across the southern portion of the TFM (Figures 1-2 and 1-3).

1.1.3.3 Local Ecology

The TFM is vegetated by various grass species, trees, and shrubs creating diverse habitat types. There are areas of dense vegetation interspersed with sparsely vegetated areas and patches of bare or rocky ground. Species of wildlife that likely occur on the TFM include bullsnake (*Pituophis melanoleucus*), Woodhouse's toad (*Bufo woodhousei*), box turtle (*Terrapene sp.*), common garter snake (*Thamnophis sirtalis*), black ratsnake (*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 mouse (*Peromyscus leucopus*), eastern cottontail (*Sylvilagus floridanus*), white-tailed deer (*Odocoileus virginianus*), killdeer (*Charadrius vociferous*), mourning dove (*Zenaida macroura*), cooper's hawk (*Accipiter cooperii*), red-winged blackbird (*Agelaius phoeniceus*), American robin (*Turdus migratorius*), barn swallow (*Hirundo rustica*), and scissor-tailed flycatcher (*Tryannus forficatus*). These are common species that are typically found in areas that exhibit varying amounts of disturbance.

According to the Oklahoma Natural Heritage Inventory (ONHI) database (ONHI, 2003), the following protected species are known or are likely to occur in Tulsa County:

Common Name	Scientific Name	Federal Status	State Status
American Burying Beetle	*Nicrophorus americanus*	Endangered	Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Threatened	Endangered
Least Tern	*Sterna antillarum*	Endangered	Endangered
Texas Horned Lizard	*Phrynosoma cornutum*	--	Candidate

Several additional protected terrestrial and aquatic species have the potential to be present within the general area (OSDH, 1992); however, based on topography and surface features, only the federally threatened western prairie fringed orchid (*Platanthera praeclara*) and the prairie mole cricket (*Gryllotalpa major*), a species that is proposed for federal listing, could potentially be present at the TFM.

Based on evidence of hunting (i.e., decoys present in the on-site ponds), waterfowl are present at least some time during the year. During a site visit conducted during USEPA's Removal Assessment, local fishermen reported that catfish and bass were present in the southern strip mine pit (USEPA, 1999).

1.1.3.4 Climatology

Located in northeast Oklahoma, approximately 22 miles north of Tulsa, the TFM primarily has a continental climate, with pronounced daily and seasonal temperature changes. Summers are hot and fairly humid, with average high temperatures in July and August above 90 degrees Fahrenheit (^{o}F) and average low temperatures slightly above 70 ^{o}F during these months. Winters are fairly short and mild, with January typically being the coldest month. The average high temperature in January is 46 ^{o}F, and the average low temperature is 26 ^{o}F (National Weather Service [NWS], 2005).

Severe weather storms with strong winds, hail, thunder/lightning storms, and tornadoes occur primarily between the months of March and June. From 1888 to present, the average annual rainfall was 42.4 inches. May was the wettest month, with average monthly rainfall of 6.1 inches (NWS, 2005). The record 24-hour rainfall was 9.27 inches and occurred during the month of May. Between 1950 and 2000, 68 tornadoes were reported in Tulsa County, which averages just over one per year (Oklahoma Climatological Society [OCS], 2005).

Snowfall is infrequent, with an average of approximately 9.2 inches per year. Snow primarily occurs from December through March. January has the highest monthly average snowfall of 3 inches (NWS, 2005).

Prevailing surface winds as measured at the Tulsa International Airport are from the south at an average approximate velocity of 10.7 miles per hour (mph) (National Water and Climate Center [NWCC], 2005). In the winter months from November through March, winds are variable with predominant directions from the south, south-southeast, north, and north-northwest. During the spring season from April to May, winds are predominantly from the south and south-southeast. During the summer and fall, there is also a south-southwesterly component to the predominant winds (NWCC, 2005). Wind rose data from the Tulsa International Airport is provided in Appendix A of the RI/FS Work Plan (BMcD, 2005c).

1.1.3.5 Geology and Soils

Collinsville is located in the North American Central Lowlands physiographic province. The terrain is characterized by nearly level uplands, bottomlands around the major streams, and gentle, rolling hills. The TFM topography is generally flat with an elevation of approximately 650 ft above mean sea level (msl) and elevations within a one-mile radius of the TFM ranging from 620 to 740 ft msl.

The geologic strata underlying the TFM consists of shale and sandstone with interbedded coal deposits of the Pennsylvanian-aged Seminole Formation. The Seminole Formation, generally exhibiting a thickness of 200 ft, is divided into an upper sandstone, a middle shale, and a basal sandstone (Tulsa Geological Survey [TGS], 1973). The middle shale zone locally contains the Dawson Coal, up to 30 inches thick, which was mined locally in the Collinsville area. Underlying the Seminole Formation is the Pennsylvanian Holdenville Shale, composed of shale with minor sandstone and limestone strata. Based on drilling logs obtained from wells installed in the vicinity, shale is anticipated to be encountered beneath the TFM at depths ranging from 17 to 28 ft below ground surface (bgs).

According to previous studies completed in the Collinsville area, soils at the TFM are expected to include the Kanima Series and the Okemah-Parson-Carytown complex (United States Department of Agriculture [USDA], 1977). The Kanima soils consist of a shalely, silty clay loam, have moderate to low permeability and normally form on slopes greater than 3 percent within strip-mining areas. Soils of the Okemah-Parson-Carytown complex consist of acidic, silty loam to silty clay and are typically found on slopes between 0 and 1 percent. These soils are moderately to poorly drained with low to very low permeability.

1.1.3.6 Hydrogeology and Surface Water Hydrology

The Seminole Formation, the upper bedrock aquifer beneath the TFM, consists of shale, sandstone, and thin coal beds and has a thickness of approximately 200 ft. The Seminole Formation reportedly yields small amounts of fair to poor quality water and has been designated Class IIB as a minor use general basin (Oklahoma Administrative Code [OAC], 2004). There are no municipal or other public water wells or Wellhead Protection Areas within a 4-mile radius of the TFM. A water well search identified several private wells located within a one-mile radius of the TFM, including a residential well located on the TFM property. The identified wells varied in depth from 32 ft to 200 ft bgs and exhibited yields ranging from one to 40 gallons per minute (gpm). No yield data was available from the on-site residential well. Groundwater flow direction is anticipated to be to the north, consistent with the general direction of surface water flow in the vicinity of the TFM.

Surface water is present at the TFM in several ponds and intermittent drainages. A surface impoundment from a former strip mining pit comprises the southern boundary of the TFM. Water from this strip pit impoundment flows into an intermittent drainage ditch (also described as the eastern wetlands) that borders the eastern edge of the site near the waste piles (DEQ, 1994). Three ponds, which are assumed to be remnants of an old reservoir, are located in the area north of the waste piles and south of the dirt access

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road (Figures 1-2 and 1-3). Additionally, two smaller ponds have been identified on the property, one located just northwest of the larger three ponds and the other located near the western boundary of the TFM. The overall surface drainage is to the east, towards Blackjack Creek, a meandering stream located to the east of the TFM (Figure 1-1). Blackjack Creek flows northerly for approximately five miles until it meets Horsepen Creek, which in turn flows approximately two miles easterly before meeting the Caney River (DEQ, 1994). The Caney River has been designated for the following uses by the State of Oklahoma: public and private water supply, warm water aquatic community, class I irrigation, industrial and municipal process and cooling water, primary body contact recreation beneficial use, and aesthetics beneficial use (OAC, 2004). The major recreational water body in the Collinsville area is Oolagah Lake, located approximately 15 miles to the northeast. Oolagah Lake is also the source of drinking water for the city of Collinsville and the rural water supplies (OSDH, 1992).

1.2 SUMMARY OF EXISTING SITE DATA

Previous investigations of the TFM and other locations in the Collinsville area are detailed in the RI/FS Work Plan (BMcD, 2005c).

1.3 POTENTIAL SAMPLING AND ANALYTICAL CHALLENGES

Intrusive sample locations may need to be adjusted in the field due to the presence of subsurface obstructions. In areas south of the access road/driveway, the presence of slag-like waste piles may create difficult conditions for direct-push or drilling activities. In many instances, the use of trenching should overcome these difficulties. BMcD will attempt to offset sample locations, where necessary, such that the rationale for the sample location remains valid.

* * * * *

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2.0 ORGANIZATION AND RESPONSIBILITIES

Planning, field investigation, and reporting will be conducted by BMcD and coordinated with the DEQ, and the USEPA. Key project personnel and other parties involved with this project are outlined in this section and presented in Figure 2-1.

2.1 OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

The DEQ is the lead agency for the TFM and has entered into a Cooperative Agreement with the USEPA to conduct an RI/FS of the TFM. The DEQ will direct overall project efforts. DEQ and USEPA will be responsible for final approval of environmental data and decisions based on data related to the facility. Mr. George Thomas will serve as the DEQ Project Manager. The primary responsibilities for the DEQ Project Manager are as follows:

- overall responsibility for project coordination
- review and approve the project documents and subsequent revisions
- ensure implementation of project documents
- coordinate sample analysis with Oklahoma State Environmental Lab (SEL)
- coordinate involvement of USEPA Region 6
- coordinate involvement of the Inter-Tribal Environmental Council (ITEC)

Contact information for the DEQ Project Manager follows:

Oklahoma Department of Environmental Quality
Land Protection Division
707 N. Robinson
Oklahoma City, OK 73102

Attn: George Thomas
(405) 702-5126
George.Thomas@deq.state.ok.us

2.2 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

The DEQ has entered into a Cooperative Agreement with the USEPA to conduct the RI/FS of the TFM. The USEPA is providing overall regulatory oversight of the RI/FS. USEPA has review responsibilities

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for the project plans, RI Report, and FS that are being developed as part of this project. Mr. Michael Torres will serve as the USEPA Region 6 Project Manager. The primary responsibilities for the USEPA Project Manager are as follows:

- review and approve the project documents and subsequent revisions
- coordinate involvement of USEPA Region 6 Lab and Contract Laboratory Program (CLP) lab(s)
- develop Record of Decision (ROD) for the TFM following the RI/FS

Contact information for the USEPA Region 6 Project Manager follows:

United States Environmental Protection Agency
Superfund – Louisiana/Oklahoma
1455 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Attn: Michael Torres
(214) 665-2108
Torres.Michael@epa.gov

2.3 INTER-TRIBAL ENVIRONMENTAL COUNCIL

The mission of the ITEC is to protect the health of Native Americans, their natural resources, and their environment as it relates to air, land, and water. Since the TFM lies within the jurisdictional boundaries of the Cherokee Nation and tribal members are known to live within one-half mile of the TFM, ITEC has interest in the RI/FS. As such, ITEC is providing technical management assistance for environmental matters related to the TFM. Mr. Frank Harjo will serve as the ITEC representative. The primary responsibilities for the ITEC representative are as follows:

- Identify and communicate any tribal concerns regarding activities on the TFM
- Communicate TFM activities and findings to tribal members within the community

Contact information for the ITEC Representative follows:

Inter-Tribal Environmental Council of Oklahoma
Cherokee Nation Office of Environmental Services
115 W. North Street
Tahlequah, OK 74465

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Attn: Frank Harjo
(918) 458-5496
fharjo@cherokee.org

2.4 BURNS & MCDONNELL

DEQ has contracted BMcD to support DEQ's Cooperative Agreement with USEPA in conducting the RI/FS. The BMcD Project Manager serves as a direct liaison between the DEQ and BMcD project team and coordinates all BMcD activities for the TFM. Mr. Tracy Cooley will serve as the Project Manager for BMcD. The BMcD Project Manager for the RI/FS will provide guidance, direction, and support to the project team and will be ultimately responsible to the DEQ for all BMcD project-related activities. The BMcD Project Manager will be the primary point of contact between BMcD, the DEQ project manager, and all contracted services (e.g., laboratories, drillers, etc.). Responsibility for coordination with contracted services may be delegated by the Project Manager to a project team member such as the Project Chemist, Field Site Manager (FSM), or other qualified individual. Project Manager responsibilities include implementing adequate internal controls and review procedures to eliminate conflicts, errors, and omissions; and verifying technical accuracy.

Contact information for the BMcD Project Manager follows:

Burns & McDonnell
9400 Ward Parkway
Kansas City, MO 64114

Attn: Tracy Cooley
(816) 822-3369
tcooley@burnsmcd.com

Mr. Michael Gossett will serve as the FSM for field activities. The FSM is responsible for supervising all field investigation activities. The FSM reports directly to the BMcD Project Manager. The FSM will have direct responsibility for field activities and for continued daily adherence to the quality standards set forth in the RI/FS FSP and the QAPP (BMcD, 2005a).

Contact information for the BMcD FSM follows:

Burns & McDonnell
9400 Ward Parkway
Kansas City, MO 64114

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Attn: Michael Gossett
(816) 333-4900, extension 2652
mgossett@burnsmcd.com

A site health and safety supervisor (SHSS) will be identified prior to the start of field activities. Responsibilities of the SHSS are discussed fully in Section 2.0 of the *Remedial Investigation/Feasibility Study Health and Safety Plan, Tulsa Fuel and Manufacturing, Oklahoma* (RI/FS HSP) (BMcD, 2005b). The SHSS will be responsible for decisions regarding the immediate safety of investigation personnel, and will report to BMcD's Health and Safety Manager (HSM), FSM, and Project Manager. The SHSS is responsible for overseeing personnel on the TFM, maintaining proper medical surveillance, providing hazard communication information, training employees in safe operating procedures, and advising the HSM and Project Manager on matters concerning the health and safety of employees or the public. The SHSS may be required to perform various types of area or personnel monitoring to verify worker exposure and ensure the proper selection of personal protective equipment (PPE). The SHSS should be consulted before any changes in the recommended procedures or levels of protective clothing are made.

The HSM is a Certified Industrial Hygienist (CIH) who will provide professional support by reviewing all health and safety programs as they apply to this project. The HSM will approve the RI/FS HSP and all modifications to the plan as they affect the health and safety of field personnel. The HSM is responsible for providing professional health and safety support and oversight management to the SHSS. The HSM will review and provide support in all concerns regarding the health and safety of field personnel assigned to this project. Periodic field audits of the project work site may be conducted by the HSM to evaluate the adequacy of the program and implement any necessary changes.

Contact information for the BMcD HSM follows:

Burns & McDonnell
9400 Ward Parkway
Kansas City, MO 64114

Attn: Eric Wenger
(816) 822-3894
ewenger@burnsmcd.com

The Quality Control (QC) Director serves as the senior reviewer, providing technical quality control, oversight, and direction for all aspects of the planning, execution, analyses, and reporting of the RI/FS at the TFM. The QC Director, Mr. Bill Halliburton, has ultimate authority and responsibility to verify that

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the analyses specified and procedures established by BMcD for the RI/FS satisfy the data quality objectives (DQOs) discussed in Section 4.0 of the RI/FS Work Plan (BMcD, 2005c).

Contact information for the BMcD QC Director follows:

Burns & McDonnell
9400 Ward Parkway
Kansas City, MO 64114

Attn: Bill Halliburton
(816) 822-3545
bhalli@burnsmcd.com

The BMcD Project Chemist, Ms. Sharon Shelton, oversees the activities involving the field procedures for chemical samples, laboratory analyses, chemical sample documentation procedures, and tracking of chemical samples. The chemist also coordinates data validation of analytical laboratory deliverables.

The project chemist often serves as the point-of-contact for subcontracted analytical laboratories with responsibilities as described below:

- verify appropriate analyses to achieve project DQOs
- estimate costs for analytical services for any subcontracted lab services
- prepare purchase orders/authorizations for any subcontracted lab services
- schedule analytical services and order adequate/appropriate sample containers
- confirm sample receipt and laboratory log-in
- answering questions from the laboratory concerning sample anomalies and coordinate resolution of data evaluation issues between BMcD and the laboratory
- track the receipt of deliverables
- inform the BMcD QC Director and BMcD Project Manager of the project status and any potential lab problems that may jeopardize the quality of project data

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Contact information for the BMcD Project Chemist follows:

Burns & McDonnell
9400 Ward Parkway
Kansas City, MO 64114

Attn: Sharon Shelton
(816) 822-3168
sshelton@burnsmcd.com

2.5 CC ENVIRONMENTAL

CC Environmental (CCE) will serve as a local subcontractor to BMcD. CCE will provide local knowledge and technical expertise in support of project activities. CCE will report to the BMcD Project Manager.

Contact information for the CCE follows:

CC Environmental
155 Triad Village Drive
Norman, OK 73071

Attn: Geoff Canty, Ph.D.
(405) 321-8181
geoffc@ccenviro.net

2.6 ANALYTICAL LABORATORIES

Samples will be analyzed in accordance with the procedures in USEPA's Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846, Final Update III, as amended (SW-846) (USEPA, 1997) and Methods for Chemical Analysis of Water and Wastes (USEPA, 1983), where applicable. Additional potential analytical methods are presented in Section 3.0 of the RI/FS QAPP (BMcD, 2005a).

The primary analytical laboratory for the RI/FS is the Oklahoma SEL. Additional laboratories are presented to address matrices that SEL does not analyze, unforeseen situations at the SEL (i.e., sample overload, power outage, etc.), or expanded investigation needs. Analytical laboratories that may be used for the implementation of the RI/FS at the TFM are discussed in the following sections.

Oklahoma State Environmental Lab

Primary analytical services for the RI/FS will be provided by the SEL. The SEL is charged with analyzing samples that are collected to aid in the evaluation of project data. SEL's primary analytical

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responsibilities will be the analysis of soil and water matrices for metals, toxicity characteristic leaching procedure (TCLP) metals, and general water chemistry parameters. Ms. Susan Elmenhorst serves as the laboratory Quality Assurance (QA) Manager. The primary responsibilities for the Laboratory QA Manager are as follows:

- actively support the implementation of the SEL QAPP
- maintain accurate standard operating procedures and enforce their use in the laboratory
- maintain a work environment that emphasizes the importance of data quality
- provide appropriate management support

Contact information for the SEL follows:

Oklahoma Department of Environmental Quality
State Environmental Lab
707 N. Robinson
Oklahoma City, OK 73102

Attn: Susan Elmenhorst
(405) 702-1038
Susan.Elmenhorst@deq.state.ok.us

USEPA Region 6 Environmental Branch

While SEL is providing the primary analytical services for the RI/FS, additional laboratories are presented to address unique matrices, unforeseen circumstances, or expanded investigation needs. To address these situations, the USEPA Region 6 Environmental Services Branch (ESB), also know as the Houston Laboratory, may provide certain analytical services for the RI/FS. The ESB is charged with analyzing samples that are collected to aid in evaluation of project data. In the event that these services are needed, it is anticipated that the ESB would be charged with analysis of samples for one or more of the following: target analyte list (TAL) metals, cyanide, target compound list (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), TCL pesticides, and TCL polychlorinated biphenyls (PCBs). Christy Warren serves as the Sample Control Manager for the Sample Management Team. The primary responsibilities for the Sample Control Manager are as follows:

- management of the Regional Sample Control Center (RSCC) (Region 6)
- coordination of transfer of samples to the CLP laboratories

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- scheduling, receiving, and tracking all samples through the Houston Laboratory

Contact information for USEPA's Region 6 Sample Control Manager is as follows:

United States Environmental Protection Agency
Region 6 Laboratory
10625 Fallstone Road
Houston, TX 77099

Attn: Christy Warren
(281) 983-2137
Warren.Christy@epa.gov

Depending upon analytical needs, samples may also be transferred to a CLP laboratory instead of the ESB for analysis. Myra Perez serves as the Region 6 CLP RSCC Coordinator. The primary responsibilities of the CLP RSCC Coordinator are as follows:

- technical oversight of the CLP contracts
- perform CLP sample scheduling through management of the RSCC
- oversight of contractor data verification and validation activities determining contractor generated data usability for client programs

Contact information for USEPA's Region 6 CLP RSCC Coordinator is as follows:

United States Environmental Protection Agency
Region 6 Laboratory
10625 Fallstone Road
Houston, TX 77099

Attn: Myra Perez
(281) 983-2130
Perez.Myra@epa.gov

Other Analytical Laboratories

As previously presented, the majority of the analytical data for the RI/FS will be generated by the Oklahoma SEL. Additionally, support for additional investigation activities or backup in the event of unforeseen circumstances at the SEL will be provided by the USEPA Region 6 Lab (i.e., ESB), and/or CLP lab(s). Contracting and certification of these laboratories will be handled by the appropriate DEQ or USEPA contact (see above).

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For analysis of certain constituents (i.e., ecological samples, air samples, etc.), BMcD will need to subcontract analytical services. Subcontracted laboratories are expected to meet the certification requirements for DEQ and/or the National Environmental Laboratory Accreditation Program (NELAP).

Air/Ecological Samples:
STL Burlington
208 South Park Drive, Suite 1
Colchester, VT 05446
Attn: Don Dawicki
(802) 655-1023
DDawicki@stl-inc.com

Ecological Samples:
Midwest Laboratories
13611 B Street
Omaha, NE 68144
Attn: Seth Frishman
(402) 334-7770
seth@midwestlabs.com

The laboratory will have a QA program consistent with a national accreditation program and will be capable of achieving project-required method reporting limits, as well as project DQOs for accuracy, precision and bias to the extent that this is technically feasible using standard technology.

2.7 DIRECT-PUSH AND DRILLING CONTRACTOR

The subcontractor responsible for direct-push and drilling services will have the capabilities and knowledge to perform the drilling services required for the TFM. The drilling contractor will meet health and safety requirements necessary for operating on hazardous waste sites. Additionally, for monitoring well installation, the drilling contractor must be a licensed Well Driller by the State of Oklahoma. The drilling contractor will report directly to the FSM. Contact information for the drilling subcontractor is as follows:

CRC & Associates (Cherokee America Drilling)
916 West 23rd Street
Tulsa, OK 74107
Attn: Kevin Wilke
(918) 582-9110

2.8 TRENCHING CONTRACTOR

The contractor responsible for the trenching services will have the capabilities and knowledge to perform the trenching services required for the TFM. The trenching contractor will meet health and safety requirements necessary for operating on hazardous waste sites. The trenching contractor will report directly to the FSM. Contact information for the trenching contractor is as follows:

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Bingham Resources, Inc.
4515 East 105th Street
Tulsa, OK 74137
Attn: Jeff Bingham
(800) 750-3704

2.9 SURVEYOR

An Oklahoma State Registered Land Surveyor (RLS) will be used to establish an on-site benchmark and survey coordinates (including elevations) for monitoring wells and piezometers. The surveyor will report directly to the FSM. Contact information for the RLS is as follows:

L.W. Survey Company
2156 West Albany Street
Tulsa, OK 74012
Attn: David Arnold
(918) 251-1035

BMcD staff will perform all other surveys using Global Positioning System (GPS) techniques and provide survey data necessary for completion of investigative activities.

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3.0 SCOPE AND OBJECTIVES

3.1 OBJECTIVES

The objectives of this RI/FS FSP are to describe current site conditions and outline future investigation and planning activities necessary to assess and address potential threats to human health and the environment associated with the TFM. The RI/FS FSP was also prepared to satisfy the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

This RI/FS FSP presents and evaluates existing data and defines the objectives and scope of work for the RI/FS.

Objectives of the RI are:

- Quantify the nature and extent of on-site contamination;
- Quantify the volume of waste material present on-site;
- Determine the nature and extent of any off-site contamination;
- Characterize the physical and chemical nature of the TFM, including fate and transport mechanisms;
- Determine ecological and human health risk; and
- Obtain information necessary to evaluate remedial alternatives in the FS.

Objectives of the FS are:

- Develop and evaluate remediation alternatives.

The RI/FS will be performed in accordance with CERCLA and the National Contingency Plan (NCP), and will follow *USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (RI/FS Guidance) (USEPA, 1988), the *Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual (Parts A and D)* (USEPA, 1989 and 2001), as well as all other applicable regulations and requirements.

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3.2 FIELD ACTIVITIES

Planned investigative activities at the TFM include the following:

- survey of land use and demography
- sampling of waste materials
- visual survey of surrounding area to determine potential extent of waste materials placed off-site
- sampling of on-site surface soil and subsurface soil
- installation of temporary piezometers to determine groundwater flow direction and collection of groundwater samples for the monitoring network design
- monitoring well installation and groundwater sampling
- sampling of on-site and off-site surface water and sediment
- sampling surface soil on agricultural and residential properties surrounding the TFM
- background sampling for surface water, sediment, surface soil, subsurface soil, groundwater, and vegetation
- air quality sampling
- ecological (i.e., vegetation) sampling

Details regarding the sampling process design and rationale are provided in Section 5.3 of the RI/FS Work Plan. Section 4.0 of this RI/FS FSP presents general discussion of field procedures, sampling locations, and analytical requirements.

3.3 SAMPLE ANALYSES SUMMARY

The bulk of sampling activities will occur from June to September 2005 (i.e., RI Phase I). Surface soil, subsurface soil, sediment, surface water, groundwater, ecological, and air samples will be collected to determine the nature and extent (horizontal and vertical) of contamination and the potential risk the contamination may pose to human health and the environment.

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The primary constituents of interest for the TFM are metals. However, critical parameters are limited to arsenic, cadmium, lead, and zinc which have historically been found in smelter environments and have been preliminarily identified by DEQ as chemicals of potential concern (COPCs) (DEQ, 2005b). Samples will be analyzed for the list of constituents indicated on Table 3-1 as "Primary Analyses". Identification as a parameter for "Primary Analysis" was based on results of previous investigation activities and expected constituents at former smelter sites.

The results of RI Phase I will be used to evaluate if the TFM has been fully characterized with regard to COPCs. Based upon this evaluation, a recommendation will be presented to the DEQ Project Manager and other decision-makers (e.g., USEPA) concerning the need for any additional characterization of the TFM. The recommended additional characterization will occur as part of RI Phase II field sampling effort. As mentioned in Section 1.1.2, the area in the vicinity of the former residence has become a trash dump. It may be determined this area requires additional sampling for an expanded list of constituents such as TCL VOCs, SVOCs, pesticides, PCBs, and TAL metals. Therefore, Table 3-1 also presents "Potential Analyses" and parameter lists that encompass constituents that may be analyzed in the event of an expanded investigation during RI Phase II.

Laboratory analytical data will be validated as it is received in accordance with the procedures described in the RI/FS QAPP (BMcD, 2005a). The chemical results will be compared to background data, applicable or relevant and appropriate requirements (ARARs), to be considered (TBC) criteria, and other screening levels to aid in the further identification of COPCs at the TFM. Tables 3-1 through 3-5 of the RI/FS Work Plan (BMcD, 2005c) present potential chemical-specific TBCs under consideration.

QA/QC samples will be collected on a percentage and/or sampling type (i.e., waste pile, on-site samples, off-site samples, etc.) basis as discussed in Section 4.0.

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4.0 FIELD OPERATIONS AND SAMPLING PROCEDURES

Each sample, field measurement, and field activity will be properly documented to facilitate timely, correct, and complete analyses in support of actions concerning the TFM. The documentation system will provide a means to identify, track, and monitor individual samples from the point of collection through the final reporting of data. Standard field forms are presented in Appendix A.

4.1 FIELD PREPARATION

The majority of field activities will be conducted during Phase I of the RI. As preparation for Phase I field activities, the following preparations will be undertaken:

- The BMcD Project Manager or FSM will ensure that subcontractors (i.e., drilling, direct-push, trenching, surveying, laboratories, etc.) have been contracted and scheduled.
- The BMcD Project Manager or FSM will ensure that all necessary supplies (i.e., sampling tools, instruments, sample containers, etc.) have been ordered and are ready for use. Sample containers, coolers, and other necessary sampling supplies will be procured from an external vendor.
- The BMcD Project Manager or FSM will ensure that a field site office is available for use by the field team.
- The DEQ Project Manager will make arrangements for access to off-site sampling locations, as appropriate.
- Coordination regarding sample collection, delivery, analysis, and requested deliverables will be undertaken with the Oklahoma SEL.

4.2 SAMPLE LOCATIONS

Samples will be collected in accordance with Tables 4-1 through 4-6 and proposed sample locations will be identified and marked in the field as shown on Figures 4-1 through 4-4. Should the designated sample locations be inaccessible due to field conditions, the selected sample locations will be offset as close as possible to the original designated location or replaced with an alternate location with the approval of DEQ to meet the objectives provided in the RI/FS Work Plan (BMcD, 2005c).

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During sampling activities, the field crew will take care to note the location of visible waste materials in the field logbook and on maps, as appropriate. The crew will be particularly careful to look for apparent smelter waste when travelling to off-site sampling locations or sampling at off-site locations.

4.3 SAMPLE CONTAINERS AND PRESERVATION TECHNIQUES

Table 4-7 summarizes sample containers, preservation techniques, and sample holding times for the analytical methods.

4.4 SUBSURFACE SOIL

4.4.1 Rationale

Subsurface soil samples will be collected to determine the presence and extent (horizontal and vertical) of contamination, if present. Subsurface soil samples will also aid in the determination of the nature of contamination, if present, the potential risk the contamination may pose to human health and the environment, and the most appropriate method of remediation. Subsurface soil samples will be collected in accordance with Tables 4-1, 4-2, and 4-6. Sample locations are presented on Figures 4-1 and 4-4. Additional rationale for sampling is provided in the RI/FS Work Plan (BMcD, 2005c).

Prior to any field work involving intrusive subsurface activities, utility clearance will be required as discussed in Section 4.12. Proposed locations for subsurface soil samples were selected based on potential source locations, suspected contaminant mobility, and available analytical data. Proposed sample locations will be identified and marked in the field as shown on Figures 4-1 and 4-4. Locations will be surveyed using GPS technology, as described in Standard Operating Procedure (SOP) TFM-117, “Surveying Using Global Positioning System Procedures” (Appendix B), after sampling is complete.

4.4.2 Sample Collection – Direct Push Sampling

Shallow soil exploration for area screening will be conducted using truck or van-mounted direct push sampling equipment (e.g., Geoprobe®). Direct push sampling utilizes a hydraulically-powered percussion/probing machine to advance probe rods containing acetate liners into the unconsolidated subsurface material as described in SOP TFM-101, “Direct Push Soil Sampling”, which is provided in Appendix B. For each probehole, a geologic log will be prepared in the field by a BMcD geologist, as described in SOP TFM-116, “Logging Procedures”, which is provided in Appendix B.

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Direct-push sampling techniques will be used to collect soils in on-site areas where slag-like materials are not expected to provide subsurface obstruction. As indicated on Figure 4-1, direct push sampling locations were approximately placed in a 200-ft grid pattern. Samples will be collected from the surface (0 to 6 inches bgs), shallow subsurface (6 inches to 2 ft bgs), and deeper subsurface (2 to 4 ft bgs). Additionally, samples will be collected at depth to provide a vertical profile of TFM soils (See Table 4-2) at locations selected for installation of temporary piezometers (See Section 4.8). At direct push sampling locations, samples will be collected and submitted to SEL for off-site laboratory analysis of arsenic, cadmium, lead, and zinc using a laboratory X-Ray Fluorescence Spectrometer (XRF), and 10 percent of the XRF data will be confirmed using inductively coupled plasma (ICP) methodology. Additionally, 10 percent of the direct push soil samples will be analyzed for TCLP arsenic, cadmium, and lead.

4.4.3 Sample Collection – Hollow Stem Auger Sampling

While not currently planned, soil samples may be collected using split-barrel samplers or Shelby tubes advanced using hollow stem augers (HSAs) to provide geologic information for logging and/or samples for geotechnical and chemical analysis. Samples collected using a split-barrel sampler are acceptable for disturbed soils chemical analysis. A Shelby tube will be used to collect soil for physical analyses, such as dry bulk density and hydraulic conductivity, which need to be performed on undisturbed samples as discussed in SOP-TFM-102, “Drilling – Hollow Stem Auger Subsurface Soil Sampling”, which is presented in Appendix B. For each borehole, a geologic log will be prepared in the field by a BMcD geologist, as described in SOP TFM-116, “Logging Procedures”, which is provided in Appendix B.

4.4.4 Sample Collection – Trench Sampling

Smelter waste samples will be collected using track hoe or back hoe as described in SOP TFM-122, “Excavation Slag Sampling” (Appendix B) to determine waste characteristics of the material. Soil samples will also be collected beneath the waste as described in SOP TFM-123, “Excavation Soil Sampling” (Appendix B) to evaluate the potential for leaching of waste materials to soil and groundwater.

Trench sampling techniques will be used to collect samples on-site in apparent areas of waste deposition. Emphasis will be placed on collecting samples at the surface (0 to 6 inches bgs) and the native clay under the waste materials. At 50 percent of the trench locations, a sample of the waste materials will be collected mid-depth in the trench. Samples will be collected and submitted to SEL for off-site laboratory analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF, and 10 percent of the XRF data will be confirmed using ICP methodology. Additionally, 10 percent of the trench samples will be analyzed for TCLP arsenic, cadmium, and lead.

4.4.5 Background Samples

As required, background subsurface soil sample locations will be selected and sampled to represent the various soil types present at the TFM. Proposed subsurface soil background sample locations are presented on Figure 4-4. Background samples will be collected using the same procedures as other subsurface soil samples. Background samples will be analyzed for the same constituents as the other subsurface soil samples, as indicated on Table 4-6. The background subsurface soil samples will be used to evaluate sample constituent concentrations at the site that are not related to TFM activities or may be present due to natural occurrences.

4.4.6 Decontamination Procedures

Decontamination of subsurface soil sampling equipment will be conducted in accordance with the procedures in SOP TFM-110, "Decontamination of Sampling Equipment", which is provided in Appendix B. Investigation derived waste (IDW) generated during the decontamination procedures will be managed in accordance with the procedures in Section 7.0 and SOP TFM-111, "Investigation-Derived Waste", which is provided in Appendix B.

4.5 SURFACE SOIL

4.5.1 Rationale

Surface soil samples will be collected to determine the presence and extent of surficial contamination for on-site and off-site sampling locations. Surface soil samples will also aid in the determination of the nature of contamination present, the potential risk the contamination may pose to human health and the environment, and the most appropriate method of remediation. Samples will be collected in accordance with Tables 4-1, 4-2, 4-3, and 4-6. Sample locations are presented on Figures 4-1, 4-2, and 4-4. The rationale for sampling is provided in the RI/FS Work Plan (BMcD, 2005c).

4.5.2 Sample Collection

By general definition, surface soil samples will be collected from 0 to 6 inches bgs for on-site sampling locations in accordance with SOP TFM-103, "Surface Soil Sampling", which is provided in Appendix B. Sampling locations will be surveyed according to SOP TFM-117, "Surveying Using Global Positioning System Procedures".

In addition to shallow soil samples collected during direct push sampling, surface soil samples will also be collected from 0 to 6 inches bgs at eight on-site locations (Figure 4-1). These samples will be

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submitted to SEL for off-site laboratory analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF, and 10 percent of the XRF data will be confirmed using ICP methodology. Additionally, 10 percent of the surface samples will be analyzed for TCLP arsenic, cadmium, and lead. Table 4-2 provides a summary of the on-site surface soil samples and analyses.

In all cases, off-site surface soil will be collected from 0 to 3 inches bgs. A shallower depth interval was selected for the off-site surface soil samples as compared to the on-site samples to avoid overly diluting disperse aerial deposition. That is, the probability of emissions from the TFM smokestack being present below 3 inches bgs is expected to be minimal given its limited years of operation, and the concentration of metal constituents below this depth is expected to be at or near background. Therefore, including soil from 3 to 6 inches bgs for the off-site surface soil samples could dilute potentially elevated metals concentrations in the 0 to 3 inch bgs interval. Additionally, sample locations will not be placed adjacent to buildings, roadways, or railroad sidings to minimize the likelihood of non-smelter materials (i.e., leaded paint, leaded gas, etc.) affecting results. Surface soil samples will be submitted to SEL for off-site analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF, and 10 percent of the XRF data will be confirmed using ICP methodology. Additionally, 10 percent of the surface soil samples will be analyzed for TCLP arsenic, cadmium, and lead. Table 4-3 provides a summary of the off-site surface soil samples and analyses.

In order to provide real-time delineation of the off-site surface soils, a hand-held XRF will be used during collection of surface soil samples from off-site locations. Use of the instrument will provide immediate feedback regarding the off-site sampling grid and any need for its expansion (e.g., Results from the XRF indicate that aerial deposition from the TFM smokestack is more dispersed than initially thought, and additional samples should be collected.) However, all samples selected for field XRF analysis will also be submitted to the SEL for analysis of metals in a laboratory setting. The laboratory-analyzed samples will be used to make decision regarding the TFM. Procedures for use of the hand-held instrument are provided in SOP TFM-124, “X-Ray Fluorescence Procedures for Field Analysis”.

Off-site surface soil samples will be collected as four distinct sets of data (Figure 4-2 and Table 4-3):

- Tribal Residence Sampling Location – Based on information obtained from ITEC, surface soil samples will be collected from tribal residence locations that are within ½ mile of the TFM.

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- Targeted Off-Site Sampling Location – A survey was conducted of the surrounding area to target high-interest sampling locations such as parks, schools, play grounds, day care centers, etc. Surface soil samples will be collected from these "targeted" areas.

- Off-Site Grid Sampling Location – As shown on Figure 4-2, off-site surface soil sampling locations were placed approximately 500-ft apart in a grid surrounding the site. The grid was oriented in the prevailing north-south wind direction, and was also adjusted based on placement of the Tribal Residence Samples and Targeted Off-Site Samples. For the first two rows (i.e., 1000 ft) of the grid that are immediately north and south of the site, surface soil samples will be collected at each of the grid locations. After these rows, the distance between sampling locations on the grid will be increased such that samples are collected at every other grid location (i.e., approximate 1000-ft grid spacing) as indicated on Figure 4-2. If the field XRF indicates the presence of lead at these expanded grid locations, then the sampling grid will be reduced such that the samples are again collected at 500-ft spacing (i.e., from locations marked as "potential samples" on Figure 4-2).

- Distance Sampling – Samples will be collected at distances of ½ mile, 1 mile, and 1 ½ miles from the site to determine the long-range extent of aerial deposition of metals. Prevailing winds in the area are north, north-northwest, south, and south-southeast. Surface soil samples will be collected at 1 mile and 1 ½ miles from the TFM in these directions. The off-site grid sampling locations were sufficient to capture the interval ½ mile from the TFM. Since there is less of an easterly or westerly component to winds in this area, surface soil samples in the east and west direction will only be collected at ½ mile and 1 mile from the TFM.

During off-site sampling activities, the field crew will take care to note the location of visible waste materials in the field logbook and on maps, as appropriate. The crew will be particularly careful to look for apparent smelter waste when travelling to off-site sampling locations or sampling at off-site locations.

4.5.3 Background Samples

Background surface soil sample locations will be chosen to represent the various soil types present at the site. Proposed background sample locations are presented on Figure 4-4. Background samples will be collected using the same procedures as the investigative surface soil samples. Background samples will be analyzed for the same constituents as the other surface soil samples, as indicated on Table 4-6. The

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background surface soil samples will be used to evaluate sample constituent concentrations at the site that are not related to TFM activities or may be present due to natural occurrences.

4.5.4 Decontamination Procedures

Decontamination of surface soil sampling equipment will be conducted in accordance with the procedures in SOP TFM-110, "Decontamination of Sampling Equipment", which is provided in Appendix B. IDW generated during the decontamination procedures will be managed in accordance with the procedures in Section 7.0 and SOP TFM-111, "Investigation-Derived Waste", which is provided in Appendix B.

4.6 SURFACE WATER

4.6.1 Rationale

Surface water samples will be collected to assess the potential of waste migration to the surrounding stream, ponds, and strip mine pit. Surface water samples will also aid in the determination of the nature of any contamination present, the potential risk the contamination may pose to human health and the environment, and the most appropriate method of remediation. Surface water samples will be collected at locations where surface water transport of contaminants may occur. The surface water sampling plan is presented in Table 4-4 and Figure 4-3. The rationale for the collection of each of the surface water samples is provided in the RI/FS Work Plan (BMcD, 2005c).

All surface water bodies on the TFM were selected for surface water sampling. This includes three large ponds assumed to be associated with the former reservoir, 2 smaller ponds, the strip mine pit, and an intermittent drainage that cuts through the main area of waste deposition. Off-site sampling includes a drainage associated with TFM's intermittent drainage and eastern wetlands area, as well as an intermittent stream east of the TFM that drains into Blackjack Creek. Surface water sample locations were selected based on access, source, and drainage channel locations. Sample locations from surface water bodies on the TFM were based on knowledge of surface flows and/or site history. Proposed sampling locations are shown on Figure 4-3.

4.6.2 Surface Water Sample Collection

Surface water samples will be collected directly into sample container(s), without the aid of an intermediate sample container, whenever possible in accordance with SOP TFM-104, "Surface Water Sampling", which is provided in Appendix B. This method eliminates any potential effects of sampling devices or equipment. When collecting both water and sediment samples at a specific location, the water

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sample will always be obtained first. Surface water flow will be estimated, where applicable, in accordance with SOP TFM-121, "Surface Water Flow Estimation", which is provided in Appendix B.

Samples will be collected from five on-site ponds, an on-site intermittent drainage, the strip mine pit, and 13 off-site locations (Figure 4-3). Surface water samples will be submitted to SEL for off-site analysis of arsenic, cadmium, lead, and zinc. Additionally, surface water samples will be submitted to SEL for analysis of general water chemistry parameters (i.e., total organic carbon [TOC], chemical oxygen demand [COD], alkalinity, nitrate as nitrogen, sulfate, and chloride). Table 4-4 provides a summary of the surface water samples and analyses. If insufficient water is available at the time of sampling to fill all sample containers, then the containers for metals analysis will be filled first followed by the containers for general water chemistry parameters.

During off-site sampling activities, the field crew will take care to note the location of visible waste materials in the field logbook and on maps, as appropriate. The crew will be particularly careful to look for apparent smelter waste when travelling to off-site sampling locations or sampling at off-site locations.

4.6.3 Background Samples

Background surface water sample locations will be selected from locations upgradient of the TFM to represent the surface water at the TFM. Proposed background sample locations are presented on Figure 4-4. Background samples will be collected using the same procedures as the investigative surface water samples. Background samples will be analyzed for the same constituents as the other surface water samples, as indicated on Table 4-6. The background surface water samples will be used to evaluate sample constituent concentrations at the site that are not related to TFM activities or may be present due to natural occurrences.

4.6.4 Decontamination Procedures

Decontamination of surface water sampling equipment, if needed, will be conducted in accordance with the procedures in SOP TFM-110, "Decontamination of Sampling Equipment", which is provided in Appendix B. IDW generated during the decontamination procedures will be managed in accordance with the procedures in Section 7.0 and SOP TFM-111, "Investigation-Derived Waste", which is provided in Appendix B.

4.7 SEDIMENT

4.7.1 Rationale

Sediment samples will be collected from ponds, strip mine pit, streams, and wetlands to determine the potential presence and extent of contamination. Sediment samples will also aid in the determination of the nature of any contamination present, the potential risk the contamination may pose to human health and the environment, and the most appropriate method of remediation. Sediment samples will be collected at locations where surficial transport of contaminants may have occurred. The sediment sampling plan is presented in Table 4-4 and Figure 4-3. The rationale for the collection of each of the sediment samples is provided in the RI/FS Work Plan (BMcD, 2005c).

All surface water bodies on the TFM were selected for sediment sampling. This includes three large ponds assumed to be associated with the former reservoir, 2 smaller ponds, the strip mine pit, and an intermittent drainage that cuts through the main area of waste deposition. Off-site sampling includes a drainage associated with the intermittent drainage and eastern wetlands area, as well as an intermittent stream east of the TFM that drains into Blackjack Creek. Sediment sample locations in the intermittent streams were selected based on access, source, and drainage channel locations. Sample locations from below surface water bodies such as ponds were based on knowledge of surface flows and/or site history. Proposed sampling locations are shown on Figure 4-3.

4.7.2 Sediment Sample Collection – Dry Locations

Sediment samples will be collected from 0 to 6 inches bgs from dry locations. Dry sediment samples may be collected by surface scraping, hand augering, or direct push sampler with acetate liners. Sediment samples from dry locations will be collected in accordance with SOP TFM-105, “Sediment Sampling from Ponds and Intermittent Streams” which is provided in Appendix B. Sediment samples for chemical analysis will be collected near the inlets (where applicable), which is where the sediment deposition is likely to be the thickest. A discussion of sampling and sediment thickness and depth estimation methods when direct-push sampling collection techniques are used is provided in SOP TFM-118, “Sediment Thickness and Depth Estimation Methods”, which is provided in Appendix B.

Samples will be collected from five on-site ponds, an on-site intermittent drainage, the strip mine pit, and 13 off-site locations (Figure 4-3). Likely dry locations include intermittent drainages both on-site and off-site. Sediment will be submitted to SEL for off-site analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF, and 10 percent of the XRF data will be confirmed using ICP methodology. Additionally,

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10 percent of the sediment samples will be analyzed for TCLP arsenic, cadmium, and lead. Table 4-4 provides a summary of the sediment samples and analyses.

During off-site sampling activities, the field crew will take care to note the location of visible waste materials in the field logbook and on maps, as appropriate. The crew will be particularly careful to look for apparent smelter waste when travelling to off-site sampling locations or sampling at off-site locations.

4.7.3 Sediment Sample Collection – Wet Locations

Sediment samples will be collected from 0 to 6 inches bgs. The use of a ladle or dredge when water is present is an appropriately simple and direct method of sample collection. A small boat will be used if necessary to access locations further from the shoreline. Sediment samples from wet locations will be collected in accordance with SOP TFM-105, "Sediment Sampling from Ponds and Intermittent Streams", which is provided in Appendix B. Sediment samples for chemical analysis will be collected near the inlets (where applicable) which is where the sediment deposition is likely to be the thickest. In addition, the sediment thickness and depth bgs will be estimated in two or three locations (depending upon pond size). A discussion of sampling and sediment thickness and depth estimation methods is provided in SOP TFM-118, "Sediment Thickness and Depth Estimation Methods", which is provided in Appendix B.

Samples will be collected from five on-site ponds, an on-site intermittent drainage, the strip mine pit, and 13 off-site locations (Figure 4-3). The ponds and strip mine pit are known wet locations. Sediment will be submitted to SEL for off-site analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF, and 10 percent of the XRF data will be confirmed using ICP methodology. Additionally, 10 percent of the sediment samples will be analyzed for TCLP arsenic, cadmium, and lead. Table 4-4 provides a summary of the sediment samples and analyses.

During off-site sampling activities, the field crew will take care to note the location of visible waste materials in the field logbook and on maps, as appropriate. The crew will be particularly careful to look for apparent smelter waste when travelling to off-site sampling locations or sampling at off-site locations.

4.7.4 Background Samples

Background sediment sample locations will be selected from upgradient locations to represent the various sediment types present at the TFM. Proposed background sample locations are presented on Figure 4-4. Background samples will be collected using the same procedures as the investigative sediment samples. Background samples will be analyzed for the same constituents as the other sediment samples, as

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indicated on Table 4-6. The background sediment samples will be used to evaluate sample constituent concentrations at the site that are not related to TFM activities or may be present due to natural occurrences.

4.7.5 Decontamination Procedures

Decontamination of sediment sampling equipment will be conducted in accordance with the procedures in SOP TFM-110, "Decontamination of Sampling Equipment", which is provided in Appendix B. IDW generated during the decontamination procedures will be managed in accordance with the procedures in Section 7.0 and SOP TFM-111, "Investigation-Derived Waste", which is provided in Appendix B.

4.8 GROUNDWATER

4.8.1 Rationale

Groundwater samples will be collected to determine the nature and possible extent of contamination. Groundwater samples will also aid in determination of the potential risk that the contamination may pose to human health and the environment and the most appropriate method of remediation. Locations were selected to best characterize the site based on known or estimated source locations and groundwater flow direction. Groundwater samples will be collected in accordance with Tables 4-1, 4-2, and 4-6. Sample locations for temporary piezometers are presented on Figure 4-1. Locations for five newly-installed monitoring wells will be determined based upon groundwater flow direction information obtained from the temporary piezometers. The rationale for the groundwater sampling locations is provided in the RI/FS Work Plan (BMcD, 2005c).

Prior to any field work involving intrusive subsurface activities, utility clearance will be required as discussed in Section 4.12. Proposed locations will be identified and marked in the field as shown on Figure 4-1. Locations will be surveyed using GPS technology, as described in Standard Operating Procedure (SOP) TFM-117, "Surveying Using Global Positioning System Procedures" (Appendix B) after sampling is complete.

During direct-push activities piezometers will be installed to determine groundwater flow direction, and samples will be collected. Temporary piezometer locations are indicated on Figure 4-1. After review of the temporary piezometer data, recommendation for the placement of monitoring wells will be identified and provided to DEQ for approval prior to installation of the wells.

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4.8.2 Calibration of Field Instruments

Field instruments will be calibrated in accordance with SOP TFM-106, "Field Equipment Calibration", which is provided in Appendix B, and manufacturer's instructions. All calibrations and calibration checks will be recorded in the field logbook and appropriate field forms.

4.8.3 Temporary Piezometer Installation

Procedures for installation of temporary piezometers at the TFM are covered in detail in SOP TFM-127, "Temporary Piezometer Installation", which is provided in Appendix B.

4.8.4 Monitoring Well Installation

Procedures for monitoring well installation at the TFM are covered in detail in SOP TFM-107, "Monitoring Well Installation, Development, and Abandonment", which is provided in Appendix B.

4.8.5 Slug Testing

In-situ permeability or slug testing may be conducted in wells at the TFM (existing and newly-constructed) to determine the hydraulic conductivity of the water-bearing media immediately surrounding the well. To conduct a test on a well recently purged for groundwater sampling, the measured water level will be allowed to return to static level prior to testing. The procedures for conducting a rising head slug test are provided in SOP TFM-119, "Slug Testing Procedures", which is provided in Appendix B.

4.8.6 Groundwater Sample Collection

Groundwater samples will be collected from monitoring wells using stainless steel or polyvinyl chloride (PVC) bladder pumps with teflon bladders and teflon-lined polyethylene tubing. Bladder pumps allow groundwater samples to be retrieved with little disturbance to the sample matrix and little exposure to the atmosphere using low flow procedures as discussed in SOP TFM-120, "Low-Flow Groundwater Sampling", which is provided in Appendix B. In special situations, groundwater samples may also be collected using bailers according to the procedure discussed in SOP TFM-108, "Groundwater Sampling", which is also provided in Appendix B. Use of bailers will be approved by the DEQ Project Manager. Groundwater may be encountered during direct push sampling. This groundwater will be sampled according to the procedures specified in SOP TFM-126, "Direct Push Groundwater Sampling", which is provided in Appendix B.

Groundwater samples will be collected in a staged approach. Direct-push techniques will be used to install 11 temporary piezometers at the TFM (Figure 4-1 and Table 4-2). During installation of the piezometers, samples will be collected from the first encountered groundwater. Groundwater samples will be collected and submitted to SEL for analysis of arsenic, cadmium, lead, and zinc, and general water chemistry parameters (TOC, COD, alkalinity, nitrate as nitrogen, sulfate, and chloride). If sample turbidity exceeds 50 nephelometric turbidity units (NTUs), metals samples will be submitted to the SEL as both field-filtered and unfiltered samples to account for potential turbidity problems associated with collection using direct-push techniques. If insufficient water is available at the time of sampling to fill all sample containers, then the containers for metals analysis will be filled first followed by the containers for general water chemistry parameters. Once installed, the temporary piezometers will be used to determine groundwater flow direction in the area.

Following determination of groundwater flow direction using the temporary piezometers, five monitoring wells will be located and installed at the TFM in a manner to evaluate the impact to groundwater, if any, at the TFM boundaries (upgradient and downgradient) and downgradient of suspected sources of contamination. Groundwater samples will be collected from these new wells and the existing residential well (Table 4-2) and submitted to SEL for analysis of arsenic, cadmium, lead, and zinc and general water chemistry parameters. If sample turbidity exceeds 50 nephelometric turbidity units (NTUs), metals samples will be submitted to the SEL as both field-filtered and unfiltered samples. If insufficient water is available at the time of sampling to fill all sample containers, then the containers for metals analysis will be filled first followed by the containers for general water chemistry parameters.

4.8.7 Equipment Malfunction Procedures

Every effort will be made to obtain and maintain properly functioning equipment. However, occasionally equipment malfunctions occur. In these instances, the FSM will be contacted immediately and then the DEQ Representative at the site, followed by the DEQ Project Manager. New equipment will be ordered immediately for next-day delivery. Stabilization parameters must also meet stabilization criteria prior to commencing sampling.

Any other equipment malfunctions will be brought to the attention of the DEQ Representative at the site and then the DEQ Project Manager and a temporary site-specific sampling protocol will be initiated. Any equipment malfunctions and remedies will also be noted in the field logbook.

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4.8.8 Background Samples

After determination of groundwater flow direction using temporary piezometers, a location for a background monitoring well, presumed to be hydraulically upgradient of the TFM, will be determined. Background samples will be collected using the same procedures as the other groundwater samples. Background samples will be analyzed for the same constituents as the other groundwater samples, as indicated on Table 4-6. The background groundwater samples will be used to evaluate sample constituent concentrations at the site that are not related to TFM activities or may be present due to natural occurrences.

4.8.9 Decontamination Procedures

Decontamination of groundwater sampling equipment will be conducted in accordance with the procedures in SOP TFM-110, "Decontamination of Sampling Equipment", which is provided in Appendix B. IDW generated during the decontamination procedures will be managed in accordance with the procedures in Section 7.0 and SOP TFM-111, "Investigation-Derived Waste", which is provided in Appendix B.

4.9 AIR

4.9.1 Rationale

Perimeter air samples will be collected from two locations to evaluate the air quality at the TFM. Preliminary sampling locations were chosen to provide a representative worst-case scenario at technically feasible sampling locations using criteria such as a combination of winds and low precipitation, proximity to waste source, and access and/or land use associated with downwind areas. At the time of sampling, locations will be finalized such that a sample is collected upwind and downwind of the TFM in the direction of the prevailing wind. Samples will be collected over a one-week period. Potential impact of waste materials on ambient air quality will be determined by sampling and analysis for total suspended particulate (TSP), small particulate matter (PM_{10}), and airborne particulate metals (See Section 5.3 of the RI/FS Work Plan). Proposed sampling locations are shown on Figure 4-1, but will be modified in the field based upon prevailing winds at the time of sampling.

Additionally, personal air monitoring for airborne lead was established in Appendix C of the RI/FS HSP (BMcD, 2005b). Such monitoring will be conducted to monitor potential lead exposure of the field sampling team.

4.9.2 Air Sample Collection

Perimeter air samples will be collected according to SOP TFM-128, "Particulate Matter Sampling", which is provided in Appendix B. Air samples representative of work breathing zones will be conducted in accordance with SOP TFM-109, "Personal Air Monitoring". Appendix C of the RI/FS HSP (BMcD, 2005b) provides further information regarding personal air monitoring.

Air samples will be collected based on the prevailing wind at the time of sampling. One upwind (i.e., background) and one downwind location from the TFM will be chosen. A high volume air sampler will be utilized such that a sample is collected continuously over a seven-day period. Sample filters are changed daily during the one-week sampling period (i.e., 7-day, 24-hour continuous monitoring). Potential sampling locations are provided on Figure 4-1. Samples will be submitted to STL-Burlington for analysis of TSP, PM_{10}, and airborne particulate metals (i.e., arsenic, cadmium, lead, and zinc) as listed on Table 4-2.

4.9.3 Background Samples

A background (i.e., upwind) sample will be collected using the same procedures as the investigative air samples. Background samples will be analyzed for the same constituents as the investigative air sample. The background air sample will be used to evaluate sample constituent concentrations at the site that are not related to TFM activities or may be present due to natural occurrences.

4.10 ECOLOGICAL SAMPLES

4.10.1 Rationale

Collection of blackberry samples has been observed from bushes growing in the eastern fence line of the TFM. In some instances, these bushes appear to be growing in slag-like waste materials. Ecological samples (i.e., vegetation from blackberry bushes) will be collected to evaluate the presence of metals in berries and leaves that may be ingested by human and/or ecological receptors. The intent is to collect berries, leaves, roots, and materials surrounding the roots for analysis. The rationale for the collection of each of the ecological samples is provided in the RI/FS Work Plan (BMcD, 2005c).

On-site blackberry bushes (blackberries, leaves, and roots) were sampled during the 2004-growing season by DEQ (Appendix C). An additional set of samples will be collected during the RI. Proposed sampling locations are shown on Figure 4-1, but will be modified in the field based upon the presence of blackberry bushes producing fruit at the time of sampling. The analytical protocol is provided on Table 4-5.

4.10.2 Ecological Sample Collection

Ecological samples will be collected in accordance with SOP TFM-125, "Vegetation Sampling", which is provided in Appendix B.

Ecological samples will be collected from blackberry bushes growing along the eastern fence line of the TFM. Individual blackberries, leaves, roots, and soil surrounding the roots will be sampled from two on-site locations. Washed and unwashed samples of the blackberries and leaves will be collected. Washed samples from the roots will be collected. Lastly, soil from the area around the roots will be collected. The samples will be used to evaluate the potential metals content within on-site plant material, both due to aerial deposition (unwashed) and plant uptake (washed). Potential sampling locations are provided on Figure 4-1. The samples collected by DEQ in 2004 have been frozen and are currently stored. These samples and samples collected during the RI will be submitted to STL Burlington for analysis of arsenic, cadmium, lead, and zinc as indicated on Table 4-5.

4.10.3 Background Samples

Background samples will be collected using the same procedures as the investigative ecological samples. Background samples will be analyzed for the parameters of interest at the TFM. The background ecological samples will be used to evaluate sample constituent concentrations at the site that are not related to TFM activities or may be present due to natural occurrences. DEQ collected a set of background samples from the Oxley Nature Center in Tulsa, Oklahoma during the 2004-sampling event (Appendix C). In addition, DEQ collected another set of background samples from a property adjacent to the TFM in 2004. DEQ has recommended collecting background ecological samples collected from the Oxley Nature Center during RI Phase I.

4.11 FIELD QA/QC SAMPLE COLLECTION

Field duplicates will be collected on a 10 percent frequency basis. Laboratory QC samples will be collected on at least a 5 percent frequency to ensure that at least one matrix spike/matrix spike duplicate (MS/MSD) or one MS/laboratory duplicate sample is included in each analytical batch. Trip blanks will accompany each cooler containing samples for VOC analysis. Temperature blanks will accompany each cooler shipped to the laboratory with samples requiring icing for preservation. QC data will be used to determine the accuracy and precision of the off-site laboratory. Field screening data will not require the same QC samples as fixed laboratory data.

Field Duplicate Samples

All chemical analyses to be conducted must be duplicated in at least one sample to assess the precision of the sample collection process. Each field (blind) duplicate sample will be obtained at the same time and analyzed for the same set of parameters as the investigative sample it is intended to replicate. The first sample will serve as the original sample and the second as the field duplicate sample. All field samples will be identified with unique sample identification numbers as described in SOP TFM-113, "Sample Numbering and Documentation", which is provided in Appendix B. Sample locations where field duplicate samples are collected will be documented in the field logbook.

Field duplicate soil and sediment samples will be collected from the same section or area and from within the same depth interval as the original sample. Each field duplicate sample for VOC analysis will consist of parallel portions of the soil or sediment sample. The remaining sample will be homogenized as described in the appropriate SOP and separated into two portions. Each portion will be placed in separate, but identical containers and preserved in the same manner. One sample will be considered the original and the other will be the field duplicate sample and both samples will be sent to the laboratory and analyzed for the same analytical parameters.

Field duplicate groundwater and surface water samples will be collected by first filling the bottles for all VOC analysis for the original sample, followed by all of the bottles for the VOC analysis for the duplicate sample. Bottles for remaining analyses will then be filled by order of volatility, alternating between an original sample bottle and then a duplicate sample bottle until all containers have been filled. The original and duplicate samples will be placed in separate, but identical containers and preserved in the same manner. One sample will be considered the original and the other will be the field duplicate sample and both samples will be sent to the laboratory and analyzed for the same analytical parameters.

Laboratory QC (MS/MSDs [Organics] and MS/Laboratory Duplicates [Inorganics])

A laboratory QC sample is an additional analysis of a field sample, as required by the laboratory's CLP contract. There are three types of laboratory QC samples: MSs, MSDs, and laboratory duplicates. One sample per matrix per 20 samples will be selected as a laboratory QC sample and noted as such on the Traffic Report / Chain of Custody (TR/COC). The laboratory QC sample must not be designated in the "Field QC Qualifier" column on either the organic or inorganic TR/COC Records.

Extra volumes should be shipped with each group of samples (i.e., with each Sample Delivery Group [SDG]). For organic analyses, extra volumes will be collected in separate containers for MS and MSD samples. These extra volume containers will be marked with the CLP sample number and "MS/MSD".

Aqueous samples will be collected in triplicate at certain locations for the completion of MS/MSDs. Soil and sediment samples will be collected in triplicate at certain locations also unless previous arrangements have been made with the analytical laboratory regarding sample volume requirements. Soil and sediment MS/MSD samples for volatile analyses will always be collected in triplicate. The samples will be identified as the original, MS, and MSD. The samples will be collected in the same manner as the duplicate samples. MS/MSDs will be labeled as described in Section 5.3. The COC will be completed to notify the laboratory that a MS/MSD should be completed in addition to the original sample. MS/MSDs will be collected for the same constituents as the actual sample. MS/MSD samples provide information on matrix interference encountered during extraction, digestion, and analysis (i.e., suppression or enhancement of instrument signals). MS samples are principally used to evaluate accuracy by measuring recovery of the spiked compounds. When the MS sample is used together with an associated MSD sample (for organic analyses), information is obtained on analytical precision. For inorganics analyses, an MS sample is used together with an associated laboratory duplicate to obtain information regarding analytical precision.

CLP projects generally require a site-specific MS/MSD (or MS/laboratory duplicate) for each batch analyzed at the laboratory. For analytical methods with short holding times (i.e., less than 7 days), it may be necessary to collect MS/MSDs (or MS/laboratory duplicates) at a frequency greater than 5 percent.

Field Blanks

Field blanks for VOCs samples will be prepared in the field on a daily basis by sampling personnel to assess the ambient conditions under which the samples were collected. Field blanks will be prepared by pouring deionized water directly into the VOC sample containers. The field blanks will be submitted to the laboratory for VOC analysis.

Trip Blanks

Trip blanks for VOCs samples will be prepared by the laboratory and will accompany sample containers transported to the TFM. The trip blanks will remain at the TFM during sampling activities. One trip blank set will be included in each cooler shipped to the laboratory that contains samples for VOC analysis for all matrices. The result from these analyses will be used to determine whether VOCs are introduced into aqueous samples as a result of on-site conditions, conditions during sample shipment, and/or laboratory operations.

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Temperature Blanks

Temperature blanks will consist of small containers filled with water. A temperature blank will be included in each cooler that contains samples requiring icing for preservation. The temperature of each blank will be measured by laboratory personnel upon arrival at the laboratory to ensure that method-specific preservative requirements (i.e., 4 $\pm$ 2 degrees Celsius [^{o}C]) were met.

4.12 UTILITY CLEARANCE

Prior to any field work involving intrusive subsurface activities, utility clearance will be required. BMcD personnel will locate utilities with the aid of DEQ and USEPA personnel and Oklahoma One-Call, a utility location service. A 48-hour notification is required for Oklahoma One-Call prior to commencing intrusive activities.

Utility clearance activities, including the ticket number, utilities notified, and the names of all persons granting utility clearance will be recorded on the Field Safety Checklist, Intrusive Activities, found in the HSP (BMcD, 2005b). Subsurface activities will not be conducted within 5 feet of any marked underground utilities. In addition, all drilling rigs will be positioned such that they are no closer than the lesser of the height of the mast or 30 feet, measured laterally, from overhead power lines. All other vehicles will remain a minimum lateral distance of 30 feet from overhead utilities to reduce the possibility of arcing. The minimum lateral distance may be adjusted if specified in the HSP (BMcD, 2004c). The Field Safety Checklist, Intrusive Activities, provided in the HSP (BMcD, 2005b), will be completed for each site.

Due to the presence of underground or overhead utilities, it may be necessary to offset boring locations. This will be done with the approval of the FSM and documented in the field logbook. Notification of the relocation of boring locations due to utility or other interference will be reported to the DEQ Project Manager within 24 hours; however approval prior to executing the work need not be obtained.

4.13 SURVEYING

For all of the following field activities, pertinent site locations will be surveyed to allow the locations to be properly documented and placed on TFM figures using GPS:

- Subsurface Soil Sampling
- Surface Soil Sampling

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- Sediment/Surface Water Sampling
- Installation of Monitoring Wells and Temporary Piezometers
- Background Sampling
- Ecological Sampling
- Air Sampling

All sample locations will be surveyed horizontally to the nearest 0.1 foot and tied into the Universal Transverse Mercator (UTM). The ground surface elevation of the sample locations will be measured to the nearest 0.1 foot relative to mean sea level (MSL) and reported using North American Vertical Datum 88 (NAVD 88). For all monitoring wells and piezometers, the reference notch in the top of the riser pipe and the monitoring well monument in the concrete base (or ground surface if no concrete base is present) will be surveyed to the nearest 0.01 foot relative to MSL and reported using NAVD 88.

4.14 POTENTIAL RI PHASE II PREPARATION

Prior to Phase II field work similar preparation will be made as done for Phase I (Section 4.1). During Phase II, it may be necessary to utilize the USEPA Region 6 Lab (i.e., ESB) and/or CLP lab(s) to address expanded investigation needs in the area of the former residence. Use of CLP labs requires extensive coordination and communication with the CLP RSCC Coordinator, the CLP Sample Management Office (SMO), the field samplers, and the laboratories that will be accepting samples. The following actions will be undertaken in preparation for shipment of samples to CLP lab(s), as appropriate.

Step 1

1. A CLP Request for Laboratory Sample Analysis Form (See Appendix A) is completed by the BMcD Project Manager or FSM and submitted to the DEQ Project Manager. This form should be submitted approximately one month prior to the start of field activities/sample collection.

2. The DEQ Project Manager reviews the CLP Request for Laboratory Sample Analysis Form and submits it to the USEPA Project Manager.

3. The USEPA Project Manager reviews and approves the form. The USEPA Project Manager submits the approved CLP Request for Laboratory Sample Analysis Form to the Sample Control Manager by no later than the Monday of the week preceding the sampling event.

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4. The Sample Control Manager coordinates the transfer of samples to the CLP lab(s).

Step 2

1. After the Sample Control Manager has made arrangements for the transfer of samples to the CLP lab(s), the BMcD Project Manager or FSM contacts the RSCC Coordinator to begin the process of setting up the sampling event.

2. The RSCC Coordinator contacts the SMO to schedule the sampling event.

   Note: The RSCC Coordinator must be contacted so there is sufficient time for the RSCC Coordinator to contact the SMO by 12:00 p.m. on the Wednesday of the week prior to the start of the sampling event. This notification enables the CLP SMO to provide the SMO-assigned case number and CLP sample numbers in time for the sampling event. It will also allow the CLP SMO to schedule a laboratory and to make sure the laboratory will have sufficient capacity to analyze the samples. The CLP RSCC Coordinator shall be notified immediately of any changes in the sampling event due to a cancellation or an increase or decrease in the number of samples that will be sent to the laboratory so that the CLP RSCC Coordinator can work with the CLP SMO to remedy potential capacity, availability, or overbooking problems.

3. The SMO schedules the sampling event, establishes laboratory availability, and arranges for the laboratory to accept the project samples.

4. The BMcD Project Manager or FSM will contact the RSCC Coordinator on a weekly basis during the time that CLP lab(s) are utilized to provide updates on the sampling schedule.

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5.0 SAMPLE CHAIN OF CUSTODY/DOCUMENTATION

Each sample, field measurement, and field activity will be properly documented to facilitate timely, correct, and complete analyses, and support actions concerning the TFM site RI/FS. The documentation system should provide a means to identify, track, and monitor individual samples from the point of collection through the final reporting of data. Standard field forms are presented in Appendix A.

5.1 FIELD LOGBOOK

Information pertinent to the investigation will be recorded in a bound logbook as described in SOP TFM-112, "Logbook Documentation", which is provided in Appendix B. General rules cannot specify the exact information that must be entered in a logbook for a particular situation at a site. However, the logbook should contain sufficient information so that field activities can be reconstructed.

5.2 PHOTOGRAPHS

Sample points may be documented using photographs. These photographs may include the sample itself, collection activities, and surrounding areas. Photographs taken to document sampling points should include two or more reference points to facilitate relocating the sample location at a later date. The following items will be noted in the field logbook:

- Date
- Time
- Photographer
- Name of site
- General direction faced and description of subject
- Sequential number of the photograph and the roll number
- Type of film used
- Camera type

A photograph location sketch may also be drawn in the field logbook.

5.3 SAMPLE NUMBERING SYSTEM

All samples will be identified with a unique sample number as described in SOP TFM-113, "Sample Numbering and Documentation", which is provided in Appendix B. Sample numbers will be used on all sample labels, TR/COCs, field logbooks, and all other applicable documentation. In addition, QC samples, such as MS/MSDs, will be clearly labeled on all sample labels and TR/COCs.

5.4 SAMPLE DOCUMENTATION

Sampling personnel must adhere to the documentation procedures in SOP TFM-113, "Sample Numbering and Documentation", which is provided in Appendix B.

5.5 LABORATORY ASSIGNMENT

It is anticipated that the DEQ Project Manager will deliver samples directly to the SEL periodically during a week's sampling activities. If this becomes impractical, samplers are responsible for shipping all samples directly to the SEL or other laboratory (i.e., STL Burlington).

When analyzing samples through the CLP, samplers are responsible for shipping samples to the laboratory assigned by the SMO for analysis. The RSCC Coordinator will assign laboratories and inform the field sampling team of the assignment.

5.6 DOCUMENTATION PROCEDURES

The following procedure is a general reference for completing the sample documentation:

1. Determine the samples to be packaged and shipped that day and the laboratory to be used.
2. Complete a shipping bill (if applicable) and enter the shipping record number in the field logbook.
3. Complete the TR/COC in accordance with SOP TFM-115, "Traffic Report/Chain of Custody Preparation", which is provided in Appendix B. Enter the TR/COC document control number in the field logbook.
4. Prepare the samples for shipment.
5. Complete all necessary forms, including the Sample Log-In forms and cooler return documentation discussed below.

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A suitable work area will be established with sufficient space to process forms and package samples. After all sample documentation has been completed and before the samples are prepared for shipping, another project team member will cross-check the data on all forms and labels, and compare the data to the field logbook entries.

5.6.1 Sample Log-In Forms

In addition to completing the TR/COC as discussed in SOP TFM-115, "Traffic Report/Chain of Custody Preparation" and provided in Appendix B, a Sample Log-In form must be completed for each sample analysis for the SEL. The Sample Log-In forms specify the type of analysis by Project Code for each sample submitted to the SEL. The SEL will provide a list of the various Project Codes and example Sample Log-In forms prior to field sampling.

5.6.2 Cooler/Shipping Container Return Documentation Preparation

CLP laboratories must routinely return sample shipping containers within 14 calendar days following receipt of the shipment from the sampler. In order for sample coolers to be returned, the samplers will complete cooler return documentation for laboratories to return the empty coolers. The sampling container return documentation can be prepared in advance and provided to sampling personnel before field activities begin. CLP laboratories are not responsible for paying for the return of the cooler, so airbills will be prepared with either DEQ's or BMcD's account number as well as a return address. The SMO-assigned case number will also be noted on the airbill.

5.6.3 Filing System

A filing system consisting of an on-site file, record data file, and a project file will be established to organize and maintain data. The on-site file will be maintained at the site under the direction of the FSM. The file will consist of copies of record documents generated in the field. The file contents will include, but will not be limited to, the following:

- Field logbooks
- SAP and appendices
- Contract specifications
- Subcontractor agreements
- Material Safety Data Sheets (MSDSs) for chemicals used by BMcD on the site

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- Field instrument operating manuals (PID, combustible gas indicator [CGI], etc.)
- List of important phone numbers
- Shipping forms
- Equipment calibration records
- Health and safety forms (see the HSP [BMcD, 2005b])
- Applicable field forms (see Appendix A)
- Applicable laboratory forms (see the QAPP [BMcD, 2005a])

The record data file will be maintained in a lockable filing cabinet located in BMcD's offices. It will include, but will not be limited to the following:

- Chemical laboratory data file including copies of the COCs, Sample Container Receipt Forms, and requests for chemical analysis
- Physical laboratory data file including requests for physical analysis and the laboratory results
- Field data file including boring log originals, field logbooks, field transmittals, and field performance and system reviews
- Data record file including backup copies of the computerized data record system.

In addition to these items, the on-site file will also be added to the data record file as the field work is completed.

A project file will be maintained in BMcD's offices. The file will include, but not be limited to the following:

- Project correspondence including transmittal letters
- Project memoranda including minutes of meetings and progress reports
- QA/QC file including copies of the laboratory's QA/QC manual, the laboratory's QA/QC project plan, the laboratory's QA/QC internal audit, and performance and system QA reviews
- Report originals

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- Drawing and plan file including original report exhibits, original maps, and miscellaneous plans and drawings related to the field investigation

5.7 CORRECTIONS TO DOCUMENTATION

Original recorded data will be written with indelible ink. Accountable serialized documents will not be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. Errors will be corrected by marking a line through the error, entering the correct information, and initialing and dating the correction. The erroneous information will not be obliterated. Any subsequent error discovered later on an accountable document will be corrected, initialed, and dated by the person who made the entry.

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TFM-0000314

6.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

It is anticipated that the DEQ Project Manager will deliver samples directly to the SEL periodically during a week's sampling activities. In these instances, the sample packing and shipping procedures are less stringent than those required for shipment by an overnight, commercial carrier. If this becomes impractical, samplers are responsible for shipping all samples directly to the SEL or other laboratory (i.e., STL Burlington) using a commercial carrier.

For samples submitted and shipped using a commercial overnight carrier, the sample packaging and shipping procedures are based on USEPA specifications and U.S. Department of Transportation (DOT) regulations (49 Code of Federal Regulations [CFR] Parts 172 and 173). Samples will be packed and shipped according to requirements for low hazard-level samples. Samples will be packaged and shipped, unless holding the samples is necessitated due to the sample receipt requirements discussed in Section 4.0. The specific procedure to be used to pack and ship samples via overnight carrier are presented in SOP TFM-114, "Sample Packaging and Shipping", which is provided in Appendix B.

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TFM-0000315

7.0 INVESTIGATION-DERIVED WASTES

During the RI/FS at the TFM site, various activities such as direct-push and excavation soil sampling, soil boring and monitoring well installation, groundwater sampling, and decontamination of environmental equipment and investigative personnel will produce liquid and solid IDW. Waste management procedures for IDW are based on the requirements specified in Title 40 of the CFR, Part 262 (40 CFR 262) Standards Applicable to Generators of Hazardous Waste; applicable portions of the Oklahoma Hazardous Waste Management Rules (OAC 252:205), and good engineering judgement. BMcD will analyze samples of the IDW prior to disposal. The following sections detail the handling of all IDW resulting from field activities at the TFM site.

7.1 SOLID IDW

Various field activities, such as direct-push activities, soil sampling, soil borings, and monitoring well installation, will produce solid IDW including soil cuttings and excess soil sample material. All solid IDW of this type will be containerized and disposal options evaluated based upon laboratory and site historical data. Solid PPE IDW consisting of used PPE, disposable equipment (bailers, rope, acetate liners, etc.), and other trash that may have come into contact with contamination will be rendered non-hazardous through the removal of gross contamination. All gross contamination removed from the PPE IDW in accordance with the HSP (BMcD, 2005c) will be placed with the appropriate IDW.

7.1.1 Containerization, Labeling, and Storage

Solid IDW, consisting of soil cuttings and excess soil sample material generated from drilling and direct-push activities will be containerized into 55-gallon drums. Solid IDW from trenching activities will be placed back into the trench. Solid IDW from off-site and residential sampling locations will not be containerized. This material will be left in place at the sampling location, as it is expected to be non-hazardous material.

The drums will be labeled to indicate the source and nature of the waste material. The following information will be marked on the top or sides of each container: container number(s) (TFM plus a sequential number); facility name; monitoring well, direct push, or probehole number; date of generation; container contents; estimated quantity; and a DEQ point of contact.

For example:

Container Number:	TFM-01
Facility Name:	Tulsa Fuel and Manufacturing
Well or Probehole Number:	SP-01 to SP-20
Dates(s) of generation (MM-DD-YY):	06-05-05
Container Contents:	Drill Cuttings
Estimated Quantity:	50 gallons
DEQ Contact Name and Phone Number:	George Thomas (405) 702-5126

Drums will be marked with 2-inch letters and numbers using a waterproof paint pen. An IDW Inventory Worksheet (Appendix A) will be maintained by the FSM to facilitate the identification and tracking of solid IDW for appropriate disposal. This inventory will include the above information and the location of each drum. In addition to the IDW Inventory Worksheet, the estimated amount of solid IDW generated will be noted in the field logbook on a daily basis.

The containers will be covered and secured except when adding to or disposing of the contents. Containers of the solid IDW will be temporarily stored at the site until characterized. The containers should not remain in storage for longer than necessary to determine the regulatory status of the waste through laboratory testing and to evaluate disposal options.

Containers of solid IDW determined to be hazardous waste or non-hazardous waste will be relabeled in a manner consistent with applicable state and federal requirements including, but not limited to, the RCRA and the DOT (40 CFR 171-179). Based on available information, none of the soil is anticipated to be hazardous, but is being segregated as a precaution.

Used PPE, disposable equipment, and other potentially contaminated material will be disposed as general trash on a daily basis. The PPE IDW will be double bagged and disposed in the on-site dumpster as solid waste. Plastic trash bags containing used PPE, disposable equipment, and other potentially contaminated material will be placed in the designated location on the site for later disposal.

7.1.2 Solid IDW Evaluation

Within two weeks of the completion of field activities collect a composite sample from the soil IDW generated during field activities. Five drums may be composited per sample. The chemical analyses selected will depend upon the requirements of the disposal option. The composited samples may be submitted for analysis for one or more the following:

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- pH by SW-846 Method 9040
- Paint Filter Test by SW-846 Method 9095A
- Ignitability by SW-846 Method 1010
- Corrosivity by SW-846 Method 1110
- TCL SVOCs by SW-846 Method 8270C
- TCL VOCs by SW-846 Method 8260B
- TCL PCBs by SW-846 Method 8082
- TAL metals by SW-846 Methods 6000 and 7000 Series
- Cyanide by SW-846 Method 9000 Series

For soil IDW, TCLP extraction by SW-846 Method 1311 may be required for one or more of the above analyses as well. The analytical results will be utilized to determine if the soil IDW is non-hazardous waste, special (non-hazardous contaminated), or hazardous waste. These types of wastes are defined in 40 CFR 261 and the Oklahoma Hazardous Waste Management Rules (OAC 252:205). After review of the analytical results, BMcD will determine the appropriate management option and report the information to DEQ as part of the associated sampling report. Depending on the characterization/classification status, DEQ may consult with the USEPA during the determination process to secure any necessary approvals.

Containers of soil IDW determined to be hazardous waste or non-hazardous waste will be relabeled in a manner consistent with applicable state and federal requirements including, but not limited to, RCRA, the Toxic Substances Control Act (TSCA), and the DOT (40 CFR 171-179).

7.1.3 Disposal of Solid IDW

Depending on the classification of the soil IDW, several options are available for disposal.

- Non-hazardous solid IDW (waste soil) may be spread on the ground surface near the point of origin when possible. When the soil cannot be spread near the point of origin due to reasons including pavement, aesthetics, or having been composited, the soil will be spread on the ground in an area approved by DEQ and USEPA.

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- Non-hazardous solid IDW (used PPE, disposable equipment, and trash) will be disposed in a designated general trash dumpster on the site.

- Soil IDW classified as special waste will be managed and disposed according to 40 CFR 261 and the Oklahoma Hazardous Waste Management Rules (OAC 252:205).

- No solid IDW is anticipated to be deemed as hazardous based on available information.

7.2 LIQUID IDW

7.2.1 Containerization, Labeling, and Storage

Decontamination, development, and purge water from activities on the site will be temporarily stored in 55-gallon, DOT-approved containers at the site. The containers will be labeled to indicate the source and nature of the waste material. The following information will be marked on the top or sides of each container: container number(s) (TFM plus a sequential number); facility name; monitoring well, direct push, or probehole number; date of generation; container contents; estimated quantity; and a DEQ point of contact.

For example:

Container Number:	TFM-02
Facility Name:	Tulsa Fuel and Manufacturing
Well or Probehole Number:	MW-1 through MW-5
Dates(s) of generation (MM-DD-YY):	06-05-05
Container Contents:	Purge Water
Estimated Quantity:	50 gallons
DEQ Contact Name and Phone Number:	George Thomas (405) 702-5126

Containers will be marked with 2-inch letters and numbers using a waterproof paint pen. An IDW Inventory Worksheet (Appendix A) will be maintained by the FSM to facilitate the identification and tracking of liquid IDW for appropriate disposal. This inventory will include all of the above information, and the location of the container. In addition to the IDW Inventory Worksheet, the total number of containers of liquid IDW generated will be noted in the field logbook on a daily basis.

The containers will be closed and secured except when adding to or disposing of the contents. Liquid IDW, including decontamination, development, and purge waters, resulting from the installation of a new

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monitoring well will be containerized on a per well basis. Decontamination and/or purge waters resulting from direct-push activities or other field activities will be containerized based on the area being investigated.

Containers of liquid IDW will be temporarily stored at the site until characterized. The containers should not remain in storage for longer than necessary to determine the regulatory status of the waste through laboratory testing and to evaluate disposal options.

7.2.2 Liquid IDW Evaluation

Within two weeks of the completion of field activities, a sample from each container of liquid IDW will be obtained and composited with the exception of samples for VOCs. When the liquid IDW is to be characterized for VOCs, one grab sample will be collected from each container of IDW. Samples for the other parameters will be composited from five drums containing liquid IDW. The composite sample will be analyzed for the same constituents analyzed for that specific site investigation. If elevated levels of contaminant concentrations at some investigation points are anticipated during the field activities, then the IDW from these points will be stored in separate containers and analyzed separately from the other liquid IDW.

The chemical analyses may include the following:

- pH by SW-846 Method 9040
- Total suspended solids by USEPA Method 160.2
- Ignitability by SW-846 Method 1010
- Corrosivity by SW-846 Method 1110
- TCL SVOCs by SW-846 Method 8270B
- TCL VOCs by SW-846 Method 8260B
- TAL metals and cyanide by SW-846 Methods 6000 and 7000 Series

The analytical results will be compared with the maximum contaminant level (MCL) and TCLP values. After review of the analytical results, BMcD will determine the appropriate management option and report the information to DEQ as part of the associated sampling report. Depending on the

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characterization/classification status, DEQ may consult with the USEPA during the determination process to secure any necessary approvals.

The results of the above analyses will be utilized to determine if the liquid IDW is non-hazardous waste, special waste, or hazardous waste. These types of wastes are defined in 40 CFR 261 and the Oklahoma Hazardous Waste Management Rules (OAC 252:205).

Containers of liquid IDW determined to be hazardous waste or non-hazardous waste will be relabeled in a manner consistent with applicable state and federal requirements including, but not limited to, the RCRA, the TSCA, and the DOT (40 CFR 171-179).

7.2.3 Disposal of Liquid IDW

Depending on the classification of the liquid IDW, several options are available for disposal.

- Non-hazardous liquid IDW (below MCLs and TCLP thresholds) will be discharged directly to the ground with DEQ and USEPA approval.

- Non-hazardous liquid IDW (special waste above MCLs, but below TCLP thresholds) may be discharged to the City of Collinsville wastewater treatment system after receiving authorization. If it is determined that the liquid IDW requires treatment prior to disposal via the wastewater treatment system, the most appropriate treatment technology to employ will be determined.

- No liquid IDW is anticipated to be deemed as hazardous based on available information.

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8.0 CORRECTIVE ACTION

Discrepancies discovered by field, laboratory, or office personnel will be immediately brought to the attention of the Project Manager. If the problem is not readily correctable, the Project Manager will contact the DEQ Project Manager, explain the discrepancy, and reach a mutually agreeable solution. The Project Manager will then implement the solution and submit a memo to the DEQ Project Manager detailing the problem and resolution.

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TFM-0000322

9.0 PROJECT SCHEDULE

Investigation activities for the TFM site are being carried out in accordance with the schedule as set forth in the contract with DEQ. The schedule for specific investigations performed using this FSP is provided as Figure 9-1.

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TFM-0000323

10.0 REFERENCES

Burns & McDonnell Engineering Company, Inc. (BMcD), 2005a. *Remedial Investigation/Feasibility Study Sampling and Analysis Plan, Volume II, Quality Assurance Project Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma,* May 12. (RI/FS QAPP)

Burns & McDonnell Engineering Company, Inc. (BMcD), 2005b. *Remedial Investigation/Feasibility Study Health and Safety Plan, Tulsa Fuel and Manufacturing, Oklahoma,* May 12. (RI/FS HSP)

Burns & McDonnell Engineering Company, Inc. (BMcD), 2005c. *Remedial Investigation/Feasibility Study Work Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma,* May 19. (RI/FS Work Plan)

Exponent, 2001. *Focused Remedial Investigation, Collinsville Smelter Site*. Prepared for Phelps Dodge Corporation: Tempe, Arizona. January.

Fluor Daniel, Inc. (FDI), 1997. *USEPA Brownfields Final Report Collinsville Strip Mine Site. Collinsville, Oklahoma.* January 21.

National Weather Service (NWS), 2005. *Tulsa, Oklahoma Climatology*. April 1. Available at: http://www.srh.noaa.gov/tsa/climate/tulsacli.html

National Water and Climate Center (NWCC), 2005. *Wind Rose Data for Tulsa International Airport 1961 – 1990*. Available at: http://www.wcc.nrcs.usda.gov/climate/windrose.html.

Oklahoma Administrative Code (OAC), 2004. *Title 785: Oklahoma Water Resrouces Board, Chapter 45: Oklahoma's Water Quality Standards.* July 1.

Oklahoma Climatological Society (OCS), 2005. *Climatological Information for Tulsa County, Oklahoma*. Available at: http://www.ocs.ou.edu

Oklahoma Department of Environmental Quality (DEQ), 1994. *Site Inspection Report, Tulsa Fuel & Manufacturing, Tulsa County, Oklahoma. EPA ID No. OKD987096195*. September 30.

Oklahoma Department of Environmental Quality (DEQ), 2001. *Community Relations Plan for Tulsa Fuel and Manufacturing Superfund Site, Tulsa County, Collinsville, Oklahoma*. November 8.

Oklahoma Department of Environmental Quality (DEQ), 2005a. *The 2004 Land Report*. January 11.

Oklahoma Department of Environmental Quality (DEQ), 2005b, *Consultant Scope of Work for the Remedial Investigation/Feasibility Study (RI/FS) for the Tulsa Fuel and Manufacturing Superfund Site,* January 28.

Oklahoma Natural Heritage Inventory (ONHI), 2003. *Oklahoma Biological Survey, Federal and State Endangered, Threatened, and Candidate Species in Oklahoma by County*. May 5. Available at: http://www.biosurvey.ou.edu\heritage\publicat.html

Oklahoma State Department of Health (OSDH), 1992. *Preliminary Assessment, Acme Brick Strip Mines, Collinsville, Oklahoma, Tulsa County.* November 16.

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Sanborn Fire Insurance Map, 1919. *Tulsa Fuel & Manufacturing Company, Collinsville, Oklahaoma*. February.

Tulsa Geological Survey (TGS), 1973. *Tulsa's Physical Environment*.

United States Department of Agriculture (USDA), 1977. *Soil Survey of Tulsa County, Oklahoma*.

United States Environmental Protection Agency (USEPA), 1983. *Methods for Chemical Analysis of Water and Wastes*. March.

United States Environmental Protection Agency (USEPA), 1988. *EPA Guidance for Conducting Remedial Investigations and Feasibility Studies, Interim Final, EPA/540/G-89/004, October*.

United States Environmental Protection Agency (USEPA), 1989. *Risk Assessment Guidance for Superfund: Volume 1: Human Health Evaluation Manual, Part D; Standardized Planning, Reporting, and Review of Superfund Risk Assessments, PB 96-963203, December*.

United States Environmental Protection Agency (USEPA), 1997. *Test Method for Evaluating Solid Waste, Physical/Chemical Methods. Final Update III*. July. (SW-846 Methods)

United States Environmental Protection Agency (USEPA), 1999. *Removal Assessment Report. Tulsa Fuel and Manufacturing Site, Collinsville, Tulsa County, Oklahoma. CERCLIS #: OKD987096195*. May 14.

United States Environmental Protection Agency (USEPA), 2001. *Risk Assessment Guidance for Superfund: Volume 1: Human Health Evaluation Manual, Part D; Standardized Planning, Reporting, and Review of Superfund Risk Assessments, PB 96-963203, December*.

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TFM-0000325

TABLES

Table 3-1
Analytical Parameter List
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

PRIMARY SOIL ANALYSES		
Metal Constituents		
* Arsenic	* Lead	* Zinc
* Cadmium		
Toxicity Characteristic Leaching Procedure (TCLP) Metals		
* Arsenic	* Cadmium	* Lead

PRIMARY WATER ANALYSES		
Metal Constituents		
* Arsenic	* Lead	* Zinc
* Cadmium		
Water Quality		
pH (field measured)	Alkalinity	Sulfate
Specific conductivity (field measured)	Chemical Oxygen Demand	Nitrate as Nitrogen
Temperature (field measured)	Total Organic Carbon	
Turbidity (field measured)	Chloride	

PRIMARY AIR ANALYSES		
Particulate Matter		
PM_{10}	Total Suspended Particulate Matter	
Airborne Particulate TAL Metals		
* Arsenic	* Lead	* Zinc
* Cadmium		

POTENTIAL SOIL AND WATER ANALYSES (Limited Locations RI Phase 2)		
Target Compound List Volatile Organic Compounds (TCL VOCs)		
1,1-Dichloroethane	4-Methyl-2-pentanone	Dichlorodifluoromethane
1,1-Dichloroethene	Acetone	Ethylbenzene
1,1,1-Trichloroethane	Benzene	Isopropylbenzene
1,1,2-Trichloroethane	Bromodichloromethane	Methyl Acetate
1,1,2-Trichloro-1,2,2,-trifluoroethane	Bromoform	Methylene Chloride
1,1,2,2-Tetrachloroethane	Bromomethane	Methylcyclohexane
1,2-Dibromoethane	Carbon Disulfide	Methyl tert-Butyl Ether
1,2-Dichlorobenzene	Carbon Tetrachloride	Styrene
1,2-Dichloroethane	Chlorobenzene	Tetrachloroethene
1,2-Dichloropropane	Chloroethane	Toluene
1,2-Dibromo-3-chloropropane	Chloroform	trans-1,2-Dichloroethene
1,2,4-Trichlorobenzene	Chloromethane	trans-1,3-Dichloropropene
1,3-Dichlorobenzene	cis-1,2-Dichloroethene	Trichlorofluoromethane
1,4-Dichlorobenzene	cis-1,3-Dichloropropene	Trichloroethene
2-Butanone	Cyclohexane	Vinyl Chloride
2-Hexanone	Dibromochloromethane	Xylenes (total)
1,1'-Biphenyl	4-Nitroaniline	Dibenzofuran
2-Chloronaphthalene	4-Nitrophenol	Diethylphthalate
2-Chlorophenol	4,6-Dinitro-2-methylphenol	Dimethylphthalate
2-Methylnaphthalene	Acenaphthene	Di-n-butylphthalate
2-Methylphenol	Acenaphthylene	Di-n-octylphthalate
2-Nitroaniline	Acetophenone	Fluoranthene

Table 3-1
Analytical Parameter List
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

POTENTIAL SOIL AND WATER ANALYSES (Limited Locations RI Phase 2)		
Target Compound List Semivolatile Organic Compounds (TCL SVOCs)		
2-Nitrophenol	Anthracene	Fluorene
2,2'-oxybis(1-chloropropane)	Atrazine	Hexachlorobenzene
2,4-Dichlorophenol	Benzaldehyde	Hexachlorobutadiene
2,4-Dimethylphenol	Benzo(a)anthracene	Hexachlorocyclopentadiene
2,4-Dinitrophenol	Benzo(a)pyrene	Hexachloroethane
2,4-Dinitrotoluene	Benzo(b)fluoranthene	Indeno(1,2,3-cd)pyrene
2,4,5-Trichlorophenol	Benzo(g,h,i)perylene	Isophorone
2,4,6-Trichlorophenol	Benzo(k)fluoranthene	Naphthalene
2,6-Dinitrotoluene	bis(2-Chloroethyl)ether	Nitrobenzene
3-Nitroaniline	bis(2-Chloroethoxy)methane	N-Nitroso-di-n-propylamine
3,3'-Dichlorobenzidine	bis(2-Ethylhexyl)phthalate	N-Nitrosodiphenylamine
4-Bromophenyl-phenylether	Butylbenzlphthalate	Pentachlorophenol
4-Chloro-3-methylphenol	Caprolactam	Phenanthrene
4-Chloroaniline	Carbazole	Phenol
4-Chlorophenyl-phenyl ether	Chrysene	Pyrene
4-Methylphenol	Dibenzo(a,h)anthracene	
Target Compound List Pesticides (TCL Pesticides)		
alpha-BHC	Endosulfan I	4,4'-DDT
beta-BHC	Dieldrin	Methoxychlor
delta-BHC	4,4'-DDE	Endrin Ketone
gamma-BHC (Lindane)	Endrin	Endrin Aldehyde
Heptachlor	Endosulfan II	alpha-Chlordane
Aldrin	4,4'-DDD	gamma-Chlordane
Heptachlor epoxide	Endosulfan sulfate	Toxaphene
Target Compound List Polychlorinated Biphenyls (TCL PCBs)		
Aroclor-1016	Aroclor-1242	Aroclor-1260
Aroclor-1221	Aroclor-1248	
Aroclor-1232	Aroclor-1254	
Target Analyte List Inorganic Compounds (TAL Inorganics)		
Aluminum	Cobalt	Potassium
Antimony	Copper	Selenium
* Arsenic	Iron	Silver
Barium	* Lead	Sodium
Beryllium	Magnesium	Thallium
* Cadmium	Manganese	Vanadium
Calcium	Mercury	* Zinc
Chromium	Nickel	Cyanide
TCLP Metals		
* Arsenic	Chromium	Selenium
Barium	* Lead	Silver
* Cadmium	Mercury	

* Critical parameters

Table 4-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide
On-Site Soil and Groundwater Sampling														
Surface Soil Sample Collection	Surface Soil	0-6"	8		X	10%	10%							
Direct-Push Sample Collection (Includes samples collected during temporary piezometer installation)	Surface Soil	0-6"	48		X	10%	10%							
	Subsurface Soil	6"-2'	48		X	10%	10%							
		2-4'	48		X	10%	10%							
		4-8'	3 [5]		X	10%	10%							
		8-16'	3 [5]		X	10%	10%							
		16'-Refusal	3 [5]		X	10%	10%							
	Groundwater[6]	Top of Bedrock	11 [5]			X[6]		X						
Monitoring Well Sample Collection	Groundwater[6]	Newly Installed Wells	5			X[6]		X						
		On-Site Residential Well	1			X[6]		X						
Waste Sampling														
Trench Sample Collection	Surface Soil	0-6"	21		X	10%	10%							
	Subsurface Soil	Mid-Trench	10		X	10%	10%							
		Clay just below slag	21		X	10%	10%							
Off-Site Surface Soil Sampling														
Tribal Member Properties	Surface Soil	0-3"	10	XRF	X	10%	10%							
Targeted Sampling Locations	Surface Soil	0-3"	8	XRF	X	10%	10%							
Off-Site Grid Sampling Locations														
Planned	Surface Soil	0-3"	49	XRF	X	10%	10%							
Potential	Surface Soil	0-3"	22	XRF	X	10%	10%							

Table 4-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide
Off-Site Surface Soil Sampling (continued)														
"Distance" Sampling Locations														
N, NNW, S, & SSE (1 mi & 1 1/2 mi)	Surface Soil	0-3"	14	XRF	X	10%	10%							
E & W (1/2 mi & 1 mi)	Surface Soil	0-3"	8	XRF	X	10%	10%							
Surface Water and Sediment Sampling														
On-Site Locations	Surface Water		12			X		X						
	Sediment	0-6"	12		X	10%	10%							
Strip Mine Pit	Surface Water		6			X		X						
	Sediment	0-6"	6		X	10%	10%							
Off-Site Locations	Surface Water		13			X		X						
	Sediment	0-6"	13		X	10%	10%							
Background Sampling														
Surface Soil Sample Collection	Surface Soil	0-3"	2		X	10%	10%							
Direct-Push Sample Collection	Surface Soil	0-6"	2		X	10%	10%							
	Subsurface Soil	6"-2'	2		X	10%	10%							
		2-4'	2		X	10%	10%							
Monitroing Well Sample Collection	Groundwater[6]	NA	1			X[6]		X						
Surface Water Sample Collection	Surface Water	NA	2			X		X						
Sediment Sample Collection	Sediment	0-6"	2		X	10%	10%							

Table 4-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide
Background Sampling (continued)														
Ecological Sample Collection	Berries	Washed	1			X								
		Unwashed	1			X								
	Leaves	Washed	1			X								
		Unwashed	1			X								
	Roots	Washed	1			X								
	Soil/Slag	Soil/slag around plant's roots	1			X	10%							
Perimeter Air Monitoring														
Air Quality Sample Collection[7]	Air	NA	14						X					
Ecological Sampling														
DEQ 2004 Samples	Berries	Washed	4			X								
		Unwashed	8			X								
	Leaves	Washed	4			X								
		Unwashed	4			X								
	Roots	Washed	4			X								
	Soil/Slag	Soil/slag around plant's roots	6			X	10%							
Phase I RI Samples	Berries	Washed	2			X								
		Unwashed	2			X								
	Leaves	Washed	2			X								
		Unwashed	2			X								
	Roots	Washed	2			X								
	Soil/Slag	Soil/slag around plant's roots	2			X	10%							

Table 4-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide
Phase II RI Potential Sampling														
Information needed for	Surface Soil	On-Site = 0-6" or Off-Site=0-3"	20		X	10%	10%							
Treatability Study, RI Report,	Subsurface Soil	>6"	60		X	10%	10%							
and Risk Assessments	Groundwater[5]	NA	3			X[5]		X						
	Surface Water	NA	5			X		X						
	Sediment	0-6"	5		X	10%	10%							
	Ecological	Berries - Washed	1			X								
		Berries - Unwashed	1			X								
		Leaves - Washed	1			X								
		Leaves - Unwashed	1			X								
		Roots - Washed	1			X								
		Soil/slag around plant's roots	1			X	10%							
Waste Sampling	Waste Material	NA	4							X				
Vicinity of Former Residence	Surface Soil	0-6"	5								X	X	X	X[6]
(i.e., Trash Dump Area)	Subsurface Soil	>6"	10								X	X	X	X[6]
	Groundwater[6]	On-Site Residential Well	1								X	X	X	X[6]

Notes:

1 = Sample count only includes field samples and does not include QC samples such as field duplicates, MSs, or MSDs.
Increase count by 10% to account for field duplicates, 5% to account for MSs, and 5% to account for MSDs.

2 = General Water Chemistry analyses as the lab include total organic carbon (TOC), chemical oxgen demand (COD), alkalinity, nitrate as nitrogen, chloride, and sulfate.
Specific conductivity, pH, temperature, and turbidity will be measured in the field.

3 = Air Quality analyses include total suspended particulates (TSP), PM10, and Metals (As, Cd, Pb, and Zn).

4 = During Phase II, waste samples may be analyzed for all 8 RCRA metals and all 8 TCLP metals for purposes of waste characterization and disposal.

5 = Samples will be collected from temporary piezometer locations only.

6 = If sample turbidity is greater than 50 NTUs, groundwater samples for metals analysis will be submitted as filtered and unfiltered samples.

7 = Perimeter air montoring will be performed at 2 locations (one upwind and one downwind) for one week as 24-hour composite samples.
Filters will be changed daily over the course of the week, resulting in 7 samples being collected at each location.

Table 4-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide

As = Arsenic
Cd = Cadmium
COD = Chemical Oxygen Demand
DEQ = Oklahoma Department of Environmental Quality
ICP = Inductively Coupled Plasma
MS/MSD = Matrix Spike/Matrix Spike Duplicate
NA = Not Applicable
NTU = Nephlometric Turbidity Unit
Pb = Lead
RCRA Metals = Arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver
RCRA = Resource Conservation and Recovery Act
RI = Remedial Investigation
SVOC = Semivolatile Organic Compound
TAL = Target Analyte List
TCL = Target Compound List
TCLP = Toxicity Characteristic Leaching Procedure
TOC = Total Organic Carbon
VOC = Volatile Organic Compound
XRF = X-Ray Fluorescence Spectroscopy
Zn = Zinc

Laboratories for Phase I RI Samples

Soil and Water Matrices
Oklahoma State Environmental Lab (SEL)
707 N. Robinson
Oklahoma City, OK 73102

Lab QA Manager: Susan Elmenhorst
Phone: (405) 702-1038
Email: Susan.Elmenhorst@deq.state.ok.us

Air and Ecological Matrices
STL Burlington
208 South Park Drive, Suite 1
Colchester, VT 05446

Project Manager: Don Dawicki
Phone: (802) 655-1023
Email: Ddawicki@stl-inc.com

Laboratories for Phase II RI Samples

Non-Organic Analysis for Soil and Water
Oklahoma State Environmental Lab (SEL)
707 N. Robinson
Oklahoma City, OK 73102

Lab QA Manager: Susan Elmenhorst
Phone: (405) 702-1038
Email: Susan.Elmenhorst@deq.state.ok.us

Air and Ecological Matrices
STL Burlington
208 South Park Drive, Suite 1
Colchester, VT 05446

Project Manager: Don Dawicki
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Email: Ddawicki@stl-inc.com

Organic Analysis of Soil and Water
USEPA Region 6 Laboratory
Contract Laboratory Program Sample Control Manager
10625 Fallstone Road
Houston, TX 77099

Attn: Christy Warren
Phone: (281) 983-2137
Email: Warren.Christy@epa.gov

AND

USEPA Region 6 Laboratory
Contract Laboratory Program Regional Sample Control Center Coordinator
10625 Fallstone Road
Houston, TX 77099

Attn: Myra Perez
Phone: (281) 983-2130
Email: Perez.Myra@epa.gov

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Analyses				
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]
Direct-Push Sample Collection								
SP-01	SS01	0-6"		X		X		
SP-01	SS01CF	0-6"	Confirmation		X			
SP-1000	SS01	0-6"	Field Dup of SP-01/SS01	X		X		
SP-1000	SS01CF	0-6"	Field Dup of SP-01/SS01CF		X			
SP-02	SS02	6"-2'		X				
SP-03	SS03	2-4'		X				
SP-03	SS03MS	2-4'	Matrix Spike	X				
SP-03	SS03MSF	2-4'	Matrix Spike Duplicate	X				
SP-02	SS01	0-6"		X				
SP-03	SS01	0-6"		X				
SP-03	SS02	6"-2'		X				
SP-03	SS03	2-4'		X				
SP-04	SS01	0-6"		X				
SP-05	SS01	0-6"		X		X		
SP-05	SS01CF	0-6"	Confirmation		X			
SP-06	SS01	0-6"		X				
SP-06	SS02	6"-2'		X				
SP-1001	SS02	6"-2'	Field Dup of SP-06/SS02	X				
SP-06	SS03	2-4'		X				
SP-07	SS01	0-6"		X				
SP-08	SS01	0-6"		X				
SP-09	SS01	0-6"		X				
SP-09	SS02	6"-2'		X				
SP-09	SS03	2-4'		X				
SP-10	SS01	0-6"		X				
SP-10	SS02	6"-2'		X				
SP-10	SS03	2-4'		X		X		
SP-10	SS03CF	2-4'	Confirmation		X			
SP-11	SS01	0-6"		X				
SP-1002	SS01	0-6"	Field Dup of SP-11/SS01	X				
SP-11	SS02	6"-2'		X				
SP-11	SS03	2-4'		X				
SP-11	SS03MS	2-4'	Matrix Spike	X				
SP-11	SS03MSD	2-4'	Matrix Spike Duplicate	X				
SP-12	SS01	0-6"		X				
SP-13	SS01	0-6"		X				
SP-13	SS02	6"-2'		X				
SP-13	SS03	2-4'		X				
SP-14	SS01	0-6"		X				
SP-15	SS01	0-6"		X				
SP-16	SS01	0-6"		X				
SP-16	SS02	6"-2'		X				
SP-16	SS03	2-4'		X				
SP-1003	SS03	2-4'	Field Dup of SP-16/SS03	X				
SP-17	SS01	0-6"		X				
SP-17	SS02	6"-2'		X				
SP-17	SS03	2-4'		X				

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Analyses				
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]
SP-18	SS01	0-6"		X				
SP-18	SS02	6"-2'		X				
SP-18	SS03	2-4'		X		X		
SP-18	SS03CF	2-4'	Confirmation		X			
SP-19	SS01	0-6"		X				
SP-1004	SS01	0-6"	Field Dup of SP-19/SS01	X				
SP-19	SS02	6"-2'		X				
SP-19	SS03	2-4'		X				
SP-20	SS01	0-6"		X				
SP-20	SS01MS	0-6"	Matrix Spike	X				
SP-20	SS01MSD	0-6"	Matrix Spike Duplicate	X				
SP-20	SS02	6"-2'		X				
SP-20	SS03	2-4'		X				
SP-21	SS01	0-6"		X				
SP-21	SS02	6"-2'		X				
SP-21	SS03	2-4'		X				
SP-22	SS01	0-6"		X		X		
SP-22	SS01CF	0-6"	Confirmation		X			
SP-22	SS02	6"-2'		X				
SP-1005	SS02	6"-2'	Field Dup of SP-22/SS02	X				
SP-22	SS03	2-4'		X				
SP-23	SS01	0-6"		X				
SP-23	SS02	6"-2'		X				
SP-23	SS03	2-4'		X				
SP-24	SS01	0-6"		X				
SP-24	SS02	6"-2'		X				
SP-24	SS03	2-4'		X				
SP-25	SS01	0-6"		X				
SP-25	SS02	6"-2'		X		X		
SP-25	SS02CF	6"-2'	Confirmation		X			
SP-1006	SS02	6"-2'	Field Dup of SP-25/SS02	X		X		
SP-1006	SS02CF	6"-2'	Field Dup of SP-25/SS02CF		X			
SP-25	SS03	2-4'		X				
SP-26	SS01	0-6"		X				
SP-26	SS02	6"-2'		X				
SP-26	SS02MS	6"-2'	Matrix Spike	X				
SP-26	SS02MSD	6"-2'	Matrix Spike Duplicate	X				
SP-26	SS03	2-4'		X				
SP-27	SS01	0-6"		X				
SP-27	SS02	6"-2'		X				
SP-27	SS03	2-4'		X				
SP-28	SS01	0-6"		X				
SP-28	SS02	6"-2'		X				
SP-28	SS03	2-4'		X				
SP-29	SS01	0-6"		X		X		
SP-29	SS01CF	0-6"	Confirmation		X			
SP-29	SS02	6"-2'		X				
SP-1007	SS02	6"-2'	Field Dup of SP-29/SS02	X				
SP-29	SS03	2-4'		X				

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Analyses				
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]
SP-30	SS01	0-6"		X				
SP-30	SS02	6"-2'		X				
SP-30	SS03	2-4'		X				
SP-31	SS01	0-6"		X				
SP-31	SS02	6"-2'		X				
SP-31	SS03	2-4'		X				
SP-32	SS01	0-6"		X				
SP-32	SS02	6"-2'		X		X		
SP-32	SS02CF	6"-2'	Confirmation		X			
SP-32	SS03	2-4'		X				
SP-1008	SS03	2-4'	Field Dup of SP-32/SS03	X				
SP-33	SS01	0-6"		X				
SP-33	SS01MS	0-6"	Matrix Spike	X				
SP-33	SS01MSD	0-6"	Matrix Spike Duplicate	X				
SP-33	SS02	6"-2'		X				
SP-33	SS03	2-4'		X				
SP-34	SS01	0-6"		X				
SP-34	SS02	6"-2'		X				
SP-34	SS03	2-4'		X				
SP-35	SS01	0-6"		X				
SP-35	SS02	6"-2'		X				
SP-35	SS03	2-4'		X				
SP-36	SS01	0-6"		X		X		
SP-36	SS01CF	0-6"	Confirmation		X			
SP-36	SS02	6"-2'		X				
SP-1009	SS02	6"-2'	Field Dup of SP-36/SS02	X				
SP-36	SS03	2-4'		X				
SP-37	SS01	0-6"		X				
SP-37	SS02	6"-2'		X				
SP-37	SS03	2-4'		X				
SP-38	SS01	0-6"		X				
SP-38	SS02	6"-2'		X				
SP-38	SS03	2-4'		X				
SP-39	SS01	0-6"		X				
SP-39	SS02	6"-2'		X		X		
SP-39	SS02CF	6"-2'	Confirmation		X			
SP-39	SS03	2-4'		X				
SP-1010	SS03	2-4'	Field Dup of SP-1010/SS03	X				
SP-40	SS01	0-6"		X				
SP-40	SS02	6"-2'		X				
SP-40	SS02MS	6"-2'	Matrix Spike	X				
SP-40	SS02MSD	6"-2'	Matrix Spike Duplicate	X				
SP-40	SS03	2-4'		X				
SP-41	SS01	0-6"		X				
SP-41	SS02	6"-2'		X				
SP-41	SS03	2-4'		X				
SP-42	SS01	0-6"		X				
SP-42	SS02	6"-2'		X				
SP-42	SS03	2-4'	Confirmation	X		X		
SP-42	SS03CF	2-4'			X			

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Analyses				
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]
SP-43	SS01	0-6"		X				
SP-1011	SS01	0-6"	Field Dup of SP-43/SS01	X				
SP-43	SS02	6"-2'		X				
SP-43	SS03	2-4'		X				
SP-44	SS01	0-6"		X				
SP-44	SS02	6"-2'		X				
SP-44	SS03	2-4'		X				
SP-45	SS01	0-6"		X				
SP-45	SS02	6"-2'		X				
SP-45	SS03	2-4'		X				
SP-46	SS01	0-6"		X		X		
SP-46	SS01CF	0-6"	Confirmation		X			
SP-46	SS02	6"-2'		X				
SP-1012	SS02	6"-2'	Field Dup of SP-46/SS02	X				
SP-46	SS03	2-4'		X				
SP-47	SS01	0-6"		X				
SP-47	SS02	6"-2'		X				
SP-47	SS03	2-4'		X				
SP-47	SS03MS	2-4'	Matrix Spike	X				
SP-47	SS03MSD	2-4'	Matrix Spike Duplicate	X				
SP-48	SS01	0-6"		X				
SP-48	SS02	6"-2'		X				
SP-48	SS03	2-4'		X				
SP-49	SS01	0-6"		X				
SP-49	SS02	6"-2'		X		X		
SP-49	SS02CF	6"-2'	Confirmation		X			
SP-49	SS03	2-4'		X				
SP-1013	SS03	2-4'	Field Dup SP-49/SS03	X				
SP-50	SS01	0-6"		X				
SP-50	SS02	6"-2'		X				
SP-50	SS03	2-4'		X				
SP-51	SS01	0-6"		X				
SP-51	SS02	6"-2'		X				
SP-51	SS03	2-4'		X				
SP-52	SS01	0-6"		X				
SP-52	SS02	6"-2'		X				
SP-52	SS03	2-4'		X				
SP-53	SS01	0-6"		X		X		
SP-53	SS01CF	0-6"	Confirmation		X			
SP-1014	SS01	0-6"	Field Dup of SP-53/SS01	X		X		
SP-1014	SS01CF	0-6"	Field Dup of SP-53/SS01CF		X			
SP-53	SS02	6"-2'		X				
SP-53	SS03	2-4'		X				

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Analyses				
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]
Temporary Piezometers Installed by Direct-Push[5]								
PZ-04	SS01	0-6"		X				
PZ-04	SS02	6"-2'		X				
PZ-04	SS03	2-4'		X				
PZ-04	SS04	4-8'		X		X		
PZ-04	SS04MS	4-8'	Matrix Spike	X		X		
PZ-04	SS04MSD	4-8'	Matrix Spike Duplicate	X		X		
PZ-04	SS04CF	4-8'	Confirmation		X			
PZ-04	SS04CFMS	4-8'	Confirmation Matrix Spike		X			
PZ-04	SS04CFMSD	4-8'	Confirmation Matrix Spike Dup		X			
PZ-04	SS05	8-16'		X				
PZ-04	SS06	16'-Refusal		X				
PZ-07	SS01	0-6"		X				
PZ-07	SS02	6"-2'		X				
PZ-1000	SS02	6"-2'		X				
PZ-07	SS03	2-4'		X		X		
PZ-07	SS03CF	2-4'	Confirmation		X			
PZ-07	SS04	4-8'		X				
PZ-07	SS05	8-16'		X				
PZ-07	SS06	16'-Refusal		X				
PZ-09	SS01	0-6"		X				
PZ-09	SS02	6"-2'		X				
PZ-09	SS03	2-4'		X				
PZ-09	SS04	4-8'		X				
PZ-1002	SS04	4-8'		X				
PZ-09	SS05	8-16'		X				
PZ-09	SS06	16'-Refusal		X				
PZ-01	GW01	Top Bed			X[6]		X	
PZ-02	GW01	Top Bed			X[6]		X	
PZ-02	GW01MS	Top Bed	Matrix Spike		X[6]		X	
PZ-02	GW01MSD	Top Bed	Matrix Spike Duplicate		X[6]		X	
PZ-03	GW01	Top Bed			X[6]		X	
PZ-04	GW01	Top Bed			X[6]		X	
PZ-05	GW01	Top Bed			X[6]		X	
PZ-06	GW01	Top Bed			X[6]		X	
PZ-07	GW01	Top Bed			X[6]		X	
PZ-08	GW01	Top Bed			X[6]		X	
PZ-1001	GW01	Top Bed	Field Dup of PZ-08/GW01		X[6]		X	
PZ-09	GW01	Top Bed			X[6]		X	
PZ-10	GW01	Top Bed			X[6]		X	
PZ-11	GW01	Top Bed			X[6]		X	
Trench Sample Collection[7]								
TR-01	SS01	0-6"		X				
TR-1000	SS01	0-6"	Field Dup of TR-01/SS01	X				
TR-01	SS02	Mid-Depth		X		X		
TR-01	SS02CF	Mid-Depth	Confirmation		X			
TR-01	SS03	Clay		X				
TR-02	SS01	0-6"		X				
TR-02	SS03	Clay		X				

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

				Analyses				
Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]
TR-03	SS01	0-6"		X				
TR-03	SS02	Mid-Depth		X				
TR-03	SS02MS	Mid-Depth	Matrix Spike	X				
TR-03	SS02MSF	Mid-Depth	Matrix Spike Duplicate	X				
TR-03	SS03	Clay		X				
TR-04	SS01	0-6"		X				
TR-04	SS03	Clay		X				
TR-05	SS01	0-6"		X		X		
TR-05	SS01CF	0-6"	Confirmation		X			
TR-05	SS02	Mid-Depth		X				
TR-05	SS03	Clay		X				
TR-1001	SS03	Clay	Field Dup of TR-05/SS03	X				
TR-06	SS01	0-6"		X				
TR-06	SS03	Clay		X				
TR-07	SS01	0-6"		X				
TR-07	SS02	Mid-Depth		X				
TR-07	SS03	Clay		X				
TR-08	SS01	0-6"		X				
TR-08	SS03	Clay		X				
TR-09	SS01	0-6"		X				
TR-09	SS02	Mid-Depth		X		X		
TR-09	SS02CF	Mid-Depth	Confirmation		X			
TR-1002	SS02	Mid-Depth	Field Dup of TR-09/SS02	X		X		
TR-1002	SS02CF	Mid-Depth	Field Dup of TR-09/SS02CF		X			
TR-09	SS03	Clay		X				
TR-10	SS01	0-6"		X				
TR-10	SS03	Clay		X				
TR-11	SS01	0-6"		X				
TR-11	SS02	Mid-Depth		X				
TR-11	SS03	Clay		X				
TR-12	SS01	0-6"		X				
TR-12	SS03	Clay		X				
TR-13	SS01	0-6"		X				
TR-13	SS02	Mid-Depth		X				
TR-13	SS03	Clay		X		X		
TR-13	SS03CF	Clay	Confirmation		X			
TR-13	SS03MS	Clay	Matrix Spike	X		X		
TR-13	SS03MSD	Clay	Matrix Spike Duplicate	X		X		
TR-13	SS03CFMS	Clay	Confirmation Matrix Spike		X			
TR-13	SS03CFMSD	Clay	Confirmation Matrix Spike Dup		X			
TR-14	SS01	0-6"		X				
TR-1003	SS01	0-6"	Field Dup of TR-14/SS01	X				
TR-14	SS03	Clay		X				
TR-15	SS01	0-6"		X				
TR-15	SS02	Mid-Depth		X				
TR-15	SS03	Clay		X				
TR-16	SS01	0-6"		X				
TR-16	SS03	Clay		X				
TR-17	SS01	0-6"		X				
TR-17	SS02	Mid-Depth		X				
TR-17	SS03	Clay		X				
TR-18	SS01	0-6"		X				
TR-18	SS03	Clay		X				
TR-1004	SS03	Clay	Field Dup of TR-18/SS03	X				

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Analyses				
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]
TR-19	SS01	0-6"		X				
TR-19	SS02	Mid-Depth		X		X		
TR-19	SS02CF	Mid-Depth	Confirmation		X			
TR-19	SS03	Clay		X				
TR-20	SS01	0-6"		X				
TR-20	SS03	Clay		X				
TR-20	SS03MS	Clay	Matrix Spike	X				
TR-20	SS03MSD	Clay	Matrix Spike Duplicate	X				
TR-21	SS01	0-6"		X				
TR-21	SS03	Clay		X				
Monitoring Well Groundwater Samples[8]								
MW-01	GW01				X[6]		X	
MW-1000	GW01		Field Dup of MW-01/GW01		X[6]		X	
MW-02	GW01				X[6]		X	
MW-03	GW01				X[6]		X	
MW-04	GW01				X[6]		X	
MW-04	GW01MS		Matrix Spike		X[6]		X	
MW-04	GW01MSD		Matrix Spike Duplicate		X[6]		X	
MW-05	GW01				X[6]		X	
RW-01	GW01				X[6]		X	
Air Quality Samples[9]								
AQ-01	AR01							X
AQ-1000	AR01		Field Dup of AQ-01/AR01					X
AQ-01	AR02							X
AQ-01	AR03							X
AQ-01	AR04							X
AQ-01	AR05							X
AQ-01	AR06							X
AQ-01	AR07							X
AQ-02	AR01							X
AQ-02	AR02							X
AQ-02	AR03							X
AQ-02	AR04							X
AQ-02	AR05							X
AQ-02	AR06							X
AQ-02	AR07							X
Personnel Monitoring[10]								
PM-01	AR01							X
PM-02	AR01							X
PM-03	AR01							X
PM-04	AR01							X
PM-05	AR01							X

Notes:

1 = ICP Metals analysis is planned for 10% of the soil sampling locations to confirm lab XRF data.
ICP Metals analysis is planned for 100% of the groundwater and surface water locations.

2 = TCLP Metals analysis is planned for 10% of the soil sampling locations and may be adjusted in the field based upon observed visual difference in samples.

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Analyses				
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]

3 = General water chemistry parameters for lab analysis include: alkalinity, chemical oxygen demand (COD), nitrate as nitrogen, chloride, sulfate, and total organic carbon (TOC). Specific conductivity, pH, temperature, and turbidity will be measured in the field.
4 = Air Quality analyses include total suspended particulates (TSP), PM10, and Metals (As, Cd, Pb, and Zn).
5 = Groundwater samples will be collected during installation of piezometers. Soil samples will be collected from 3 temporary piezometer locations. Locations indicated are preliminary and will be adjusted in the field so that representative samples from different areas of the site are collected.
6 = If sample turbidity is greater than 50 NTUs, groundwater samples for metals analysis will be submitted as field-filtered and unfiltered samples.
7 = Samples are planned for collection in the surface soil, mid-depth of the trench, and from the clay at the slag/clay interface. Only 50% of the planned locations will be sampled at the mid-depth. Locations indicated here are preliminary and may be adjusted in the field to obtain samples from all visually unique waste materials.
8 = The location of the monitoring wells will be determined based on groundwater flow direction observed from the temporary piezometers.
9 = Air quality samples will be collected at one upwind location and one downwind location based on prevailing wind direction at the time of sample collection. Samples will be collected over a one-week time. High-volume samplers will run for 24-hours, and filters will be changed daily (Total samples to lab = 14).
10 = Personnel monitoring will be conducted during the first week of sampling to determine exposure and determination of adequate PPE. See RI/FS Health and Safety Plan, Appendix C.
11 = Locations of QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, visual observation of differing waste material, etc.

As = Arsenic
Cd = Cadmium
CF = Confirmation Sample
FD = Field Duplicate. Field duplicates will be collected at a frequency of 10% (1 in 10 samples). Locations may be adjusted in the field as long as the 10% frequency is maintained.
ICP = Inductively Coupled Plasma
MS/MSD = Matrix Spike/Matrix Spike Duplicate. MS/MSDs will be collected at a frequency of 5% (1 in 20 samples). The laboratory may substitute duplicate analysis in leiu of MS/MSD. Locations may be adjusted in the field as long as the 5% frequency is maintained.
Pb = Lead
QA = Quality Assurance
QC = Quality Control
TCLP = Toxicity Characteristic Leaching Procedure
Top Bed = Piezometers will be installed at the top of bedrock
XRF = X-Ray Fluorescence Spectroscopy
Zn = Zinc

Laboratories for Phase I RI Samples

Soil and Water Matrices
Oklahoma State Environmental Lab (SEL)
707 N. Robinson
Oklahoma City, OK 73102

Lab QA Manager: Susan Elmenhorst
Phone: (405) 702-1038
Email: Susan.Elmenhorst@deq.state.ok.us

Table 4-2
Summary of On-Site Samples

Remedial Investigation/Feasiblity Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[11]	Analyses				
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[1]	TCLP As, Cd, & Pb[2]	General Water Chemistry[3]	Air Quality[4]

Bottle Requirements

Soil/Sediment

4-oz Jar	= Lab XRF for As, Cd, Pb, and Zn
4-oz Jar	= ICP for As, Cd, Pb, and Zn plus %Solids
2 4-oz Jars	= TCLP for As, Cd, and Pb

Water

1-L Bottle Nitric Acid Preserved	= ICP for As, Cd, Pb, and Zn (Mininum 500-mL Volume)
1-L Bottle Unpreserved	= General Chemistry (all except TOC, minimum 500-mL Volume)
250-mL Bottle Sulfuric Acid	= General Chemistry (TOC)

Table 4-3

Summary of Off-Site Soil Samples[1]

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	Potential Sample Location[2]	Field XRF	QA/QC Notes[7]	Analyses		
						Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[3]	TCLP for As, Cd, & Pb[4]
Off-Site Sample Grid Locations								
OSL-07	SS01	0-3"		X		X		
OSL-08	SS01	0-3"		X		X		
OSL-09	SS01	0-3"	X	X		X		
OSL-10	SS01	0-3"		X		X		X
OSL-1000	SS01	0-3"		X	Field Dup of OSL-10/SS01	X		X
OSL-10	SS01CF	0-3"			Confirmation		X	
OSL-1000	SS01CF	0-3"			Field Dup of OSL-10/SS01CF		X	
OSL-11	SS01	0-3"	X	X		X		
OSL-12	SS01	0-3"		X		X		
OSL-13	SS01	0-3"	X	X		X		
OSL-14	SS01	0-3"		X		X		
OSL-15	SS01	0-3"	X	X		X		
OSL-16	SS01	0-3"		X		X		
OSL-17	SS01	0-3"	X	X		X		
OSL-18	SS01	0-3"		X		X		
OSL-19	SS01	0-3"	X	X		X		
OSL-20	SS01	0-3"		X		X		X
OSL-20	SS01MS	0-3"		X	Matrix Spike	X		X
OSL-20	SS01MSD	0-3"		X	Matrix Spike Duplicate	X		X
OSL-20	SS01CF	0-3"			Confirmation		X	
OSL-20	SS01CFMS	0-3"			Confirmation Matrix Spike		X	
OSL-20	SS01CFMSF	0-3"			Confirmation Matrix Spike Dup		X	
OSL-21	SS01	0-3"	X	X		X		
OSL-22	SS01	0-3"		X		X		
OSL-1001	SS01	0-3"		X	Field Dup of OSL-22/SS01	X		
OSL-23	SS01	0-3"	X	X		X		
OSL-24	SS01	0-3"		X		X		
OSL-25	SS01	0-3"	X	X		X		
OSL-26	SS01	0-3"		X		X		
OSL-27	SS01	0-3"	X	X		X		
OSL-28	SS01	0-3"		X		X		
OSL-29	SS01	0-3"	X	X		X		
OSL-30	SS01	0-3"	X	X		X		
OSL-31	SS01	0-3"		X		X		
OSL-32	SS01	0-3"		X		X		X
OSL-1002	SS01	0-3"		X	Field Dup of OSL-32/SS01	X		X
OSL-32	SS01CF	0-3"			Confirmation		X	
OSL-1002	SS01CF	0-3"			Field Dup of OSL-32/SS01CF		X	
OSL-33	SS01	0-3"		X		X		
OSL-34	SS01	0-3"		X		X		
OSL-35	SS01	0-3"		X		X		
OSL-36	SS01	0-3"		X		X		
OSL-37	SS01	0-3"		X		X		
OSL-38	SS01	0-3"		X		X		
OSL-39	SS01	0-3"		X		X		
OSL-40	SS01	0-3"		X		X		
OSL-40	SS01MS	0-3"			Matrix Spike	X		
OSL-40	SS01MSD	0-3"			Matrix Spike Duplicate	X		
OSL-41	SS01	0-3"		X		X		X
OSL-41	SS01CF	0-3"			Confirmation		X	

Table 4-3

Summary of Off-Site Soil Samples[1]

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	Potential Sample Location[2]	Field XRF	QA/QC Notes[7]	Analyses		
						Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[3]	TCLP for As, Cd, & Pb[4]
OSL-46	SS01	0-3"		X		X		
OSL-1003	SS01	0-3"		X	Field Dup of OSL-46/SS01	X		
OSL-47	SS01	0-3"		X		X		
OSL-48	SS01	0-3"		X		X		
OSL-49	SS01	0-3"		X		X		
OSL-54	SS01	0-3"		X		X		
OSL-55	SS01	0-3"		X		X		
OSL-56	SS01	0-3"		X		X		
OSL-57	SS01	0-3"		X		X		
OSL-58	SS01	0-3"		X		X		
OSL-59	SS01	0-3"		X		X		
OSL-60	SS01	0-3"		X		X		
OSL-60	SS01MS	0-3"			Matrix Spike	X		
OSL-60	SS01MSD	0-3"			Matrix Spike Duplicate	X		
OSL-61	SS01	0-3"		X		X		X
OSL-61	SS01CF	0-3"			Confirmation		X	
OSL-62	SS01	0-3"		X		X		
OSL-1004	SS01	0-3"		X	Field Dup of OSL-62/SS01	X		
OSL-63	SS01	0-3"		X		X		
OSL-64	SS01	0-3"		X		X		
OSL-65	SS01	0-3"		X		X		
OSL-66	SS01	0-3"		X		X		
OSL-67	SS01	0-3"		X		X		
OSL-68	SS01	0-3"	X	X		X		
OSL-69	SS01	0-3"	X	X		X		
OSL-70	SS01	0-3"		X		X		
OSL-71	SS01	0-3"	X	X		X		
OSL-72	SS01	0-3"		X		X		
OSL-1005	SS01	0-3"		X	Field Dup of OSL-72/SS01	X		
OSL-73	SS01	0-3"	X	X		X		
OSL-74	SS01	0-3"		X		X		X
OSL-74	SS01CF	0-3"			Confirmation		X	
OSL-75	SS01	0-3"	X	X		X		
OSL-76	SS01	0-3"		X		X		
OSL-77	SS01	0-3"	X	X		X		
OSL-78	SS01	0-3"		X		X		
OSL-79	SS01	0-3"	X	X		X		
OSL-80	SS01	0-3"		X		X		
OSL-80	SS01MS	0-3"			Matrix Spike	X		
OSL-80	SS01MSD	0-3"			Matrix Spike Duplicate	X		
OSL-81	SS01	0-3"	X	X		X		
OSL-82	SS01	0-3"		X		X		
OSL-1006	SS01	0-3"		X	Field Dup of OSL-82/SS01	X		
OSL-83	SS01	0-3"	X	X		X		
OSL-84	SS01	0-3"		X		X		X
OSL-84	SS01CF	0-3"			Confirmation		X	
OSL-85	SS01	0-3"	X	X		X		
Distance Sampling Locations								
OSL-01	SS01	0-3"		X		X		
OSL-02	SS01	0-3"		X		X		
OSL-03	SS01	0-3"		X		X		
OSL-04	SS01	0-3"		X		X		

Table 4-3

Summary of Off-Site Soil Samples[1]

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	Potential Sample Location[2]	Field XRF	QA/QC Notes[7]	Analyses		
						Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[3]	TCLP for As, Cd, & Pb[4]
OSL-05	SS01	0-3"		X		X		
OSL-1007	SS01	0-3"		X	Field Dup of OSL-05/SS01	X		
OSL-06	SS01	0-3"		X		X		
OSL-42	SS01	0-3"		X		X		
OSL-43	SS01	0-3"		X		X		
OSL-44	SS01	0-3"		X		X		
OSL-45	SS01	0-3"		X		X		
OSL-50	SS01	0-3"		X		X		
OSL-51	SS01	0-3"		X		X		X
OSL-1008	SS01	0-3"		X	Field Dup of OSL-51/SS01	X		X
OSL-51	SS01CF	0-3"			Confirmation		X	
OSL-1008	SS01CF	0-3"			Field Dup of OSL-51/SS01CF		X	
OSL-52	SS01	0-3"		X		X		
OSL-53	SS01	0-3"		X		X		
OSL-86	SS01	0-3"		X		X		
OSL-87	SS01	0-3"		X		X		
OSL-87	SS01MS	0-3"			Matrix Spike	X		
OSL-87	SS01MSD	0-3"			Matrix Spike Duplicate	X		
OSL-88	SS01	0-3"		X		X		
OSL-89	SS01	0-3"		X		X		
OSL-90	SS01	0-3"		X		X		
OSL-91	SS01	0-3"		X		X		
OSL-92	SS01	0-3"		X		X		
OSL-93	SS01	0-3"		X		X		
Targeted Off-Site Sampling Locations[5]								
TSL-01	SS01	0-3"		X		X		
TSL-02	SS01	0-3"		X		X		
TSL-03	SS01	0-3"		X		X		
TSL-04	SS01	0-3"		X		X		X
TSL-1000	SS01	0-3"		X	Field Dup of TSL-04/SS01	X		X
TSL-04	SS01CF	0-3"			Confirmation		X	
TSL-1000	SS01CF	0-3"			Field Dup of TSL-04/SS01CF		X	
TSL-05	SS01	0-3"		X		X		
TSL-06	SS01	0-3"		X		X		
TSL-06	SS01MS	0-3"			Matrix Spike	X		
TSL-06	SS01MSD	0-3"			Matrix Spike Duplicate	X		
TSL-07	SS01	0-3"		X		X		
TSL-08	SS01	0-3"		X		X		
Tribal Sampling Locations[6]								
TRB-01	SS01	0-3"		X		X		
TRB-02	SS01	0-3"		X		X		
TRB-03	SS01	0-3"		X		X		
TRB-04	SS01	0-3"		X		X		
TRB-05	SS01	0-3"		X		X		X
TRB-1000	SS01	0-3"		X	Field Dup of TRB-05/SS01	X		X
TRB-05	SS01CF	0-3"			Confirmation		X	
TRB-1000	SS01CF	0-3"			Field Dup of TRB-05/SS01CF		X	
TRB-06	SS01	0-3"		X		X		
TRB-07	SS01	0-3"		X		X		
TRB-08	SS01	0-3"		X		X		

Table 4-3

Summary of Off-Site Soil Samples[1]

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	Potential Sample Location[2]	Field XRF	QA/QC Notes[7]	Analyses		
						Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[3]	TCLP for As, Cd, & Pb[4]
TRB-09	SS01	0-3"		X		X		
TRB-09	SS01MS	0-3"			Matrix Spike	X		
TRB-09	SS01MSD	0-3"			Matrix Spike Duplicate	X		
TRB-10	SS01	0-3"		X		X		

Notes:

1 = It is anticipated that access will be denied at approximately 10% of the sampling locations. Samples should be collected away from buildings and roadways.
2 = Potential sample locations are preliminary and may not be collected. The need for these samples will be determined in the field using XRF screening. If lead is detected in samples at adjacent locations, then a sample will be collected as indicated.
3 = ICP metal analysis is planned for 10% of the soil sampling locations to confirm lab XRF data.
4 = TCLP Metals analysis is planned for 10% of the soil sampling locations and may be adjusted in the field.
5 = Targeted sampling locations include schools, play grounds, parks, day care centers, etc.
6 = Samples will be collected from tribal member properties based upon information received from ITEC.
7 = Locations of QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, visual observation of differing waste material, etc.

As = Arsenic Cd = Cadmium Zn = Zinc
Cd = Cadmium
Pb = Lead
Zn = Zinc
CF = Confirmation Sample
FD = Field Duplicate. Field duplicates will be collected at a frequency of 10% (1 in 10 samples). Locations may be adjusted in the field as long as the 10% frequency is maintained.
ICP = Inductively Coupled Plasma
ITEC = Inter-Tribal Environmental Council
MS/MSD = Matrix Spike/Matrix Spike Duplicate. MS/MSDs will be collected at a frequency of 5% (1 in 20 samples). Locations may be adjusted in the field as long as the 5% frequency is maintained.
QA = Quality Assurance
QC = Quality Control
TCLP = Toxicity Characteristic Leaching Procedure

Soil and Water Matrices
Oklahoma State Environmental Lab (SEL)
707 N. Robinson
Oklahoma City, OK 73102

Bottle Requirements
Soil/Sediment
4-oz Jar = Lab XRF for As, Cd, Pb, and Zn
4-oz Jar = ICP for As, Cd, Pb, and Zn plus %Solids
2 4-oz Jars = TCLP for As, Cd, and Pb

Table 4-4
Summary of Surface Water and Sediment Samples

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[1]	Analyses			
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[2]	TCLP As, Cd, & Pb[3]	General Chemistry[4]
On-Site Surface Water Sampling Locations							
PD1-01	SW01				X		X
PD1-01	SD01	0-6"		X			
PD1-02	SW01				X		X
PD1-02	SW01MS		Matrix Spike		X		X
PD1-02	SW01MSD		Matrix Spike Duplicate		X		X
PD1-02	SD01	0-6"		X		X	
PD1-02	SD01MS	0-6"	Matrix Spike	X		X	
PD1-02	SD01MSD	0-6"	Matrix Spike Duplicate	X		X	
PD1-02	SD01CF	0-6"	Confirmation		X		
PD1-02	SD01MSCF	0-6"	Confirmation MS		X		
PD1-02	SD01MSDCF	0-6"	Confirmation MSD		X		
PD1-03	SW01				X		X
PD1-03	SD01	0-6"		X			
PD2-01	SW01				X		X
PD2-01	SD01	0-6"		X			
PD2-02	SW01				X		X
PD2-02	SD01	0-6"		X			
PD3-01	SW01				X		X
PD3-1000	SW01		Field Dup of PD3-01/SW01		X		X
PD3-01	SD01	0-6"		X			
PD3-1000	SD01	0-6"	Field Dup of PD3-01/SD01	X			
PD3-02	SW01				X		X
PD3-02	SD01	0-6"		X			
PD4-01	SW01				X		X
PD4-01	SD01	0-6"		X			
PD5-01	SW01				X		X
PD5-01	SD01	0-6"		X			
MSR-01	SW01				X		X
MSR-01	SD01	0-6"		X			
MSR-02	SW01				X		X
MSR-02	SD01	0-6"		X			
MSR-03	SW01				X		X
MSR-03	SD01	0-6"		X			
SMP-01	SW01				X		X
SMP-01	SD01	0-6"		X			
SMP-02	SW01				X		X
SMP-02	SD01	0-6"		X			
SMP-03	SW01				X		X
SMP-1000	SW01		Field Dup of SMP-03/SW01		X		X
SMP-03	SD01	0-6"		X		X	
SMP-1000	SD01	0-6"	Field Dup of SMP-03/SD01	X		X	
SMP-03	SD01CF	0-6"	Confirmation		X		
SMP-1000	SD01CF	0-6"	Field Dup of SMP-03/SD01CF		X		
SMP-04	SW01				X		X
SMP-04	SD01	0-6"		X			
SMP-05	SW01				X		X
SMP-05	SD01	0-6"		X			

Table 4-4
Summary of Surface Water and Sediment Samples

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[1]	Analyses			
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[2]	TCLP As, Cd, & Pb[3]	General Chemistry[4]
SMP-06	SW01				X		X
SMP-06	SD01	0-6"		X			
Off-Site Surface Water and Sediment Sediment Sampling Locations							
OFF-01	SW01				X		X
OFF-01	SD01	0-6"		X			
OFF-02	SW01				X		X
OFF-02	SD01	0-6"		X			
OFF-03	SW01				X		X
OFF-03	SD01	0-6"		X			
OFF-04	SW01				X		X
OFF-04	SW01MS		Matrix Spike		X		X
OFF-04	SW01MSD		Matrix Spike Duplicate		X		X
OFF-04	SD01	0-6"		X			
OFF-04	SD01MS	0-6"	Matrix Spike	X			
OFF-04	SD01MSD	0-6"	Matrix Spike Duplicate	X			
OFF-05	SW01				X		X
OFF-05	SD01	0-6"		X			
OFF-06	SW01				X		X
OFF-06	SD01	0-6"		X			
OFF-07	SW01				X		X
OFF-07	SD01	0-6"		X			
OFF-08	SW01				X		X
OFF-1000	SW01		Field Dup of OFF-08/SW01		X		X
OFF-08	SD01	0-6"		X			
OFF-1000	SD01	0-6"	Field Dup of OFF-08/SD01	X			
OFF-09	SW01				X		X
OFF-09	SD01	0-6"		X			
OFF-10	SW01				X		X
OFF-10	SD01	0-6"		X		X	
OFF-10	SD01CF	0-6"	Confirmation		X		
OFF-11	SW01				X		X
OFF-11	SD01	0-6"		X			
OFF-12	SW01				X		X
OFF-12	SD01	0-6"		X			
OFF-13	SW01				X		X
OFF-13	SD01	0-6"		X			

Notes:

1 = Locations of QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, visual observation of differing waste material, etc.

2 = ICP metals analysis is planned for 10% of the soil samples to confirm lab XRF data. Locations may be adjusted in the field. ICP metals analysis is planned for 100% of the surface water samples.

3 = TCLP Metals analysis is planned for 10% of the soil sampling locations and may be adjusted in the field.

4 = General water chemistry parameters for lab analysis include: alkalinity, chemical oxygen deman (COD), nitrate as nitrogen, chloride, sulfate, and total organic carbon (TOC). Specific conductivity, pH, temperature, and turbidity will be measured in the field.

Table 4-4
Summary of Surface Water and Sediment Samples

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[1]	Analyses			
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[2]	TCLP As, Cd, & Pb[3]	General Chemistry[4]

As = Arsenic
Cd = Cadmium
Pb = Lead
Zn = Zinc
CF = Confirmation Sample
FD = Field Duplicate. Field duplicates will be collected at a frequency of 10% (1 in 10 samples). Locations may be adjusted in the field as long as the 10% frequency is maintained.
ICP = Inductively Coupled Plasma
MS/MSD = Matrix Spike/Matrix Spike Duplicate. MS/MSDs will be collected at a frequency of 5% (1 in 20 samples). The laboratory may substitute duplicate analysis in leiu of MS/MSD. Locations may be adjusted in the field.
QA = Quality Assurance
QC = Quality Control
TCLP = Toxicity Characteristic Leaching Procedure
XRF = X-Ray Fluorescence Spectroscopy

Soil and Water Matrices
Oklahoma State Environmental Lab (SEL)
707 N. Robinson
Oklahoma City, OK 73102

Bottle Requirements
Soil/Sediment
4-oz Jar = Lab XRF for As, Cd, Pb, and Zn
4-oz Jar = ICP for As, Cd, Pb, and Zn plus %Solids
2 4-oz Jars = TCLP for As, Cd, and Pb

Surface Water
1-L Bottle Nitric Acid Preserved = ICP for As, Cd, Pb, and Zn (Mininum 500-mL Volume)

1-L Bottle Unpreserved = General Chemistry (all except TOC, minimum 500-mL Volume)

250-mL Bottle Sulfuric Acid = General Chemistry (TOC)

Table 4-5
Summary of Ecological Samples

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Description	QA/QC Notes[1]	Analyses[2]	
				ICP for As, Cd, Pb, & Zn	TCLP As, Cd, & Zn
Ecological Samples - DEQ 2004 Samples					
OX	WBB	Berries - Washed		X	
OX	UGB	Berries - Not Washed Green		X	
OX	UBB	Berries - Not Washed		X	
OX	WBB-L	Leaves - Washed		X	
OX	UBB-L	Leaves - Not Washed		X	
OX	WBB-R	Roots - Washed		X	
OX	BB-S	Soil		X	
TFM	WBB-1	Berries - Washed		X	
TFM	UGB-1	Berries - Not Washed Green		X	
TFM	UBB-1	Berries - Not Washed		X	
TFM	WBB-L-1	Leaves - Washed		X	
TFM	UBB-L-1	Leaves - Not Washed		X	
TFM	WBB-R-1	Roots - Washed		X	
TFM	BB-S-1	Soil		X	X
TFM	BB-S-1MS	Soil	Matrix Spike	X	X
TFM	BB-S-1MSD	Soil	Matrix Spike Duplicate	X	X
TFM	BB-W-1	Waste		X	
TFM	WBB-2	Berries - Washed		X	
TFM	UGB-2	Berries - Not Washed Green		X	
TFM	UBB-2	Berries - Not Washed		X	
TFM	WBB-L-2	Leaves - Washed		X	
TFM	UBB-L-2	Leaves - Not Washed		X	
TFM	WBB-R-2	Roots - Washed		X	
TFM	BB-S-2	Soil		X	X
TFM	BB-W-2	Waste		X	
BM	WBB	Berries - Washed		X	
BM	UGB	Berries - Not Washed Green		X	
BM	UBB	Berries - Not Washed		X	
BM	WBB-L	Leaves - Washed		X	
BM	UBB-L	Leaves - Not Washed		X	
BM	WBB-R	Roots - Washed		X	
BM	BB-S	Soil		X	
Ecological Samples - Phase I					
EC-01	BR02W	Berries - Washed		X	
EC-01	BR02U	Berries - Not Washed		X	
EC-01	LV02W	Leaves - Washed		X	
EC-01	LV02U	Leaves - Not Washed		X	
EC-1000	LV02U	Leaves - Not Washed	Field Dup of EC-01/LV02U	X	
EC-01	RT02W	Roots - Washed		X	
EC-01	SS02	Root Area		X	
EC-02	BR02W	Berries - Washed		X	
EC-02	BR02U	Berries - Not Washed		X	
EC-02	LV02W	Leaves - Washed		X	
EC-02	LV02U	Leaves - Not Washed		X	
EC-02	RT02W	Roots - Washed		X	
EC-02	SS02	Root Area		X	X
EC-02	SS02MS	Root Area	Matrix Spike	X	X
EC-02	SS02MSD	Root Area	Matrix Spike Duplicate	X	X

Table 4-5
Summary of Ecological Samples

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Description	QA/QC Notes[1]	Analyses[2]	
				ICP for As, Cd, Pb, & Zn	TCLP As, Cd, & Zn

Notes:
1 = Locations of QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, visual observation of differing waste material, etc.
2 = Vegetation and and materials from the root area will be analyzed for As, Cd, Pb, and Zn by ICP. TCLP analysis will be for As, Cd, and Pb only.

As = Arsenic
Cd = Cadmium
Pb = Lead
Zn = Zinc

ICP = Inductively Coupled Plasma
MS/MSD = Matrix Spike/Matrix Spike Duplicate
QA/QC = Quality Assurance/Quality Control
TCLP = Toxicity Characteristic Leaching Procedure

Ecological Sample Laboratory
STL Burlington
208 South Park Drive, Suite 1
Colchester, VT 05446

Project Manager: Don Dawicki
Phone: (802) 655-1023
Email: Ddawicki@stl-inc.com

Table 4-6
Summary of Background Samples

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[1]	Analyses			
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[2]	TCLP As, Cd, & Zn	General Chemistry[3]
Soil Boring Samples							
BG-SP-01	SS01	0-6"		X			
BG-SP-01	SS02	6"-2'		X		X	
BG-SP-01	SS02MS	6"-2'	Matrix Spike	X		X	
BG-SP-01	SS02MSD	6"-2'	Matrix Spike Duplicate	X		X	
BG-SP-01	SS02CF	6"-2'	Confirmation		X		
BG-SP-01	SS02CFMS	6"-2'	Confirmation Matrix Spike		X		
BG-SP-01	SS02CFMSD	6"-2'	Confirmation Matrix Spike Dup		X		
BG-SP-01	SS03	2-4'		X			
BG-SP-02	SS01	0-6"		X			
BG-SP-02	SS02	6"-2'		X			
BG-SP-02	SS03	2-4'		X			
Surface Soil Samples							
BG-OSL-01	SS01	0-3"		X		X	
BG-OSL-01	SS01CF	0-3"	Confirmation		X		
BG-OSL-02	SS01	0-3"		X			
Groundwater Sample							
BG-MW-01	GW01				X		X
BG-MW-01	GW01MS		Matrix Spike		X		X
BG-MW-01	GW01MSD		Matrix Spike Duplicate		X		X
Surface Water and Sediment Samples							
BG-OFF-01	SW01				X		X
BG-OFF-1000	SW01		Field Dup of BG-OFF-01/SW01		X		X
BG-OFF-01	SD01	0-6"		X			
BG-OFF-1000	SD01	0-6"	Field Dup of BG-OFF-01/SD01	X			
BG-OFF-02	SW01				X		X
BG-OFF-02	SD01	0-6"		X			
Ecological Samples							
BG-EC-01	BR01W				X		
BG-EC-01	BR01W		Matrix Spike		X		
BG-EC-01	BR01W		Matrix Spike Duplicate		X		
BG-EC-01	BR01U				X		
BG-EC-1000	BR01U				X		
BG-EC-01	LV01W				X		
BG-EC-01	LV01U				X		
BG-EC-01	RT01W				X		
BG-EC-01	SS02	Root Area			X	X	

Notes:

1 = Locations of QA/QC samples are preliminary and may be altered based on the order in which samples are collected, the amount of sample available, visual observation of differing waste material, etc.

2 = ICP metals analysis is planned for 10% soil and sediment samples to confirm lab XRF data. ICP metals analysis is planned for 100% of the groundwater, surface water, and ecological samples.

3 = General water chemistry parameters for lab analysis include: alkalinity, chemical oxygen demand (COD), nitrate as nitrogen, chloride, sulfate, and total organic carbon (TOC). Specific conductivity, pH, temperature, and turbidity will be measured in the field.

As = Arsenic
Cd = Cadmium
ICP = Inductively Coupled Plasma
QC = Quality Control
= Lead
= Zinc
= Quality Assurance
= Toxicity Characteristic Leaching Procedure
MS/MSD = Matrix Spike/Matrix Spike Duplicate. The laboratory may substitute duplicate analysis in leiu of MS/MSD.

Table 4-6
Summary of Background Samples

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point	Sample Designator	Depth Interval	QA/QC Notes[1]	Analyses			
				Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn[2]	TCLP As, Cd, & Zn	General Chemistry[3]

Soil and Water Sample Laboratory
Oklahoma State Environmental Lab (SEL)
707 N. Robinson
Oklahoma City, OK 73102

Lab QA Manager: Susan Elmenhorst
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Table 4-7
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Oklahoma SEL Analyses **MS and MSD to be collected as separated samples, meaning triple volume is required at locations selected for the MS/MSD.**						
Metals As, Cd, Pb, & Zn by Lab XRF[3]	Soil	SW-846 6200	One 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
Metals As, Cd, Pb, & Zn by ICP for Confirmation[3] and Moisture Content	Soil	SW-846 6010B and ASTM D2216 or ILM05.3	One 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
TCLP Metals As, Cd, & Pb	Soil	SW-846 6010B	Two 4-oz. Wide-Mouth Glass Jars	Fill to capacity	None	6 months - all metals
Metals As, Cd, Pb, & Zn by Lab XRF[3]	Sediment	SW-846 6200	One 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
Metals As, Cd, Pb, & Zn by ICP for Confirmation[3] and Moisture Content	Sediment	SW-846 6010B and ASTM D2216 or ILM05.3	One 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
TCLP Metals As, Cd, & Pb	Sediment	SW-846 6010B	Two 4-oz. Wide-Mouth Glass Jars	Fill to capacity	None	6 months - all metals
Metals As, Cd, Pb, & Zn by ICP	Water	SW-846 6010B	One 1-L High-Density Polyethylene Bottle (Minimum volume required is 500-mL)	500 mL	HNO_3 to pH<2 Ice to 4°C	6 months - all metals
Alkalinity Chloride Sulfate Nitrate as N COD	Water	Alkalinity - EPA 310.2 Chloride - EPA 325.2 Sulfate - EPA 375.4 Nitrate as N - EPA 35.2 COD - EPA 410.2	One 1-L High-Density Polyethylene Bottle (Minimum volume required is 500-mL)	500 mL	Ice to 4°C	Alkanlinity - 14 days Chloride - 28 days Sulfate - 28 days
TOC	Water	TOC - EPA 415 Series	One 250-mL Amber Glass Bottle Bottle	500 mL	H_2SO_4 to pH<2 Ice to 4°C	Nitrate as N - 28 days COD - 28 days TOC - 28 days

Table 4-7
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Field Instrument Measurements						
pH[5]	Water	SW-846 9040B or EPA 150.1	One 100-mL High-Density Polyethylene Bottle	100 mL	--	ASAP (24 hours maximum)
Specific Conductivity[5]	Water	SW-846 9050A or EPA 120.1	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	28 days
Turbidity[5]	Water	EPA 180.1	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	48 hour
Temperature[5]	Water	EPA 170.1	NA - Field measurement using direct reading	--	None	Immediate
Metals by Labs other than the Oklahoma SEL						
Metals As, Cd, Pb, & Zn	Water	SW-846 6000 series or EPA 200 series or ILM05.3	One 1-L High-Density Polyethylene Bottle	1 L	HNO_3 to pH<2 Ice to 4°C	6 months - all metals
	Soil/Sediment[5]	SW-846 6000 series or EPA 200 series or ILM05.3	One 8-oz. or 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
	Vegetation	SW-846 6000 series or EPA 200 series or ILM05.3	1-Gallon Plastic Zipper Bag or 8-oz. Wide-Mouth Glass Jar	Fill to capacity	Ice to 4°C	6 months - all metals
Moisture Content[4]	Soil	ASTM D2216	4 oz. Glass Jar	Fill to capacity	None	28 days
TCLP Metals	Soil/Sediment	SW-846 6000 or 7000 series or EPA 200 series or ILM05.3	One 8-oz. or 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals

Table 4-7
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Air Quality by Labs other than the Oklahoma SEL						
PM_{10} and TSP	Air	IO-1 and IO-2 Series	Filter Cartridge	Determined by flow rate and sampling time.	Protective cover for filter	6 months
Metals As, Cd, Pb, & Zn	Air	IO-3 Series	Filter Cartridge	Determined by flow rate and sampling time.	Protective cover for filter	6 months - all metals
Water General Chemistry by Labs other than the Oklahoma SEL						
Alkalinity	Water	EPA 310 Series or SM 2320B	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	14 days
COD	Water	EPA 410 Series	One 250-mL High-Density Polyethylene Bottle	250 mL	H_2SO_4 to pH<2 Ice to 4°C	28 days
TOC	Water	EPA 415 Series	One 100-mL High-Density Polyethylene Bottle	100 mL	H_2SO_4 or HCl to pH<2 Ice to 4°C	28 days
Chloride	Water	SW-846 9000 Series or EPA 325 Series or EPA 300.0	One 100-mL High-Density Polyethylene Bottle	100 mL	--	28 days
Sulfate	Water	SW-846 9000 Series or EPA 375 Series or EPA 300.0	One 100-mL High-Density Polyethylene Bottle	100 mL	--	28 days
Nitrate as Nitrogen	Water	SW-846 9000 Series or EPA 353 Series or EPA 300.0	One 100-mL High-Density Polyethylene Bottle	100 mL	H_2SO_4 to pH<2 Ice to 4°C	28 days
pH[5]	Water	SW-846 9040B or EPA 150.1	One 100-mL High-Density Polyethylene Bottle	100 mL	--	ASAP (24 hours maximum)
Specific Conductivity[5]	Water	SW-846 9050A or EPA 120.1	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	28 days
Turbidity[5]	Water	EPA 180.1	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	48 hour
Temperature[5]	Water	EPA 170.1	NA - Field measurement using direct reading	--	None	Immediate

Table 4-7
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Potential Soil and Water Analyses during RI Phase 2						
VOCs	Water	SW-846 5030B / 8260B or OLM04.3	(2 or 3), 40-mL VOC vial with PTFE-lined septa and open screw-caps	Fill to capacity	HCl to pH<2 Ice to 4°C or Ice to 4°C, no HCl	14 days 7 days
	Soil/Sediment[4, 6]	SW-846 5035A / 8260B or OLM04.3	Option 1: At least 3 40-mL VOC vials with PTFE-lined septa and open screw-caps, pre-weighed and containing magnetic stir bars AND One container of sample filled with no headspace for determination of moisture content	5 g 5 g	Frozen (-7°C to -15°C) Ice to 4°C	14 days 48 hours
			Option 2: At least 3 40-mL VOC vials with PTFE-lined septa and open screw-caps, pre-weighed and containing magnetic stir bars. Two of the containers will also contain 5-mL of water. AND One container of sample filled with no headspace for determination of moisture content	5 g 5 g	Frozen (-7°C to -15°C) Ice to 4°C	14 days 48 hours
			Option 3: At least 3 coring tools used as transport devices (e.g., Encore™ 5g Samplers) AND One container of sample filled with no headspace for determination of moisture content	5 g 5 g	Frozen (-7°C to -15°C) or Ice to 4°C Ice to 4°C	48 hours 48 hours
		SW-846 5030 / 8260B	(1 or 2), 4-oz. Glass Jar with PTFE-lined Lid	Fill to capacity	Ice to 4°C	14 days
SVOCs	Water	SW-846 8270C or OLM04.3	At least 2 1-L Amber Glass Bottles, fitted with screw-caps lined with PTFE	2 L	Ice to 4°C	7 days to extraction 40 days to analysis after extraction
	Soil/Sediment[4]	SW-846 8270C or OLM04.3	One 8-oz. Wide-Mouth Glass Jar or two 4-oz. Wide-Mouth Glass Jars	Fill to capacity	Ice to 4°C	14 days to extraction 40 days to analysis after extraction

Table 4-7
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Potential Soil and Water Analyses (continued)						
PCBs and Pesticides	Water	SW-846 8082 or OLM04.3	At least 2 1-L Amber Glass Bottles, fitted with screw-caps lined with PTFE	2 L	Ice to 4°C	7 days to extraction 40 days to analysis after extraction
	Soil/Sediment[4]	SW-846 8082 or OLM04.3	One 8-oz. Wide-Mouth Glass Jar or two 4-oz. Wide-Mouth Glass Jars	Fill to capacity	Ice to 4°C	14 days to extraction 40 days to analysis after extraction
TAL Metals	Water	SW-846 6000 or 7000 series or EPA 200 series or ILM05.3	One 1-L High-Density Polyethylene Bottle	1 L	HNO_3 to pH<2 Ice to 4°C	28 days - Mercury only 6 months - all other metals
	Soil/Sediment[4]	SW-846 6000 or 7000 series or EPA 200 series or ILM05.3	One 8-oz. or 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
Cyanide	Water	SW-846 9000 Series or EPA 335 Series or ILM05.3	One 1-L High-Density Polyethylene Bottle	1 L	NaOH to pH>12 Ice to 4°C	14 days
	Soil/Sediment[4]	SW-846 9000 Series or EPA 335 Series or ILM05.3	One 8-oz. or 4-oz. Wide-Mouth Glass Jar	Fill to capacity	Ice to 4°C	14 days

As = Arsenic
ASAP = as soon as possbile
ASTM = American Society for Testing and Materials
°C = Degrees Celsius
Cd = Cadmium
CLP = Contract Laboratory Program
COD = Chemical Oxygen Demand
EPA = Environmental Protection Agency
g = grams
HCl = Hydrochloric Acid
HNO_3 = Nitric Acid
H_2SO_4 = Sulfuric Acid
ICP = Inductively Coupled Plasma
L = liters
mL = milliliters
MS/MSD = Matrix Spike/Matrix Spike Duplicate

Table 4-7
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time

N = Nitrogen
NaOH = Sodium Hydroxide
oz = ounces
Pb = Lead
PM_{10} = Particulate Matter of 10 um or less
PCB = Polychlorinated Biphenyl
PTFE = polytetrafluoroethylene
PUF = Polyurethane Foam
RCRA = Resource Conservation and Recovery Act
SEL = Oklahoma State Environmental Lab
SVOC = Semivolatile Organic Compound
TAL = Target Analyte List
TCLP = Toxicity Characteristic Leaching Procedure
TOC = Total Organic Carbon
TSP = Total Suspended Particulates
VOC = Volatile Organic Compound
XRF = X-Ray Fluorescence Spectroscopy
Zn = Zinc

Notes:

1 Due to the use of multiple analytical laboratories, different methods may be used for sample analysis. In general, the methods indicated here should provide comparable results for a given analysis type.

2 Bottle requirements were based on those indicated by CLP requirements. Each laboratory will indicate appropriate sampling containers to meet their volume requirements, and this may differ from those indicated here. In particular, some of the general chemistry parameters can be combined into one sample bottle. Each laboratory will specify their preference. Quality control samples (field duplicates, MS, MSD, lab duplicates, and rinsates) require the same containers and volume as a typical field sample unless otherwise notified by the laboratory.

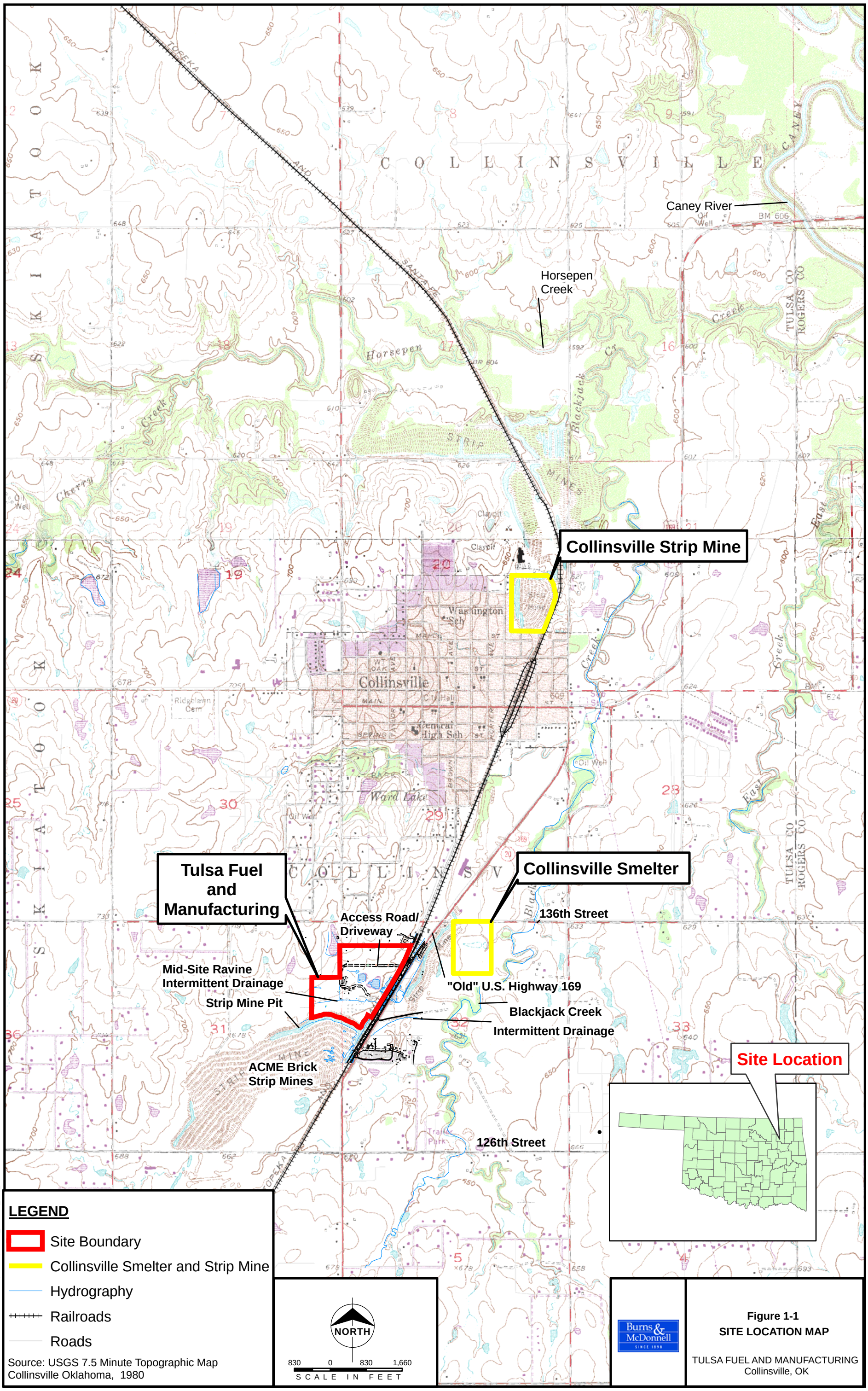
3 Metals of interest include As, Cd, Pb, and Zn. SEL will analyze 100% of the soil and sediment samples for these constituents using laboratory XRF techniques. In addition, SEL will analyze 10% of the soil and sediment samples for As, Cd, Pb, and Zn using ICP in order to confirm the laboratory XRF data.

4 Moisture content is listed since results for chemical analyses in soil are to be reported on a dry-weight basis. Unless otherwise noted, sufficient volume should be available to perform moisture content analyses using the volume collected for the primary chemical analysis.

5 Analyses are performed using direct-reading instruments while in the field. The manufacturer's instructions for the equipment provides guidance.

6 CLP methodology prefers the collection of soil/sediment samples for VOC analysis using SW-846 Method 5035. The Oklahoma SEL does not support this methodology. Soil/sediment samples

FIGURES


Caney River
Horsepen Creek
Collinsville Strip Mine
Tulsa Fuel and Manufacturing
Collinsville Smelter
Access Road/ Driveway
136th Street
Mid-Site Ravine Intermittent Drainage
Strip Mine Pit
"Old" U.S. Highway 169
Blackjack Creek Intermittent Drainage
ACME Brick Strip Mines
126th Street
Site Location
LEGEND
Site Boundary
Collinsville Smelter and Strip Mine
Hydrography
Railroads
Roads
Source: USGS 7.5 Minute Topographic Map Collinsville Oklahoma, 1980
NORTH
830 0 830 1,660
SCALE IN FEET
Burns & McDonnell
SINCE 1898
Figure 1-1
SITE LOCATION MAP
TULSA FUEL AND MANUFACTURING
Collinsville, OK
U:\Tulsa Fuels\ARC\ArcDocs\FSP Figures\Fig1-1Site_Location_Map_8x11.mxd ssl ts 05/03/2005 1:24000

136th Street
South 12th Street
Faith Assembly Church
"Old" U.S. Highway 169
Access Road/Driveway
Gate
Pond 4
Pond 3
Pond 2
Pond 1
Pond 5
Former Residence
RW-01
Mid-Site Ravine Intermittent Drainage
Supply House
Cistern
Office
Clay Bins
Crushing Rooms
Ore Bins
Mechanical Building
Open Ore Bins
Pottery
Blacksmith
Blacksmith
Machine Shop
Warehouse
Furnace 9
Furnace 8
Furnace 7
Furnace 6
Furnace 5
Furnace 4
Furnace 3
Furnace 2
Furnace 1
Metal Shed
Eastern Wetlands
Strip Mine Pit
Intermittent Drainage
Former Strip Mine Area (Acme Brick Strip Mine)
Attchinson Topeka Santa Fe Railroad
Blackjack Creek

LEGEND

- Site Boundary
- Former Building
- Former Railroad
- Railroad
- Barbed-Wire Fence
- Blackberry Bushes
- Chain-Link Fence
- Wetlands
- Hydrography
- Residental Well

NORTH

200 0 200

SCALE IN FEET

Burns & McDonnell SINCE 1898

Figure 1-2
SITE TOPOGRAPHY
AERIAL PHOTOGRAPHIC MAP

TULSA FUEL AND MANUFACTURING
Collinsville, OK

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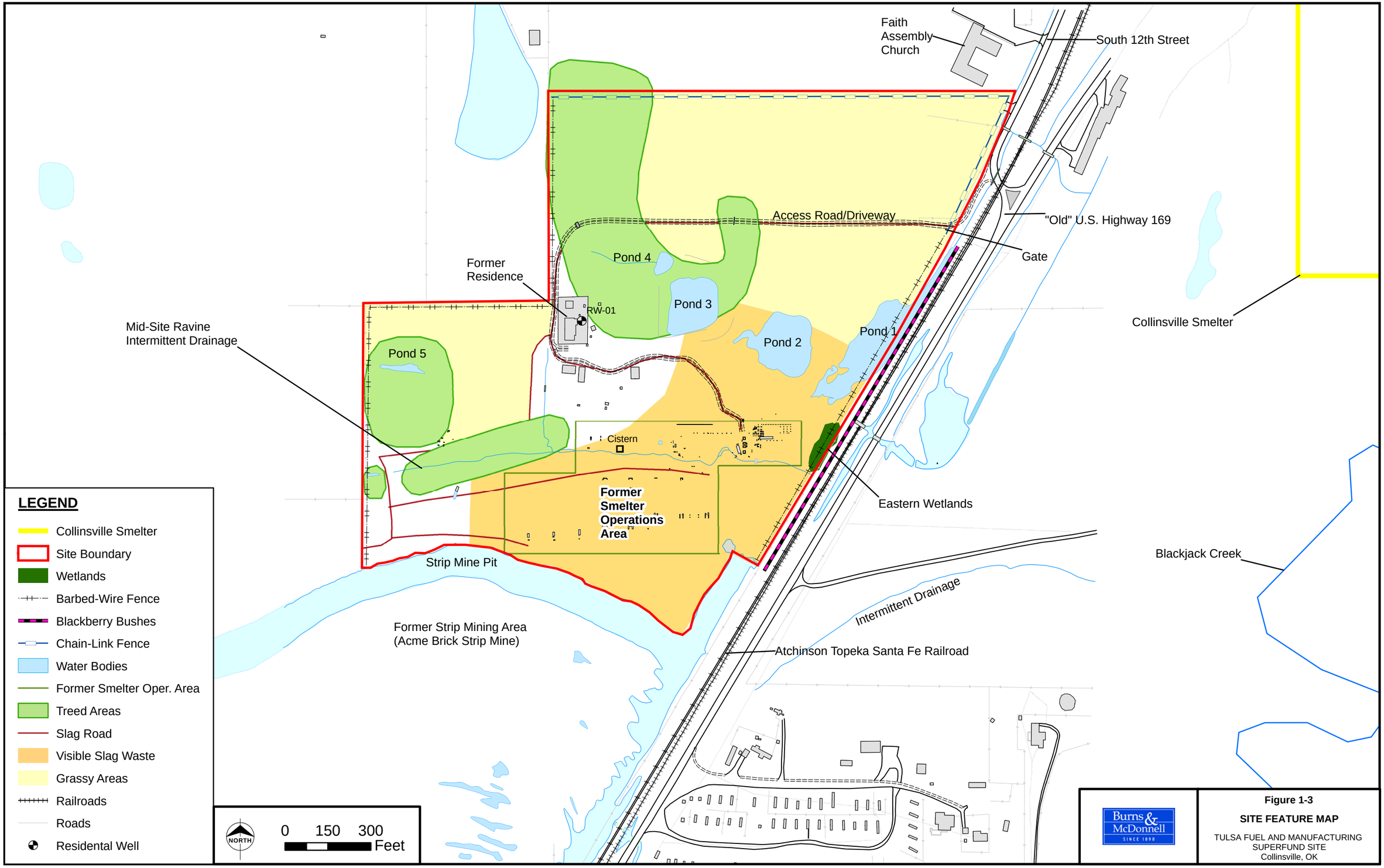

Figure 1-3

SITE FEATURE MAP

TULSA FUEL AND MANUFACTURING SUPERFUND SITE
Collinsville, OK

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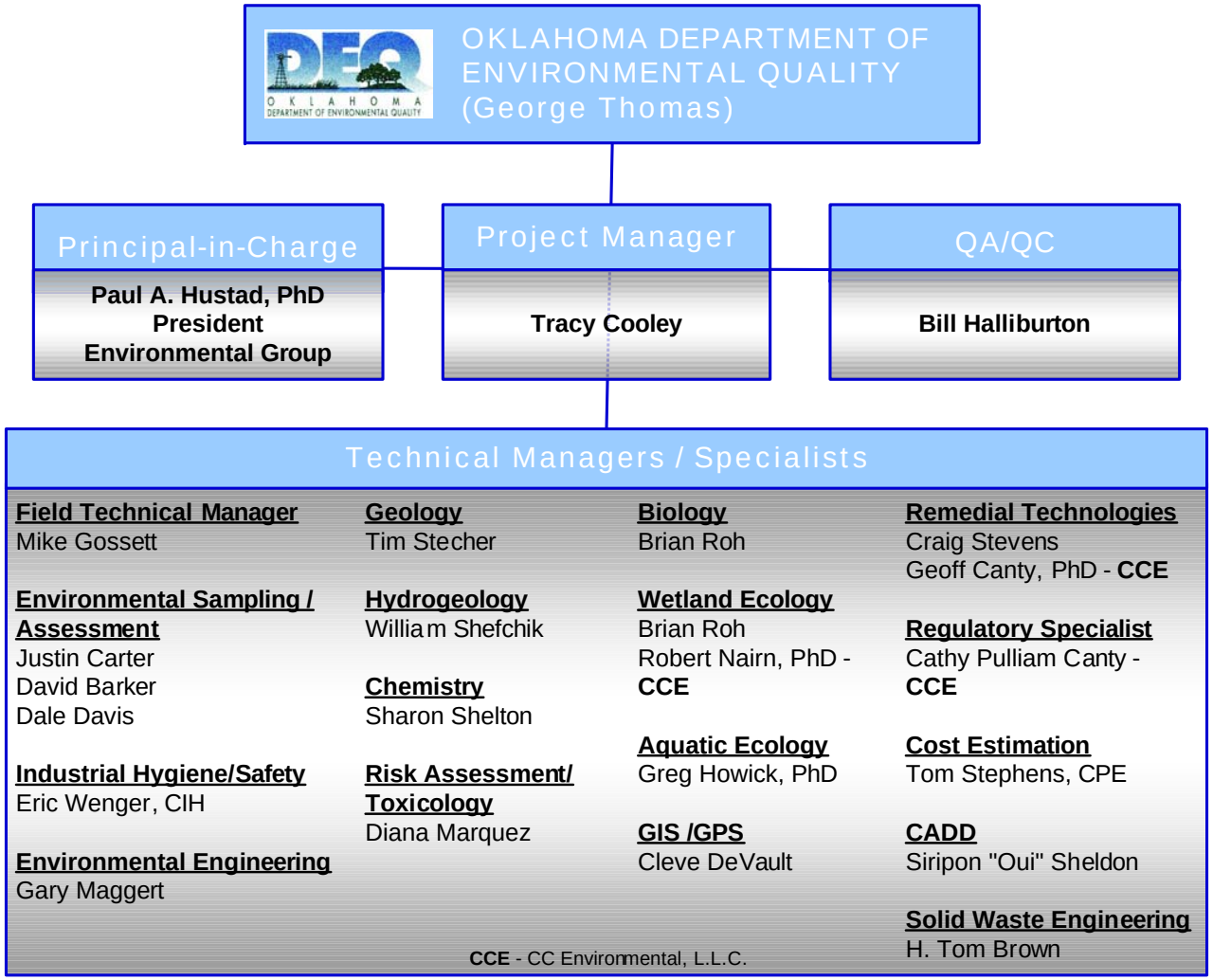


Burns & McDonnell
SINCE 1898

Figure 2-1
Organization Chart
Tulsa Fuel and Manufacturing Superfund Site
Collinsville, Oklahoma

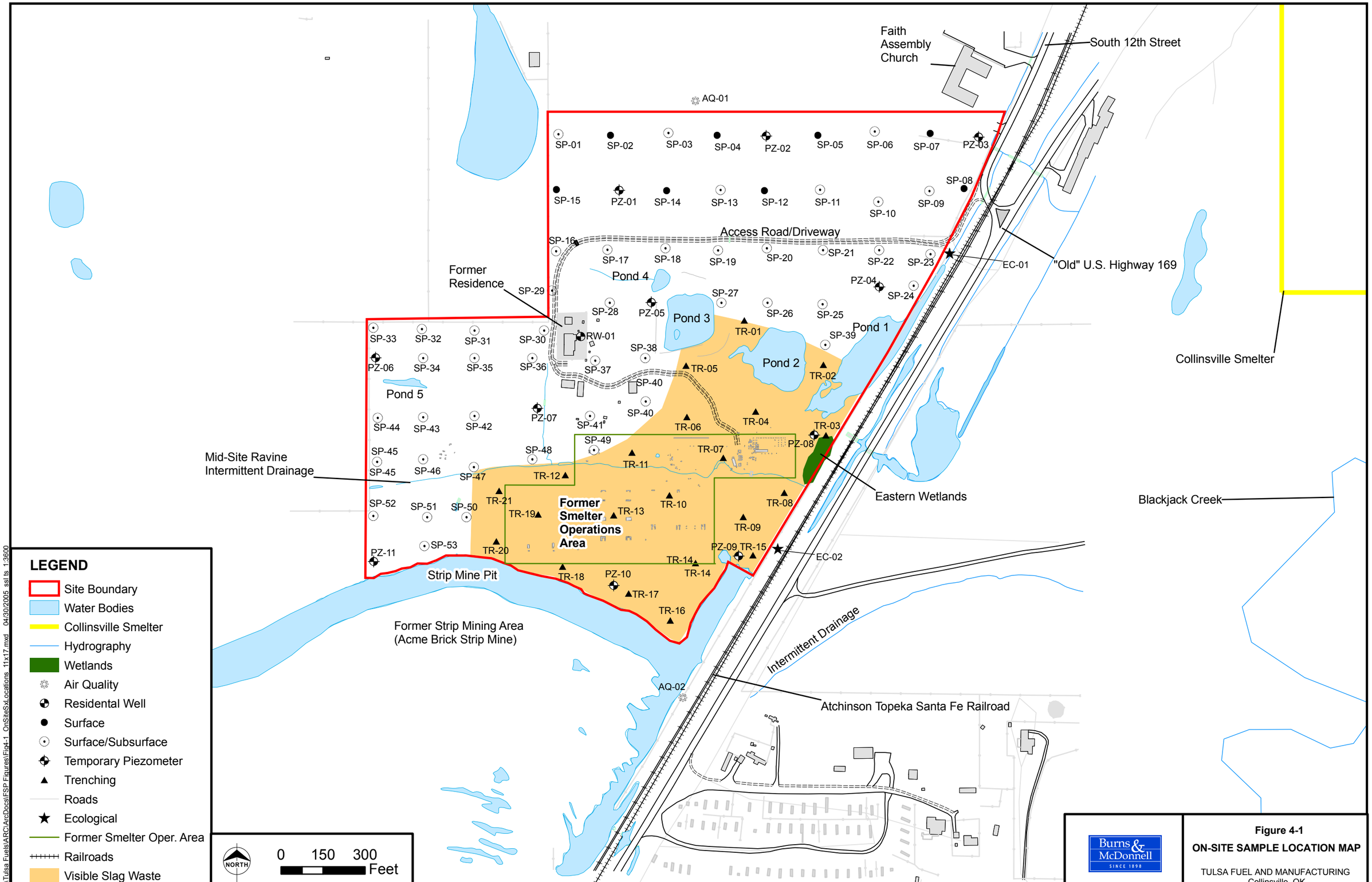


Figure 4-1
ON-SITE SAMPLE LOCATION MAP
TULSA FUEL AND MANUFACTURING
Collinsville, OK

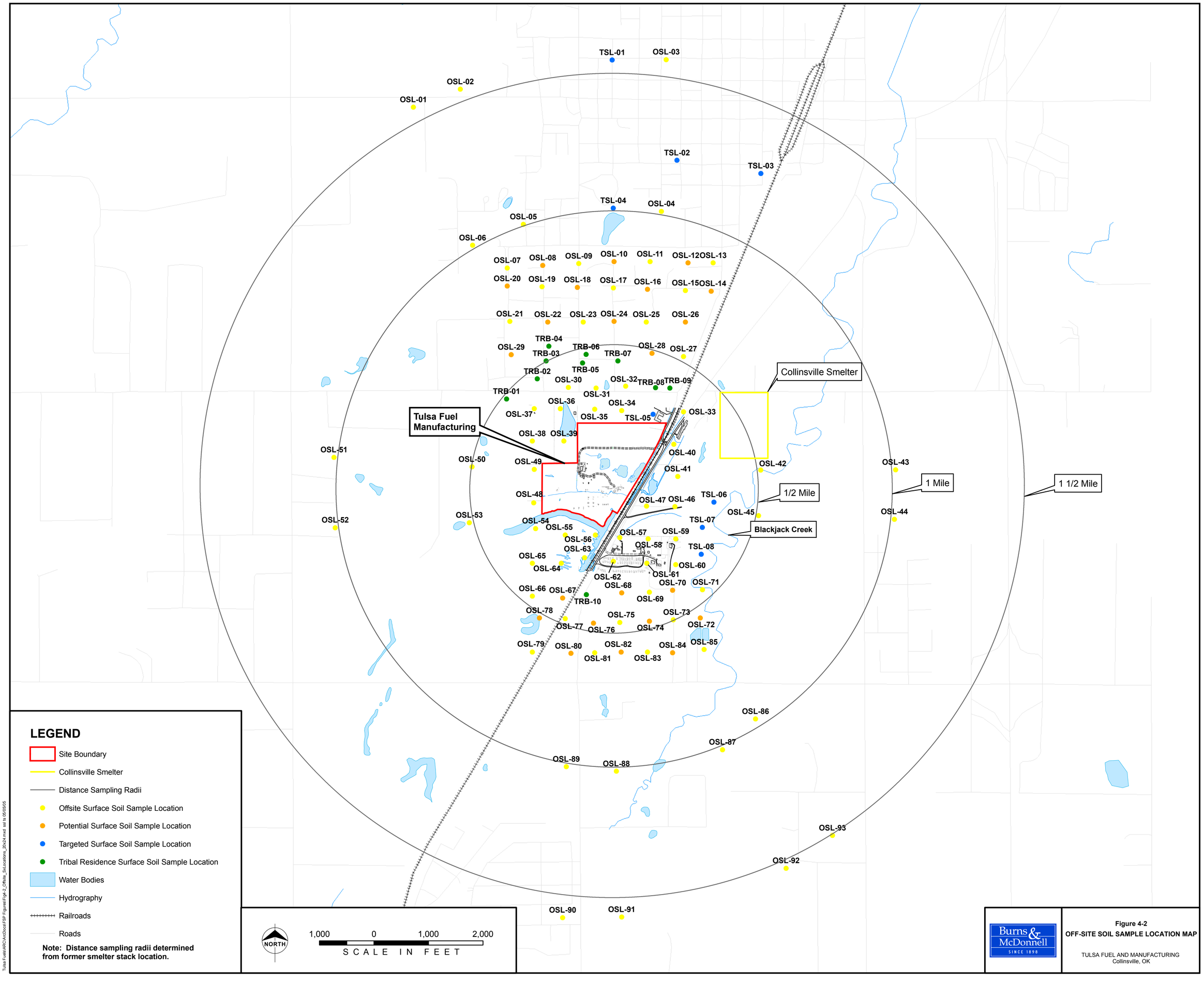
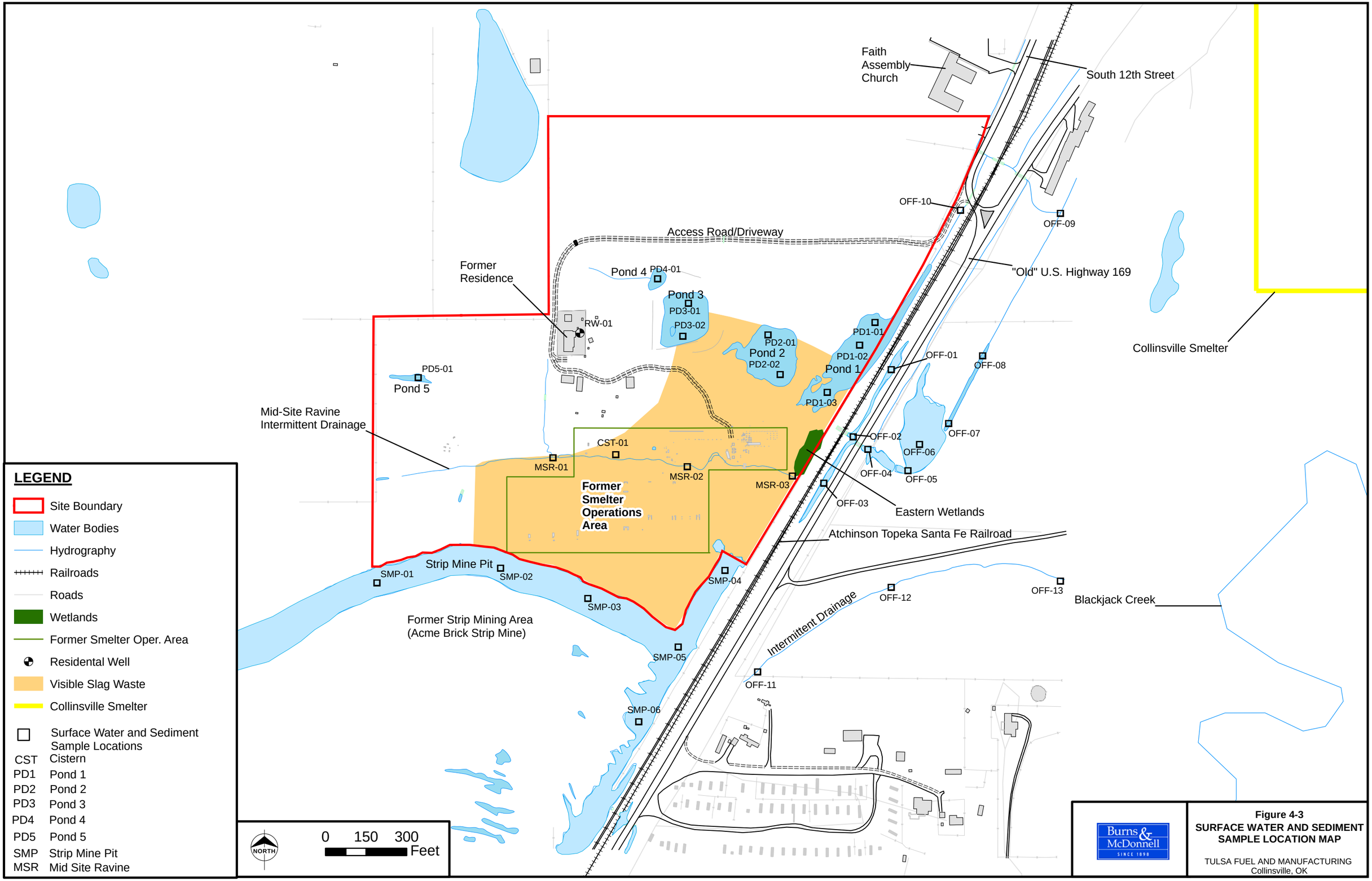


Figure 4-2
OFF-SITE SOIL SAMPLE LOCATION MAP

TULSA FUEL AND MANUFACTURING
Collinsville, OK

Tulsa Fuel\ARC\ArcDocs\FSP Figures\Fig4-2_Offsite_SvLocations_20x24.mxd sst ts 05/05/05


Faith Assembly Church
South 12th Street
OFF-10
OFF-09
Access Road/Driveway
"Old" U.S. Highway 169
Former Residence
Pond 4
PD4-01
Pond 3
PD3-01
PD3-02
RW-01
PD2-01
Pond 2
PD2-02
PD1-01
PD1-02
Pond 1
PD1-03
OFF-01
OFF-08
Collinsville Smelter
PD5-01
Pond 5
Mid-Site Ravine Intermittent Drainage
CST-01
MSR-01
MSR-02
MSR-03
Former Smelter Operations Area
OFF-02
OFF-06
OFF-07
OFF-04
OFF-05
OFF-03
Eastern Wetlands
Atchinson Topeka Santa Fe Railroad
Strip Mine Pit
SMP-01
SMP-02
SMP-03
SMP-04
SMP-05
SMP-06
Former Strip Mining Area (Acme Brick Strip Mine)
Intermittent Drainage
OFF-11
OFF-12
OFF-13
Blackjack Creek
LEGEND
Site Boundary
Water Bodies
Hydrography
Railroads
Roads
Wetlands
Former Smelter Oper. Area
Residental Well
Visible Slag Waste
Collinsville Smelter
Surface Water and Sediment Sample Locations
CST Cistern
PD1 Pond 1
PD2 Pond 2
PD3 Pond 3
PD4 Pond 4
PD5 Pond 5
SMP Strip Mine Pit
MSR Mid Site Ravine
NORTH
0 150 300 Feet
Burns & McDonnell SINCE 1898
Figure 4-3
SURFACE WATER AND SEDIMENT SAMPLE LOCATION MAP
TULSA FUEL AND MANUFACTURING
Collinsville, OK
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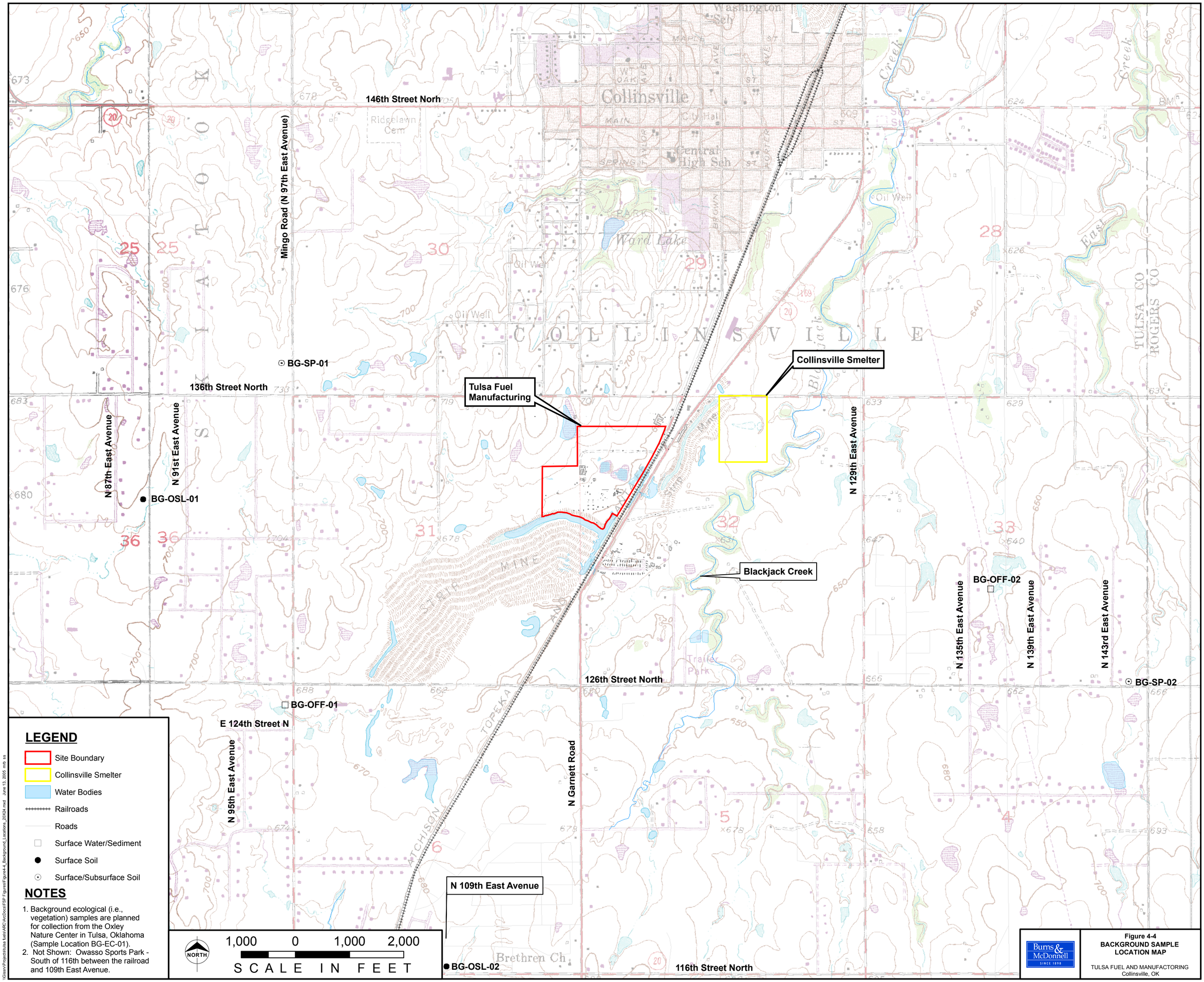

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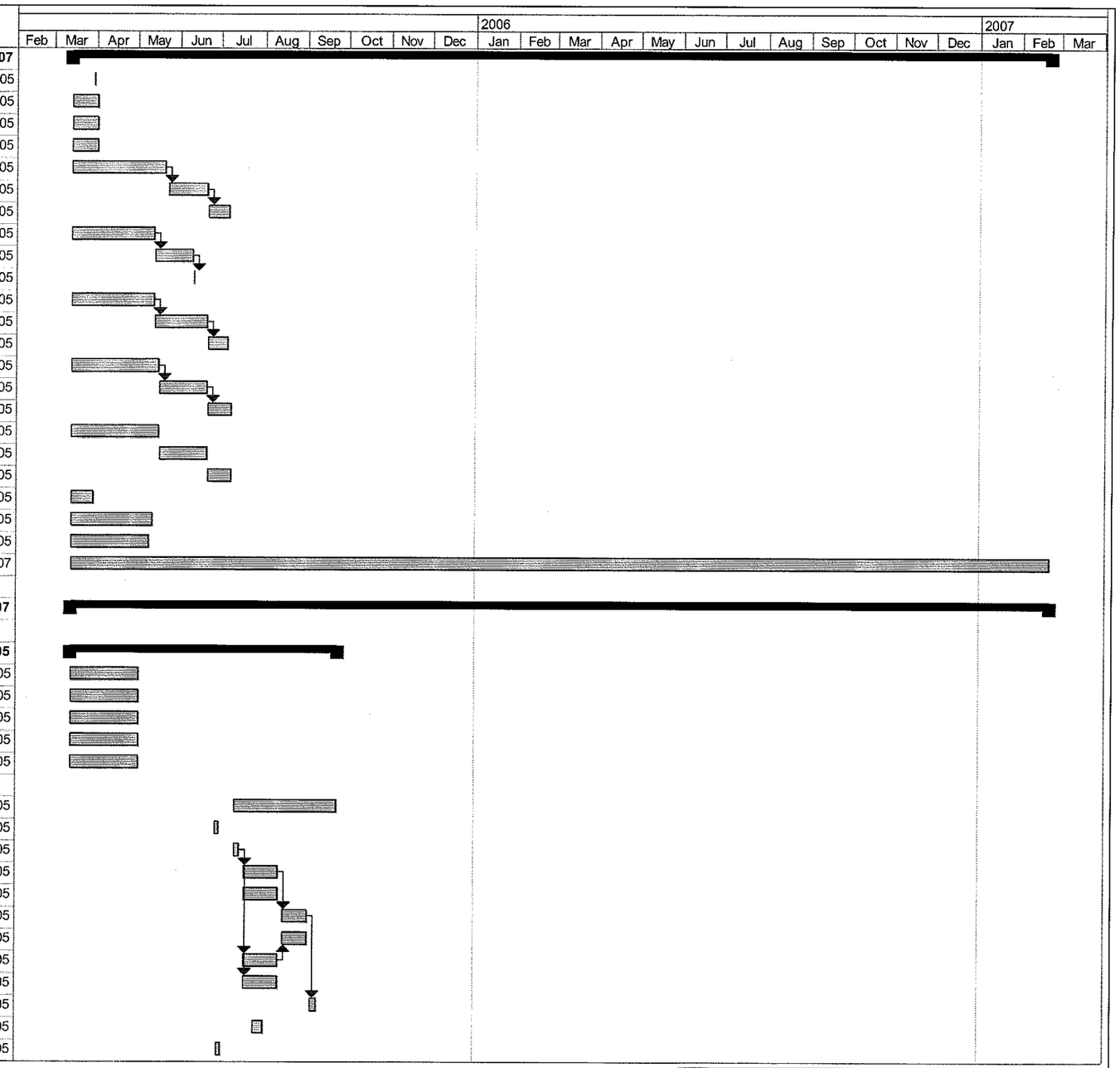
ID		Task Name	Duration	Start	Finish
1		**Task 1 - Overall Project Planning/Management**	**507 days**	**Mon 03/14/05**	**Tue 02/20/07**
2		Task 1.1.1 - Conduct Site Visit and KO Meeting	1 day	Tue 03/29/05	Tue 03/29/05
3		Task 1 1 2 - Review Existing Data	15 days	Mon 03/14/05	Fri 04/01/05
4		Task 1 1.3 - Identify Data Gaps	15 days	Mon 03/14/05	Fri 04/01/05
5		Task 1 1.4 - Determine Usability of Existing Data	15 days	Mon 03/14/05	Fri 04/01/05
6		Task 1 1 5 - Prepare Draft RI/FS Work Plan	50 days	Mon 03/14/05	Fri 05/20/05
7		DEQ/EPA Review and Comment	21 days	Mon 05/23/05	Mon 06/20/05
8		Task 1 1.6 - Prepare and Submit Final RI/FS Work Plan	12 days	Tue 06/21/05	Wed 07/06/05
9		Task 1 1.7 - Prepare Draft HASP	44 days	Mon 03/14/05	Thu 05/12/05
10		DEQ/EPA Review and Comment	20 days	Fri 05/13/05	Thu 06/09/05
11		Task 1 1 8 - Prepare and Submit Final HASP	1 day	Fri 06/10/05	Fri 06/10/05
12		Task 1 1.9 - Prepare Draft QAPP	44 days	Mon 03/14/05	Thu 05/12/05
13		DEQ/EPA Review and Comment	27 days	Fri 05/13/05	Mon 06/20/05
14		Task 1 1.10 - Prepare and Submit Final QAPP	11 days	Tue 06/21/05	Tue 07/05/05
15		Task 1 1.13 - Prepare Draft FSP	46 days	Mon 03/14/05	Mon 05/16/05
16		DEQ/EPA Review and Comment	25 days	Tue 05/17/05	Mon 06/20/05
17		Task 1 1 14 - Prepare Final FSP	14 days	Tue 06/21/05	Fri 07/08/05
18		Task 1.1 15 - Prepare Draft SOPs	46 days	Mon 03/14/05	Mon 05/16/05
19		DEQ/EPA Review and Comment	25 days	Tue 05/17/05	Mon 06/20/05
20		Task 1.1.16 - Prepare Final SOPs	14 days	Tue 06/21/05	Fri 07/08/05
21		Task 1 1.17 - Prepare Detailed Project Schedule	12 days	Mon 03/14/05	Tue 03/29/05
22		Task 1.1 18 - Prepare Data Management Plan	43 days	Mon 03/14/05	Wed 05/11/05
23		Task 1.1.19 - Develop GIS Database/Website	41 days	Mon 03/14/05	Mon 05/09/05
24		Task 1.2 - Project Management & Web Maintenance	507 days	Mon 03/14/05	Tue 02/20/07
25					
26		**Task 2 - Community Relations**	**507 days**	**Mon 03/14/05**	**Tue 02/20/07**
28					
29		**Task 3 - Information Gathering and Sampling**	**140 days**	**Mon 03/14/05**	**Fri 09/23/05**
30		Task 3 1 - Information Gathering	36 days	Mon 03/14/05	Mon 05/02/05
31		Task 3 1 1 - Prepare Conceptual Site Model	36 days	Mon 03/14/05	Mon 05/02/05
32		Task 3.1 2 - Perform Site Recon & Basemap	36 days	Mon 03/14/05	Mon 05/02/05
33		Task 3.1.3 - Identify Preliminary ARARs	36 days	Mon 03/14/05	Mon 05/02/05
34		Task 3 2 - Identify Land Use and Demographics	36 days	Mon 03/14/05	Mon 05/02/05
35					
36		Task 3 3 - Field Investigation (Field Site Manager)	55 days	Mon 07/11/05	Fri 09/23/05
37		Task 3 3a - Beetle Survey for FWS	4 days	Mon 06/27/05	Thu 06/30/05
38		Task 3 3b - Mobilize	5 days	Mon 07/11/05	Fri 07/15/05
39		Task 3.4 - Conduct Waste Sampling	20 days	Mon 07/18/05	Fri 08/12/05
40		Task 3 5 - Conduct Surface Soil Sampling	20 days	Mon 07/18/05	Fri 08/12/05
41		Task 3.6 - Conduct Surface Water/Aquatic Sed Sampling	15 days	Mon 08/15/05	Fri 09/02/05
42		Task 3 7 - Conduct Well Install/Groundwater Sampling	15 days	Mon 08/15/05	Fri 09/02/05
43		Task 3.8 - Conduct Ag Properties Sampling	20 days	Mon 07/18/05	Fri 08/12/05
44		Task 3.9 - Conduct Residential Properties Sampling	20 days	Mon 07/18/05	Fri 08/12/05
45		Task 4 0 - Conduct Background Sampling	5 days	Mon 09/05/05	Fri 09/09/05
46		Task 4 1 - Conduct Air Quality Sampling	6 days	Mon 07/25/05	Mon 08/01/05
47		Task 4.2 - Conduct Ecological Sampling	3 days	Wed 06/29/05	Fri 07/01/05



Project: Schedule June 16 2005
Date: Fri 06/17/05

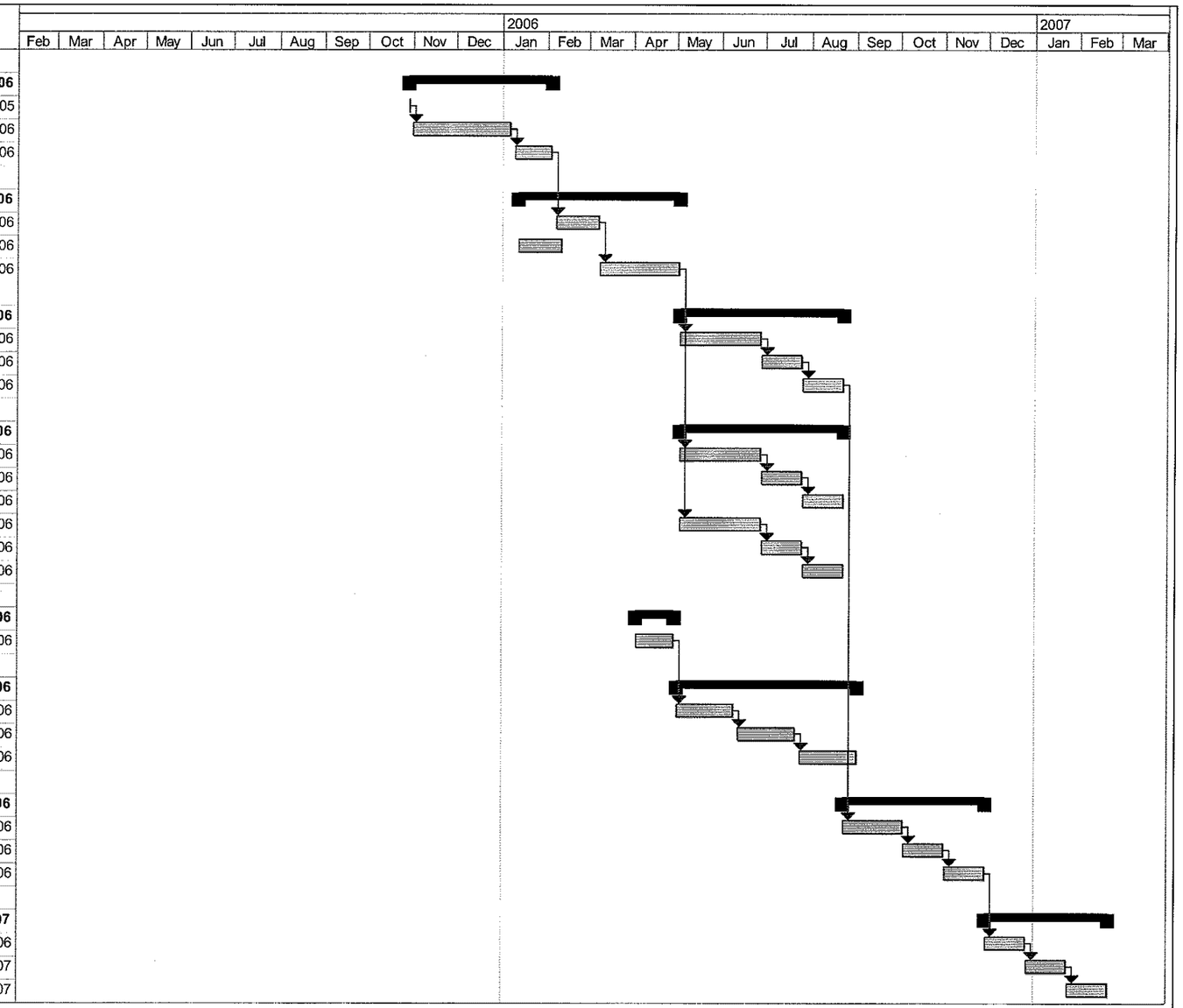
Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Burns & McDonnell SINCE 1898

Figure 9-1
Project Schedule

TULSA FUEL AND MANUFACTURING
Collinsville, Oklahoma

ID	Task Name	Duration	Start	Finish
48				
49	**Task 4 - Phase I Preliminary Data Report**	**71 days**	**Fri 10/28/05**	**Fri 02/03/06**
50	Task 4 1 - Receive Last Data Set	1 day	Fri 10/28/05	Fri 10/28/05
51	Task 4 2 - Validate Data & Prepare Data Report	50 days	Mon 10/31/05	Fri 01/06/06
52	DEQ Review and Approval	20 days	Mon 01/09/06	Fri 02/03/06
53				
54	**Task 5 - Phase II Field Work**	**79 days**	**Thu 01/12/06**	**Tue 05/02/06**
55	Task 5 1 - Conduct Additional Sampling (Optional)	22 days	Mon 02/06/06	Tue 03/07/06
56	Task 5 1 1 - Dispose of IDW	22 days	Thu 01/12/06	Fri 02/10/06
57	Receive Lab Data & Validate	40 days	Wed 03/08/06	Tue 05/02/06
58				
59	**Task 7 - Remedial Investigation Report**	**80 days**	**Wed 05/03/06**	**Tue 08/22/06**
60	Task 7 1 - Prepare Draft RI Report	40 days	Wed 05/03/06	Tue 06/27/06
61	DEQ/EPA Review and Comment	20 days	Wed 06/28/06	Tue 07/25/06
62	Task 7 2 - Prepare Final RI Report	20 days	Wed 07/26/06	Tue 08/22/06
63				
64	**Task 8 - Risk Assessment**	**80 days**	**Wed 05/03/06**	**Tue 08/22/06**
65	Task 8 1 - Prepare Draft Human Health Assessment	40 days	Wed 05/03/06	Tue 06/27/06
66	DEQ/EPA Review and Comment	20 days	Wed 06/28/06	Tue 07/25/06
67	Task 8.2 - Prepare Final Human Health Assessment	20 days	Wed 07/26/06	Tue 08/22/06
68	Task 8.3 - Prepare Draft Eco Risk Assessment	40 days	Wed 05/03/06	Tue 06/27/06
69	DEQ/EPA Review and Comment	20 days	Wed 06/28/06	Tue 07/25/06
70	Task 8 4 - Prepare Final Eco Risk Assessment	20 days	Wed 07/26/06	Tue 08/22/06
71				
72	**Task 9 - Identify Preliminary ARARs**	**20 days**	**Mon 04/03/06**	**Fri 04/28/06**
73	Task 9 - Identify Preliminary ARARs	20 days	Mon 04/03/06	Fri 04/28/06
74				
75	**Task 10, 11, 12 - Technical Memos**	**90 days**	**Mon 05/01/06**	**Fri 09/01/06**
76	Task 10 - Screen Technologies & Process Options	30 days	Mon 05/01/06	Fri 06/09/06
77	Task 11 - Prepare RA Alternatives Screening Tech Memo	30 days	Mon 06/12/06	Fri 07/21/06
78	Task 12 - Prepare RA Evaluation Tech Memo	30 days	Mon 07/24/06	Fri 09/01/06
79				
80	**Task 13 - Study Reports**	**70 days**	**Wed 08/23/06**	**Tue 11/28/06**
81	Task 13.1 - Prepare Draft Feasibility Study	30 days	Wed 08/23/06	Tue 10/03/06
82	DEQ/EPA Review and Comment	20 days	Wed 10/04/06	Tue 10/31/06
83	Task 13.2 - Prepare Final Feasibility Study	20 days	Wed 11/01/06	Tue 11/28/06
84				
85	**Tasks 14, 15, and 16 - Project Closeout**	**60 days**	**Wed 11/29/06**	**Tue 02/20/07**
86	Task 14 - Prepare Draft Proposed Plan	20 days	Wed 11/29/06	Tue 12/26/06
87	Task 15 - Provide Post RI/FS Support	20 days	Wed 12/27/06	Tue 01/23/07
88	Task 16 - Provide Administrative Record Support	20 days	Wed 01/24/07	Tue 02/20/07



Project: Schedule June 16 2005
Date: Fri 06/17/05

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Burns & McDonnell SINCE 1898

Figure 9-1
Project Schedule

TULSA FUEL AND MANUFACTURING
Collinsville, Oklahoma

APPENDIX A

Standard Field Forms

Appendix A
Field Forms

Daily Quality Control Report

Drilling Log

Monitoring Well Installation Form

Well Development Form

Observed Water Level Form

Sample Bottle Label and Custody Seal Label

Request for Chemical Analysis and Chain of Custody Record

CLP Sample Request Form

IDW Inventory Worksheet

TFM-0000372

Burns & McDonnell SINCE 1898

Form WCD-102
052101

DAILY QUALITY CONTROL REPORT

Site: _____

Project No.: _____

Date: _____

Crew No.: _____

Crew Mem.: _____

_____

Weather (circle)

	Bright Sun	Clear	Overcast	Rain	T-storm	Snow
Temp.	to 32	32-50	50-70	70-85	85+	
Wind	Still	Gusty	Moder.	High	**Direction:**	
Humidity	Dry	Moder.	Humid			

Subcontactors and Equipment on Site: _____

Health and Safety Levels: (circle)

D	Mod. D.	C	B	A

Summary of Health and Safety Activities: _____

Instruments Used: (circle)
Calibrated: (check)

OVM	LEL	pH	Cond.	Therm.	Turbidity	

For actual calibration results, see field calibration forms.

Summary of Health and Safety Activities: _____

Sample Number Collected, including QA, are listed on the table on the reverse of this sheet.

All Samples Were Collected According to Procedures Outlined in the Work Plan?

Yes _____ No _____

Problems Encountered/Corrective Action Taken: _____

Date/Time Project Manager Contacted: _____

Tomorrow's Expectations: _____

Name: _____ Signature: _____

Drilling Log

Project Name	Project Number	Boring Number
Ground Elevation	Location	Page
Air Monitoring Equipment		Total Footage

Drilling Type	Hole Size	Overburden Footage	Bedrock Footage	No. of Samples	No. of Core Boxes

Drilling Company	Driller(s)
Drilling Rig	Type of Sampler
Date / To	Field Observer(s)

Depth (feet)	Description	Class	Blow Count	Recov.	Run/ Time	Sample Desig.	PID (ppm) BZ	PID (ppm) BH	PID (ppm) S	Remarks/ Water Levels
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										

BZ=Breathing Zone BH=Bore Hole S=Sample

Burns & McDonnell SINCE 1898

051601 Form WCD-2-1

Drilling Log Continuation

	Boring Number
Project Name	Page
Project Number	Date

Depth (feet)	Description	Class	Blow Count	Recov.	Run/ Time	Sample Desig.	PID (ppm)			Remarks/ Water Levels
							BZ	BH	S	

BZ=Breathing Zone BH=Bore Hole S=Sample

Burns & McDonnell SINCE 1898

051601 Form WCD-KC-2-2

Project Number: _____ **Project Name:** _____
Monitoring Well No: _____ **Well Location:** _____
Installation Start (Date/Time): _____ **Completion (Date/Time):** _____

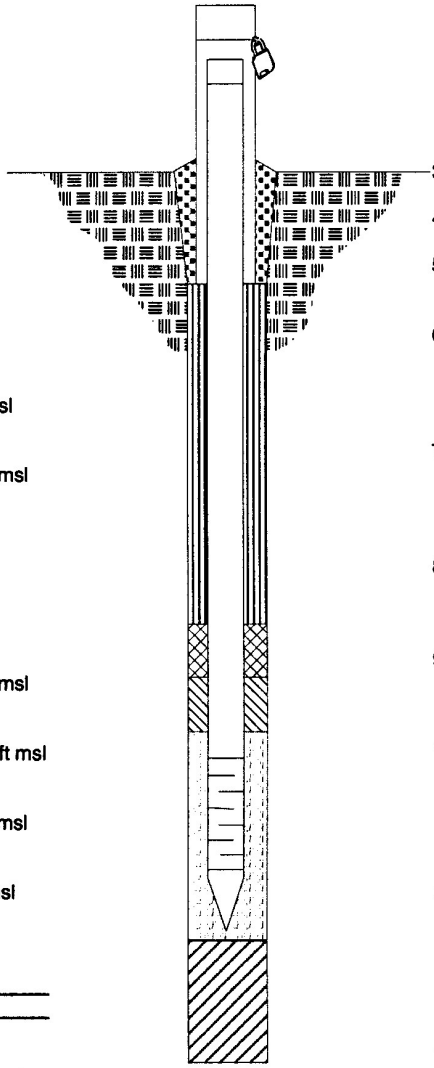
Well casing, top elevation _____ ft. msl

Land surface elevation_____ft. msl

Top View

Side View

Sketch of Surface Completion



Annular seal, top _____ ft bgs / 0.0 ft msl

Bentonite seal, top _____ ft bgs / 0.0 ft msl

Fine sand, top _____ ft bgs / 0.0 ft msl

Filter pack, top _____ ft bgs / 0.0 ft msl

Screen joint, top _____ ft bTOC / 0.0 ft msl

Bottom of end cap _____ ft bTOC / 0.0 ft msl

Filter pack, bottom _____ ft bgs / 0.0 ft msl

Borehole, bottom _____ ft bgs / 0.0 ft msl

Development:
Method: _____
Date: _____

Static water level >24hr. after development

Date	Time	Level below TOC

1. Cap and Lock? ☐Yes ☐No
2. Protective cover:
   a. Inside Diameter _____ in.
   b. Length _____ ft.
   c. Material _____
   d. Weep hole location/size: _____
   e. Add. protection? ☐Yes ☐No
3. Pad type/dimensions: _____
4. Surface Seal: ☐ Concrete ☐ _____
5. Material between well casing and protective cover: _____
6. Annular seal: ☐ Granular bentonite
   ☐ Bentonite slurry
   ☐ Bentonite-cement
   ☐ Other _____
7. Bentonite seal: ☐ Granular bentonite
   ☐ Bentonite pellets _____ inch
   ☐ Bentonite chips _____ inch
   ☐ Other _____
8. Fine sand: Manufacturer, name, & size _____
   Volume added _____ lbs.
9. Filter pack: Manufacturer, name, & size _____
   Volume added _____ lbs
10. Well casing:
    Type _____
    Manufacturer _____
    Outside diameter _____ in.
    Inside diameter _____ in.
11. Screen material:
    Type _____
    Manufacturer _____
    Slot size _____ in.
    Outside diameter _____ in.
    Inside diameter _____ in.
12. Backfill material (below filter pack):
    ☐ None ☐ Other _____
13. Centralizers: ☐ No ☐ Yes
    If yes, Type/material _____
    Number _____
    Depth(s) _____

Comments _____

Driller: _____ **Inspector:** _____

Discrepancies: _____ **Checked by:** _____ **Date:** _____

Well Development Form

Project Number:	Well Number:

Project Information	**Elevation of Well**
Facility Name:	Ground Surface Elevation (GS):
Location: N E	Top of Casing Elevation (TOC):

Well Information	
Date Well Installed:	
Total Depth of Well:	feet from
Depth to Top of Screen:	feet from
Length of Casing Screened:	feet
Type of Formation Screened:	

Well Volume Calculation

1 well volume (gallons) = initial height of water column (ft) x 0.0408 x (casing diameter (in))2

Well Development Method				
Equipment:				Method Description:
Surge		Bail		
Airlift		Pump		

Observations During Well Development

Date	Time	Depth to Water* (ft)	Total Depth* (ft)	Fluid Removed		Temp. (degrees F)	pH (units)	S.C. (S/cm)	Turbidity (NTU)	Fluid Appearance and Remarks (color, odor, etc.)
				Gallons	Total					

* From TOC unless otherwise noted in Remarks

Burns & McDonnell SINCE 1898

051801 Form WCD-KC-6-1

Observed Water Level Form

Project Number:	Well Number:
Facility Name:	Ground Surface Elevation (GS):
Location: N E	Top of Pipe Elevation (TOP):
	Reference Point Elevation (RP):
Date Drilling Began:	Total Depth of Boring: feet from
Date Drilling Completed:	Total Depth of Well: feet from
Drilling Type:	Depth to Top of Screen: feet from
Date Well Installed:	Length of Casing Screened: feet

Remarks:

Date	Time	By Whom	Depth to Water*	Water Level El.	Total Depth*	Remarks**
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
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			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	

* Depth noted from Ground Surface (GS), Top of Pipe (TOP), or Reference Point (RP)
** e.g. Added or removed water, began pumping, took samples

Burns & McDonnell SINCE 1898

051801 Form WCD-KC-5-1

TFM-0000378

Observed Water Level Form (continuation)

Page ____ of ____

Project Number: | Well Number:

Date	Time	By Whom	Depth to Water*	Water Level El.	Total Depth*	Remarks**
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
			from		from	
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			from		from	
			from		from	
			from		from	

* Depth noted from Ground Surface (GS), Top of Pipe (TOP), or Reference Point (RP)
** e.g. Added or removed water, began pumping, took samples

Burns & McDonnell SINCE 1898

051801 Form WCD-KC-5-2

Sample Bottle Label

ROUTE TO		ANALYSIS
	Burns & McDonnell WCD 9400 Ward Parkway Kansas City, MO 64114 Phone: (816) 333-8787	

Sample Group: _____

Sample Point: _____

Sample Designator: _____

Sample Round: _____ Year: _____

Sample Depth From: _____ To: _____

Date Sampled: _____

Time Sampled: _____

Preservation: _____

_____

051401 Form WCD-97N

Custody Seal Label

WCD-101

Burns & McDonnell ENV
9400 Ward Parkway
Kansas City, MO 64114-3319

Signature _____

Date _____

Burns & McDonnell
SINCE 1898

Request for Chemical Analysis and Chain of Custody Record

Burns & McDonnell Engineering
9400 Ward Parkway
Kansas City, Missouri 64114
Phone: (816) 333-8787 Fax: (816) 822-3463

Attention:

Laboratory:

Address:

City/State/Zip:

Telephone:

Document Control No:

Lab. Reference No. or Episode No.:

Project Number:

Sample Type

Client Name:

Matrix

Sample Number			Sample Event		Sample Depth (in feet)		Sample Collected		Matrix			Number of Containers	Analysis						Remarks
Group or SWMU Name	Sample Point	Sample Designator	Round	Year	From	To	Date	Time	Liquid	Solid	Gas								

Sampler *(signature)*:

Sampler *(signature)*:

Special Instructions:

Relinquished By *(signature)*: 1.

Date/Time

Received By *(signature)*:

Date/Time

Ice Present in Container: Yes ☐ No ☐

Temperature Upon Receipt:

Relinquished By *(signature)*: 2.

Date/Time

Received By *(signature)*:

Date/Time

Laboratory Comments:

052501 Form WCD-KC1

TFM-0000381

Region 6 Sample Control Center, FAX 281-983-2248

REQUEST FOR LABORATORY SAMPLE ANALYSES

Site Name: Tulsa Fuel and Manufacturing	City/State: Collinsville, OK	CERCLIS #: OKD987096195
GPRA Account #:	Site Spill ID #	Type of Investigation/Purpose: RI/FS
EPA SAM, **RPM**, OSC: Michael Torres Mail Code: 6SF-LP	Analytical Turnaround Time: _____ Region 6 Lab: 35 ____ CLP Organics: 7____ 14__ 21 X__ CLP Inorganics: 7____ 14___ 21 X_	Type of Contract: Cooperative Agreement Contractor: Burns & McDonnell Shipping Contact: Mike Gossett/Burns & McDonnell
Telephone #: (214) 665-2108	Are preliminary results required? 48 hrs VOA ( ) Yes (x) No 72 hrs Extractables ( ) Yes (x) No 72 hrs Inorganics ( ) Yes (x) No	Telephone #: 816-333-9400 Secondary Contact: Tracy Cooley 816-822-3369
Fax #: (214) 665-6660		On Site Ph #: Fax #:
Potential Enforcement Action? (x) Yes () No	**Preliminary Results Fax #:**	Date Sample Control Center Received Request For Sample Analysis:
Proposed Sampling Period:		

Preliminary Results: Requests for preliminary results must be limited to those circumstances where fast data turnaround times are needed to facilitate removal/remedial clean-up and emergency response actions. CLP preliminary results data are not considered to be data of known quality. As the name "preliminary" implies, the analytical results are tentative and may change.

Please assure that this request for analytical services has been signed and dated by the appropriate Site Assessment Manager, Remedial Project Manager, or On Scene Coordinator. Please assure that the Sample Control Center has a copy of all relevant Quality Assurance Project Plans (QAPPs) and Sampling and Analysis Plans (SAPs).

Is the QAPP,QASP,SAP,O&M Plan, GWMP,DAW, or other relevant plan being submitted with this Request For Sample Analyses?

If no, please explain(expected date of submission etc.): NA.

Signature of **EPA Site Assessment Manager (SAM), Remedial Project Manager (RPM), or On Scene Coordinator (OSC)** to signify approval of this analytical service request.

Signature: _____ Date: _____

To most efficiently obtain laboratory capability for your request, please address the following considerations. Incomplete or erroneous information may result in a delay in the processing of your request.

1. General description of analytical services requested: (QA/R5 - Element B1)

Matrix	Analysis	Number of Samples (without QC) high/low conc	Field QC Samples	
			How many?	Type?

Additional description (areas where samples are being collected etc.):

2. Analytical protocol required (analytical method & method number, extraction or digestion method & method number, CLP SOW reference, for each matrix if required, etc.): (QA/R5 - Element B4)

Matrix	Analysis	Methods

Additional Information:

Complete the following information if Method 5035 for VOA soils has been requested:

	# of low conc. soils	# of medium conc. Soils		Type of Vials	# of low conc. soils	# of medium conc. soils
ENCORES	**0**	**0**	**Pre-weighed vials**	**0**	**0**	**0**

3. Special technical instructions (specify any requirements outside of existing protocol such as target analytes, reporting limits, etc.): (QA/R5 - Elements A6 and B4)

CLP Flexibility Clause - The latest CLP Organic Statement of Work (SOW), OLM04.2, includes a flexibility clause. This clause allows the regions to request minor changes to current SOW analytical methods in order to meet specific field site requirements. The changes are limited in scope and must

be approved by the EPA CLP Program Manager and Contracting Officer before implementation. Information must be submitted four weeks prior to the sampling event, and the laboratories must agree to perform the analysis at no additional cost.
http://www.epa.gov/superfund/programs/clp/methflex.htm

4. Analytical results required (specify laboratory documentation and reporting requirements, reporting units, format requirements, etc.): (QA/R5 - Elements A6 and B4)

5. Other (any additional specifications, attach supplementary information if needed): **(QA/R5 - Element B4)**

6. Data requirements (reporting limits; per analyte per matrix; reporting units; applicable reference levels, etc.): (QA/R5 - Elements A7, B1, and B4) (Attach extra pages if necessary) For CLP capabilities - **http://www.epa.gov/superfund/programs/clp/facts.htm**. For Region 6 Laboratory capabilities - **http://www.epa.gov/earth1r6/6lab/r6lab.htm**

Note: Samples submitted to the CLP for analysis must be low or medium concentration, single phase, homogenous (not oily), soil, sediment, or water.

NOTE: Samples with matrix related problems (oily material, high concentration of compounds, etc.) and/or high moisture content will raise the detection limits.

a. Compounds/chemicals of concern (Action levels etc.)

Parameters	Detection Limit	
	water (units)	soil/sediment (units)

7. QC Requirements (PE samples & frequency, spikes, duplicates, blanks, & frequency)

*** Requirements are as stated in referred methods.**

QC Type	Frequency	QC Limits

8. Data Assessment Options (For CLP generated data only)
Data assessment options apply only to data acquired through the CLP using the Organic Multi-Media/Multi-Concentration SOW - OLM04.2. See Attachment 5 (Region 6 Organic Data Assessment Options).
Data turnaround times refer to calendar days.

Mark the level of data assessment needed:

- ☒ Level 3 - Full data validation (14-day turnaround) (or Houston Lab data package)
- ☐ Level 2 - Results qualified by computer, partial validation by ESAT (7 day turnaround)*
- ☐ Level 1 - Results qualified by computer, minimal validation by ESAT (3 day turnaround)*

*** Plus 1 - 5 days for processing and mailing.**

IDW Inventory Worksheet

Project Name:	Project Number:	BMcD Point of Contact:
Facility Name:	OU Number:	Point of Contact Phone No.:

Container No.	Location	Generation Date(s)	Contents	Quantity	Drum Condition	Remarks

APPENDIX B

Standard Operating Procedures

Appendix B
Standard Operating Procedures

TFM-101 - Direct Push Soil Sampling

TFM-102 - Drilling – Hollow Stem Auger Subsurface Soil Sampling

TFM-103 - Surface Soil Sampling

TFM-104 - Surface Water Sampling

TFM-105 - Sediment Sampling from Ponds and Intermittent Streams

TFM-106 - Field Equipment Calibration

TFM-107 - Monitoring Well Installation, Development, and Abandonment

TFM-108 - Groundwater Sampling

TFM-109 - Personal Air Monitoring

TFM-110 - Decontamination of Sampling Equipment

TFM-111 - Investigation-Derived Waste

TFM-112 - Logbook Documentation

TFM-113 - Sample Numbering and Documentation

TFM-114 - Sample Packaging and Shipping

TFM-115 - Traffic Report / Chain of Custody Preparation

TFM-116 - Logging Procedures

TFM-117 - Surveying Using Global Positioning System Procedures

TFM-118 - Sediment Thickness and Depth Estimation Methods

TFM-119 - Slug Testing Procedures

TFM-120 - Low Flow Groundwater Sampling

TFM-121 - Surface Water Flow Estimation

TFM-122 - Excavation Slag Sampling

TFM-123 - Excavation Soil Sampling

TFM-124 - X-Ray Fluorescence Procedures

TFM-125 - Vegetation Sampling

TFM-126 - Direct Push Groundwater Sampling

TFM-127 - Temporary Piezometer Installation

TFM-128 - Particulate Matter Sampling

TFM-0000388

SOP TFM-101
Direct Push Soil Sampling

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Direct Push Soil Sampling

Document Number: SOP TFM-101

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for screening and sampling subsurface soils using direct push methods.

Scope: When using direct push methods, this procedure covers:

- Administrative controls,
- Subsurface soil sample screening and collection, and
- Probehole abandonment

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting direct push soil samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Work Plan (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Subsurface Soil Sampling

2.1 Subsurface soil sampling equipment may include:

- Sample containers as per Table 4-2 in the Field Sampling Plan (FSP)
- Sample labels
- Munsell color charts (soil)
- Soil boring logs
- Field logbook
- Traffic Report (TR)/Chain of Custody (COC) form
- Resealable bags for headspace analysis

TFM-0000390

- Indelible marking pen
- Decontamination equipment
- Hand lens
- Paper towels
- Utility knife
- Stainless steel knife, spoon, and composting bowl
- Direct push sampling tools equipped with liners
- Photographic equipment
- Real-time monitoring instruments (e.g., photoionization detector [PID], combustible gas indicator [CGI], or other instruments)
- Laths, stakes, and/or flags for marking probehole locations
- Plastic sheeting
- Gloves

2.2 Sample Collection

2.2.1 Insert a liner into the sampling tool and push the tool to the specified depth. Extract the sampling tool from the probehole.

2.2.2 Remove the liner with sample from the sampling device. Either cut the liner longitudinally from top to bottom, or extrude the sample onto clean plastic. If sufficient sample volume is present, shave the outside of the core to remove potentially smeared contamination.

2.2.3 Describe the lithology of the sample (in accordance with ASTM D 2488), including soil classification, soil sample location, field screening measurement, and other observations made. Record this information on the soil boring logs - BMcD Forms WCD-KC-2-1 and WCD-KC-2-2 in accordance with SOP TFM-116, "Logging Procedures".

2.2.4 Remove rocks and/or debris as appropriate.

2.2.5 For soil samples for screening:

2.2.5.1 Obtain photoionization detector (PID) readings along the length of the soil sample to identify possible zones of volatile organic contamination. Cut the soil core across the diameter and immediately insert the PID probe into the cut. Alternately, a tool

may be used to create a hole in the soil core slightly larger than the PID probe. Insert the probe into the hole immediately to collect a reading. Record readings on the soil boring log.

2.2.6 For soil samples for chemical analysis:

Following the collection of all field screening samples for each sampling area, the field screening results will be reviewed and evaluated. Based on the field screening evaluation, sample locations will be selected for the collection of samples for chemical analyses. BMcD will forward the results to and seek approval from the DEQ Project Manager for the proposed sample locations. Upon approval, field samplers will return to the selected field screening locations and proceed to collect direct push samples from the new borings as presented in Table 4-1 of the FSP.

2.2.6.1 Follow Procedures 2.2.1 through 2.2.4 above.

2.2.6.2 If samples are to be collected for volatile organic analysis, transfer them to the appropriate sample container and immediately place the sample on ice in a cooler. Fill the container to minimize void space. Do not homogenize these samples.

2.2.6.3 If sample homogenization is required, thoroughly homogenize the soil (collected from the target sampling depth) by mixing the sample in the bowl with a spoon, by hand (wearing clean disposable gloves), or by mechanical means (e.g., mixer or blender). Fill the sample containers with the homogenized soil, label, and place immediately in a cooler on ice.

2.2.6.4 Collect samples in order of decreasing volatility. Place the soil in appropriate sample containers, and place them on ice in a cooler. In general, the following order will be used: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and inorganic (metals and cyanide) samples.

2.2.7 Decontaminate sampling equipment between samples as specified in SOP TFM-110, “Decontamination of Sampling Equipment”. When preparing

composites, sampling equipment must be decontaminated between composite samples, but not between aliquots.

2.2.8 Enter the appropriate information on the TR/COC.

3.0 Probehole Abandonment

3.1 If the probehole is 20 feet or less in depth, in uncontaminated soil, and above the water table, backfill the borehole with cuttings.

3.2 Backfill all other probeholes with cement/bentonite grout to the ground surface.

3.3 Repair the area as practical to return the site to its original condition.

SOP TFM-102
Drilling – Hollow Stem Auger Subsurface Soil Sampling

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Drilling – Hollow Stem Auger Subsurface Soil Sampling

Document Number: SOP TFM-102

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for screening and sampling subsurface soil for geotechnical analysis.

Scope: To establish a method of drilling as a means of subsurface field sampling:
- Administrative controls,
- Subsurface soil screening and sampling using drilling methods, and
- Boring abandonment.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting subsurface samples for geotechnical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Work Plan (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Subsurface Soil Sampling Using Drilling Methods

2.1 Sampling equipment may include:

- Sample containers as per Table 4-2 of the RI/FS Field Sampling Plan (FSP)
- Sample labels
- Sample tags
- Munsell color chart (soil)
- Soil boring logs
- Field log book
- Plastic resealable bags for headspace analysis

- Indelible marking pen
- Hand lens
- Paper towels
- Vinyl, nitrile, or latex gloves
- Utility knife
- Mixing bowl(s) and spoon(s)
- Real-time monitoring instruments
- Laths, stakes, and or flags for marking boring locations
- Plastic sheeting

2.2 Sample Collection

2.2.1 If shelby tube samples are collected without extruding the sample, place caps over the ends of the tubes, tape them securely, label the shelby tube, and place the sample in the cooler for transfer. Skip steps 2.2.2 through 2.2.7.

2.2.2 Open the split spoon or split barrel sampler or extrude the soil core from a shelby tube sampler onto clean plastic.

2.2.3 Describe the lithology of the sample (in accordance with ASTM D 2488), including soil classification, soil sample location, field screening measurement, and other observations made. Record this information on the soil boring logs - BMcD Forms WCD-KC-2-1 and WCD-KC-2-2 in accordance with SOP TFM-116, "Logging Procedures".

2.2.4 Obtain photoionization detector (PID) readings along the length of the soil sample to identify possible zones of volatile organic contamination. Cut the soil sample across the diameter and immediately insert the PID probe into the cut. Alternately, a tool may be used to create a hole in the soil core slightly larger than the PID probe. Insert the probe into the hole immediately to collect a reading. Record readings on the soil boring log.

2.2.5 If the homogenization is needed for the geotechnical analysis to be performed, thoroughly homogenize the soil sample by mixing the sample in the bowl with a spoon, by hand (wearing clean disposable gloves), or by mechanical means (e.g., mixer or blender).

2.2.6 Fill the sample containers with the homogenized soil, label, and place in a cooler.

2.2.7 Decontaminate sampling equipment between samples as specified in the SOP TFM-110, “Decontamination of Sampling Equipment”.

2.2.8 Enter the appropriate information on the field sample analysis form.

3 Boring Abandonment

3.1 Plug each boring not converted into a monitoring well by filling the hole from total depth to within four feet below ground surface with a cement/bentonite grout composed of Portland Type I cement with 5 percent bentonite.

3.2 If the boring is greater than 20 feet deep, grout must be emplaced using a tremie pipe from the bottom of the boring upward, taking care to keep the end of the tremie pipe submerged within the grout at all time.

3.3 Fill the remainder of the boring with clean soil.

SOP TFM-103
Surface Soil Sampling

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Surface Soil Sampling

Document Number: SOP TFM-103

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for sampling surface soil for chemical and physical analysis.

Scope: This procedure covers:
- Administrative controls,
- Equipment used to sample surface soils, and
- The surface soil sample collection process.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting surface samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Work Plan (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Surface Soil Sampling

2.1 Surface soil sampling equipment may include the following:

- Approved sampling tool (shovel, auger, spoon, push sampler, etc.)
- Indelible marking pen
- Sample containers as per Table 4-2 of the Field Sampling Plan (FSP)
- Sample labels
- Resealable bags
- Field logbook
- Traffic Report (TR)/Chain of Custody (COC) form
- Munsell soil color chart

TFM-0000399

- Vinyl, nitrile, or latex gloves
- Paper towels
- Decontamination equipment
- Safety equipment
- Garbage bags

2.2 Sample Collection

2.2.1 Note the conditions surrounding the sampling events, such as dry and cracked soil, weather conditions, etc., in the field logbook.

2.2.2 Remove surface vegetation or non-soil material at each sample location with a trowel or shovel over the area to be sampled. Describe the lithology of the sample , including soil classification, soil sample location, field screening measurement, and other observations made in the field logbook.

2.2.3 Use an approved sampling tool to collect the soil from the specified depth.

2.2.4 Transfer the soil directly into the appropriate sample container making sure to avoid sticks, rocks, and other debris.

2.2.5 Upon filling the sample container, label and immediately place in a cooler. Samples collected for volatile organic compounds (VOC) analysis will be placed in a cooler on ice.

2.2.6 Decontaminate sampling equipment between samples as specified in SOP TFM-110, "Decontamination of Sampling Equipment".

2.2.7 Enter the appropriate information on the TR/COC.

2.2.8 Backfill the hole with leftover soil. If not enough soil remains after sampling, place clean soil in the hole or smooth the area surrounding the hole.

SOP TFM-104
Surface Water Sampling

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Surface Water Sampling

Document Number: SOP TFM-104

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for performing surface water sampling for chemical analyses.

Scope: When sampling surface water, this procedure covers:
- Administrative controls,
- Surface water sampling equipment, and
- Surface water sample collection for unfiltered samples.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting surface water samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Work Plan (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Surface Water Sampling Equipment

2.1 Surface water sampling equipment may include the following:

- Sample containers per Table 4-2 of the RI/FS Field Sampling Plan (FSP)
- Sample labels
- Conductivity meter
- Temperature meter
- pH meter
- Rubber boots
- Boat or canoe, if necessary

TFM-0000402

- Waders, if necessary
- Applicable decontamination equipment
- Applicable safety equipment
- Vinyl, nitrile, or latex gloves
- Field logbook
- Traffic Report (TR)/Chain of Custody (COC) form
- Indelible marking pen
- Garbage bags

3.0 Surface Water Sample Collection (Unfiltered Samples)

3.1 Conduct sampling from downstream locations to upstream locations to avoid effects of soil and water disturbance related to the sampling. Collect surface water samples prior to sediment samples if both are to be collected at the same location.

3.2 Record the characteristics of the surface water body (e.g., size, depth, flow direction) in the field logbook.

3.3 Measure the temperature, pH, and specific conductance of the surface water body at each surface water sample location. Record the results in the field logbook.

3.4 Whenever possible, fill sample containers directly without the use of intermediate containers, by submerging the sample container in the water with the cap in place, taking care to minimize surface disturbance.

3.5 With the open end of the bottle pointed upstream, remove the cap and allow the bottle to fill slowly and continuously using the cap to regulate the speed of water entering the bottle. Collect the sample from approximately two thirds of the depth of the water. If non-aqueous phase liquids are to be sampled, collect light non-aqueous phase liquids (LNAPL) from the surface and dense non-aqueous phase liquids (DNAPL) from the bottom, taking care to minimize the amount of water in the sample.

3.6 Fill containers in the following order: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs),

inorganic (metals and cyanide), sulfate/chloride, chemical oxygen demand, nitrate, and alkalinity.

3.7 Replace the cap after the bottle is filled and before removing the bottle from the water. Record a general description of the sample in the field logbook, including the depth to sample from the water surface.

3.8 Preserve the sample as necessary and place it immediately in a cooler on ice. Some samples may require additional preservative added to the container to ensure a pH of <2. Document the preservative added in the field logbook.

3.9 Enter the appropriate information on the TR/COC.

3.10 Decontaminate sampling equipment (including personal protective equipment [PPE]) between sample locations according to SOP TFM-110, "Decontamination of Sampling Equipment".

SOP TFM-105
Sediment Sampling from Ponds and Intermittent Streams

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Sediment Sampling from Ponds and Intermittent Streams

Document Number: SOP TFM-105

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for sampling sediment from below ponds and from intermittent streams for chemical analyses.

Scope: This procedure covers:
- Administrative control of sediment sampling,
- Equipment used to sample sediment, and
- The sediment sample collection process.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting sediment samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Work Plan (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Sediment Sampling

2.1 The sediment sampling equipment may include the following:

- Approved sampling tools
- Ponar dredge, or equivalent
- Indelible marking pen
- Mixing bowl(s) and spoon(s)
- Sample containers as per Table 4-2 of the Field Sampling Plan (FSP)
- Sample labels
- Sample ladle
- Boat or canoe, if necessary

- Polypropylene rope
- Munsell Color Chart
- Decontamination equipment
- Safety equipment
- Waders, if necessary
- Vinyl, nitrile, or latex gloves
- Field logbook
- Traffic Report (TR) / Chain of Custody (COC) form
- Garbage bags

2.2 Dry Sediment Sample Collection

2.2.1 Dry sediment samples will be collected in the same manner as surface soil samples (SOP TFM-103 "Surface Soil Sampling").

2.3 Underwater Sediment Sample Collection

2.3.1 Submerge a pre-cleaned ladle or stainless-steel dredge with minimal disturbance to the sediment surface.

2.3.2 Scrape sediment into the ladle using a slow scooping motion or drop the dredge into the sediment.

2.3.3 Retrieve the ladle or dredge, minimizing disturbance to the bottom sediments.

2.3.4 Transfer the sediment directly into the appropriate sample container making sure to avoid sticks, rocks, and other debris. Decant excess water if present.

2.3.5 Upon filling the sample container, label and immediately place in a cooler. Samples collected from volatile organic compound (VOC) analysis will be placed in a cooler on ice.

2.3.6 Collect samples in order of decreasing volatility. Place the sediment in appropriate sample containers, and place them on ice in a cooler. In general, sample containers will be filled in the following order: (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and inorganic (metals and cyanide).

2.3.7 Decontaminate sampling equipment between samples as specified in SOP TFM-110, “Decontamination of Sampling Equipment”.

2.3.8 Enter the appropriate information on the TR/COC and in the field logbook.

SOP TFM-106
Field Equipment Calibration

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Field Equipment Calibration

Document Number: SOP TFM-106

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To obtain a method for calibrating field equipment.

Scope: This procedure covers:
- Administrative controls,
- Calibration of field equipment, and
- Calibration documentation

Procedure:

1.0 Administrative Controls

1.1 The requirements for calibrating field equipment are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Calibration of Field Equipment

2.1 Calibrate all field sampling equipment, including pH/temperature/conductivity probes, photoionization detector (PID), and oxygen/explosive gas meter, using known standards supplied by the manufacturer at the beginning of each day. Calibration required only for equipment being utilized each day.

2.2 Check ORP for accuracy using standard redox solution (200-275 millivolts [mV] at 25 ^{o}C.

2.3 Check calibration of DO meter (in saturated air).

2.4 Check the calibration of the turbidity meter daily using standards supplied by the manufacturer; however, adjust the turbidity meter only when the measured value of the standard exceeds the actual standard value by more than 10 percent.

2.5 Perform a calibration check at the end of the day. Also perform calibration checks and recalibration any time the readings appear to be abnormal.

2.6 Check calibration meters more frequently in extreme cold or hot weather.

3.0 Calibration Documentation

3.1 Record all calibrations and calibration checks in the field logbook and appropriate field forms.

3.2 Maintain equipment technical manuals in the field for all field measurement instruments.

3.3 Consult equipment manuals for additional technical details.

SOP TFM-107
Monitoring Well Installation, Development, and Abandonment

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Monitoring Well Installation, Development, and Abandonment

Document Number: SOP TFM-107

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for the installation, development, and abandonment of monitoring wells.

Scope: This procedure covers:

- Administrative control,
- Installation equipment,
- Specifications,
- Monitoring well installation,
- Shallow water table completions,
- Surveying requirements, and
- Monitoring well abandonment

Procedure:

1.0 Administrative Control

1.1 The requirements for monitoring well installation, development, and abandonment are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Installation Equipment

2.1 Monitoring well installation equipment may include the following:

- Well completion diagram forms
- Well casing
- Well screen
- Centralizers (if needed)

- Bentonite powder and pellets
- Type I Portland cement
- Concrete
- Outer protective casing with lock
- Camera
- Boring logs
- Field logbook
- Indelible marking pen
- Locks keyed to other site monitoring wells
- Fiberglass tape
- Electronic water level indicator
- Decontamination equipment

3.0 Specifications – All Monitoring Wells

3.1 All monitoring wells will be installed in accordance with Oklahoma Water Resources Board (OWRB) rules OAC 785:35.

3.2 Boreholes in which monitoring wells are installed must provide at least three inches of annular space around the well screen and riser pipe.

3.3 A qualified hydrogeologist must specify monitoring well size and materials, screened interval, well screen specifications, filter pack material, seal and grout intervals, and completion details.

3.4 Polyvinyl chloride (PVC) wells will be constructed of flush-threaded casings. No cement, glue, or tape will be used in monitoring well installation.

3.5 Centralizers will be used in all monitoring wells greater than 20 feet in depth. When used, centralizers will be spaced at intervals specified by a qualified hydrogeologist.

3.6 Monitoring wells will include a sump at least six inches in length below the bottom of the well screen.

3.7 Filter pack material will extend at least two feet above the top of the well screen unless this distance would create a pathway for vertical migration of surface water or other contamination into the well.

3.8 A bentonite pellet seal at least two feet thick will be placed on top of the filter pack. If bentonite slurry is used in lieu of bentonite pellets, the slurry will be at least five feet thick.

3.9 A thick cement/bentonite grout consisting of at least five pounds of bentonite per sack of cement will be placed on top of the bentonite seal to within two feet of the ground surface. Cement grout placed to depths exceeding twenty feet must be pumped from the bottom of the annular space upward through a tremie pipe.

3.10 A waterproof cap must be placed on the top of the riser pipe.

4.0 Specifications –Extending Above Grade

4.1 A locking steel well protector at least two inches larger in dimension than the well materials will extend at least twelve inches into the ground and must extend at least two feet above grade.

4.2 A concrete pad at least four feet by four feet and at least four inches thick will be poured around the well protector. The outside of the pad should be at grade elevation unless specified otherwise. The concrete will extend down the annulus to the top of the cement/bentonite grout. The concrete will slope away from the well protector. A surveying pin or bolt will be placed in the concrete protector pad to serve as a "ground elevation" survey point.

4.3 A ⅛ to ¼ inch hole will be drilled through the well protector at the top of the concrete pad.

5.0 Specifications – Flush Mounting

5.1 A waterproof locking cap will be installed in the top of the riser pipe.

5.2 A steel water meter box will be placed as a protector around the top of the riser pipe.

5.3 Concrete will extend at least two inches around the outside of the meter box and at least one foot below the bottom of the meter box. Concrete should slope gently away from the meter box so the area does not drain into the meter box. A surveyor's pin or bolt will be placed in the concrete to serve as a "ground elevation" survey point.

6.0 Specifications - Shallow Water Table

6.1 Variance from the above specifications may be necessary if the water table is within five feet of the surface. In such cases, completion details must be specified by a qualified hydrogeologist. In no case will the distance from the top of the screen to the top of the filter pack may be less than 0.5 feet, or the bentonite pellet seal thickness be less than one foot.

7.0 Monitoring Well Installation

7.1 Inspect well material to ensure it meets specifications and is clean and free of foreign matter prior to use. Wash screens and casings with Alconox or equivalent and deionized water rinse. Store washed materials in clean plastic sheeting until installation. Washing is not necessary if well material is in the manufacturer's original packaging and the packaging is intact.

7.2 Record all well completion information on the field boring log.

7.3 Lower well screen and casing (with centralizers as specified) into the borehole, recording the depth of the top and bottom of the well screen to within 0.1 feet below grade. If the terrain is very uneven, drive a bolt or spike in the ground to serve as a reference until the well is completed.

7.4 With the casing string suspended near the bottom of the boring, pour the filter pack material slowly into the annulus to prevent bridging. Calculate the estimated amount of sand needed to help determine if bridging is occurring. Use a fiberglass tape with a weight attached to the end to determine the top of the filter pack. Measure the depth to the top of the filter pack to within 0.1 foot.

7.5 Unless the hydrogeologist specifies another method, swab the well screen with a surge block and remove water from the well. Allow the filter sand pack to settle, and measure the depth to the top of the filter pack again. Add additional filter material if necessary. If over one foot of filter pack was added, repeat the process.

7.6 Pour bentonite pellets slowly down the annulus to prevent bridging. Measure the depth to the top of the bentonite seal to within 0.1 feet with the weighted tape. Ensure that the bentonite seal is at least two feet thick. If the seal is above the

water table, pour several gallons of clean (potable) water down the annulus to hydrate the bentonite seal.

7.7 Mix a thick cement/bentonite grout consisting of at least five pounds of bentonite powder per sack of concrete, and fill the annulus to within two feet of the ground surface. Allow the grout to settle before installing the concrete pad.

7.8 Cut a notch or place a mark on the top of the well casing as a reference point for top of casing (TOC) elevation and depth to water measurements.

8.0 Shallow Water Table Completions

8.1 Variance from the above specifications may be necessary if the water table is within seven feet of the surface. In such cases, completion details must be specified by a qualified hydrogeologist. In no case will the distance from the top of the screen to the top of the filter pack may be less than 0.5 feet, or the bentonite pellet seal thickness be less than one foot.

9.0 Monitoring Well Development

9.1 Collect initial water sample and measure pH, conductivity, temperature, and turbidity. Measure water level and total depth of the well. Calculated the volume of standing water. Record all measurements and calculations on the Well Development Record.

9.2 Swab the well with a surge block for 10 to 15 minutes.

9.3 Remeasure and record the depth of the well.

9.4 Bail and/or pump the well to remove any sediment brought into the well. Record the amount of water removed on the Well Development Record.

9.5 Collect water sample and measure pH, conductivity, temperature, and turbidity. Record on the Well Development Record.

9.6 Repeat steps 9-2 through 9-5 until the water bailed or pumped meets the turbidity standard of less than 50 Nephlometric Turbidity Units and the pH, conductivity, and temperature stabilize to a point that they vary by no more than 10 percent. (At a minimum, three to five times the volume of any water introduced during

drilling and installation shall be removed. Monitoring wells that purge dry during development will be purged dry three times and considered developed).

9.7 If stabilization of the monitored groundwater parameters (pH, temperature, conductivity, and turbidity) cannot be achieved, the on-site geologist will discuss the matter with the BMcD Project Manager and end development after a reasonable effort has been made

10.0 Surveying Requirements

10.1 Monitoring wells will be surveyed to within 1.0 feet horizontally, and the top of casing and ground elevations will be surveyed to within 0.01 feet and 0.1 feet above mean sea level (MSL), respectively. More stringent survey requirements may be required by the project hydrogeologist or manager.

11.0 Monitoring Well Abandonment

11.1 Either pull or overdrill the casing. If the casing is pulled, drill out the borehole to make sure it is open to the original boring depth.

11.2 Backfill the borehole with cement/bentonite grout from total depth to less than four feet below grade through a tremie pipe.

11.3 Backfill the uppermost four feet with clean soil.

11.4 If a well is not located in contaminated material, and it is not practical to remove the well casing, fill the well casing with a cement/bentonite grout from total depth to grade level.

11.5 A licensed driller in accordance with OWRB regulations will notify the appropriate regulatory agency prior to monitoring well abandonment, and fill out and submit the appropriate well abandonment report upon completion of the abandonment. A copy of the well abandonment forms will be placed in the project file.

SOP TFM-108
Groundwater Sampling

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Groundwater Sampling

Document Number: SOP TFM-108

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a procedure for sampling groundwater.

Scope: This procedure covers:

- Administrative controls,
- Groundwater purging, and
- Groundwater and free product sample collection.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting groundwater samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Work Plan (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Groundwater Purging

2.1 Groundwater purging equipment may include:

- Field logbook
- Traffic Report (TR) / Chain of custody (COC) form
- Indelible marking pen
- Field parameter forms
- Sample according to Table 4-1 in the Field Sampling Plan (FSP)
- Sample labels
- Sample tags
- Custody Seals

- Calibration Forms
- Oil/water interface probe or clear bailers
- Disposable bailers
- Polypropylene rope
- Electronic water level indicator
- Specific conductivity meter with standard solutions
- pH meter and calibration buffer solutions
- Photoionization detector (PID)
- Hach meter and calibration solutions
- Turbidity meter
- Thermometer
- Five-gallon bucket
- Disposable gloves
- Calculator
- Decontamination equipment
- Container for collection of purge water (e.g., 55-gallon drum or plastic tank)
- Garbage bags

2.2 Monitoring Well Purging

2.2.1 Monitoring well purging and sampling will be conducted using a disposable bailer, unless otherwise specified.

2.2.2 Make sure all field meters (pH, conductivity, PID, etc.) are calibrated. Check that the water level indicator and/or the oil/water interface probe are in working order. Record the instrument and confirmation of calibration in the field logbook.

2.2.3 Unlock the casing protector and remove the well cap. Monitor the air near the cap and in the casing using a PID. Record these readings in the field logbook.

2.2.4 Measure the depth to water and total well depth to within 0.01 feet relative to the measuring point at the top of the well casing (TOC). Measure the thickness of any floating or settled immiscible liquid in the well using an

oil/water interface probe or clear bailer. Record the thickness and the depths to both fluids on the field parameter form and/or in the field logbook.

2.2.5 Remove a minimum of three casing volumes of water from the well. Table 1 shows the amount of fluid to be evacuated from various common sized monitoring wells.

2.2.6 While purging the well, collect a sample of the purge water in a plastic beaker after removing each well casing volume. Record observations about the purge water on the field parameter form (e.g., oily, turbid, cloudy, clear, colored).

2.2.7 Using this sample, measure temperature to the nearest 0.1°C, pH to one decimal place, conductivity to three significant figures, and turbidity to one decimal place. Record the results in the field log book. Pour the sample into the container into which purge water is being placed.

2.2.8 Decontaminate the probes with distilled water.

2.2.9 The well may be sampled when three casing volumes have been purged if three consecutive temperature and conductivity measurements are within 10% of each other, and pH is within 0.1 unit. Turbidity measurements will also be collected. Should turbidity measurements exhibit readings greater than 50 nephlometric turbidity units (NTUs), filtering of the samples will be considered. The well must be then be sampled within 24 hours of purging.

2.2.10 Record these values as well as the total volume of purged water on the field parameter form.

2.2.11 If a well does not yield sufficient water to remove three casing volumes, record the temperature, conductivity, pH, and turbidity of the last water to be removed from the well. The well must then be sampled within 24 hours of the time it was bailed dry.

2.2.12 Place purge water into a storage container and label as “Investigation Derived Waste” (IDW). Disposal of purge water shall be performed in accordance to TFM-111, “Investigation Derived Waste”.

3.0 Sample Collection

3.1 Sample collection equipment may include:

- Sample containers and preservative as per Table 4-2 in the FSP
- Field logbook
- Indelible marking pen
- Disposable bailers
- Polypropylene rope
- Five-gallon bucket
- Disposable gloves
- Decontamination equipment

3.2 Groundwater Sample Collection

3.2.1 Lower the bailer into the well, being careful not to "plunge" the bailer into the water.

3.2.2 Retrieve the bailer from the well and pour the sample directly from the bailer into the sample container. Enter the appropriate information on the TR/COC form.

3.2.3 If dedicated bailers are not used, decontaminate sampling equipment between monitoring wells.

3.2.4 In general, sample containers will be filled in the following order: volatile organic compounds (VOCs), methane, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), inorganic (metals and cyanide), and water quality parameters. Visually check the VOC sample bottle to ensure no bubbles are present.

3.2.5 If free product is on the water table in sufficient thickness to sample, and a sample of the product is to be collected, pour the sample into a beaker or other container and decant the product off the top into the sample container(s). Alternatively, use a bottom-emptying bailer to remove and discard water from the bailer down to the level of the product, and allow product to fill sample container(s).

3.2.6 If free product is on the water table and a groundwater sample is to be collected, use a bailer with a stopcock on the bottom or other bottom

emptying device and drop it below the bottom of the product. Remove the bailer from the monitoring well and allow free product to float to the surface. Wipe the exterior of the bailer off with paper towels. Open the stopcock and fill the sample bottles from the bottom of the bailer, being careful not to allow the top of the sample to drain into the bottle. Repeat this procedure until all the samples are collected. Alternatively, ensure that the regular bailer is lowered to below the free product layer before removing bailer from well. Retrieve bailer from well and ensure that no product exists on the surface of the water before pouring into sample containers.

TABLE 1. VOLUME OF WATER TO BE PURGED FROM VARIOUS SIZED MONITORING WELLS

Feet of Water	Number of Gallons To Evacuate One Casing Volume					Number of Gallons To Evacuate Two Casing Volumes					Number of Gallons To Evacuate Three Casing Volumes				
	2”	3”	4”	5”	6”	2”	3”	4”	5”	6”	2”	3”	4”	5”	6”
1.0	0.16	0.37	0.65	1.02	1.47	0.32	0.74	1.30	2.04	2.94	0.48	1.11	1.95	3.06	4.41
2.0	0.32	0.74	1.30	2.04	2.94	0.64	1.48	2.60	4.08	5.88	0.96	2.22	3.90	6.12	8.82
3.0	0.48	1.11	1.95	3.06	4.41	0.96	2.22	3.90	6.12	8.82	1.44	3.33	5.85	9.18	13.23
4.0	0.64	1.48	2.60	4.08	5.88	1.28	2.96	5.20	8.16	11.76	1.92	4.44	7.80	12.24	17.64
5.0	0.80	1.85	3.25	5.10	7.35	1.60	3.70	6.50	10.20	14.70	2.40	5.55	9.75	15.30	22.05
6.0	0.96	2.22	3.90	6.12	8.82	1.92	4.44	7.80	12.24	17.64	2.88	6.66	11.70	18.36	26.46
7.0	1.12	2.59	4.55	7.14	10.29	2.24	5.18	9.10	14.28	20.58	3.36	7.77	13.65	21.42	30.87
8.0	1.28	2.96	5.20	8.16	11.76	2.56	5.92	10.40	16.32	23.52	3.84	8.88	15.60	24.48	35.28
9.0	1.44	3.33	5.85	9.18	13.23	2.88	6.66	11.70	18.36	26.46	4.32	9.99	17.55	27.54	39.69
10.0	1.60	3.70	6.50	10.20	14.70	3.20	7.40	13.00	20.40	29.40	4.80	11.10	19.50	30.60	44.10
15.0	2.40	5.55	9.75	15.30	22.05	4.80	11.10	19.50	30.60	44.10	7.20	16.65	29.25	45.90	66.15
20.0	3.20	7.40	13.00	20.40	29.40	6.40	14.80	26.00	40.80	58.80	9.60	22.20	39.00	61.20	88.20
25.0	4.00	9.25	16.25	25.50	36.75	8.00	18.50	32.50	51.00	73.50	12.0	27.75	48.75	76.50	110.25
30.0	4.80	11.10	19.50	30.60	44.10	9.60	22.20	39.00	61.20	88.20	14.40	33.30	58.50	91.80	132.3

SOP TFM-109
Personal Air Monitoring

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Personal Air Monitoring

Document Number: SOP TFM-109

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To obtain personal air samples for chemical analysis.

Scope: When air sampling, this procedure covers:

- Administrative controls,
- Sampling equipment, and
- Sample collection.

References: Occupational Safety and Health Administration (OSHA) Method ID-121
National Institute for Occupational Safety and Health (NIOSH)

Procedure:

1.0 Administrative Controls

1.1 The requirements for personal air monitoring are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Air Sampling Equipment

2.1 Permanent marking pen and labels

2.2 Field logbook

2.3 Leather or cotton gloves

2.4 Mixed cellulose ester (MCE) filters, or equivalent

2.5 Cellulose backup pad, or equivalent

2.6 PVC sampling cassettes

2.7 Gel bands, or equivalent, for sealing cassettes

2.8 Sampling pump

2.9 Assorted flexible tubing

2.10 Tape

2.11 Traffic Report (TR) / Chain of custody (COC) form

3.0 Personal Air Filter Samples

3.1 Place a MCE filter, or equivalent, and a cellulose backup pad in each two or three piece cassette. Seal each cassette with a gel band.

3.2 Calibrate each personal sampling pump with a prepared cassette in-line to approximately 2 L/min.

3.3 Attach prepared cassettes to calibrated sampling pumps (the backup pad should face the pump) and place in appropriate position on the employee.

3.4 Collect the samples at approximately 2 L/min for the recommended sampling times (unless otherwise noted):

Time Weighted Average Samples	240 to 480 min
Short-Term Exposure Limit Samples	15 min
Ceiling Samples	5 min

3.5 Place plastic end caps on each cassette after sampling. Attach tape to seal each cassette in such a way to secure the end caps.

3.6 Enter the appropriate information on the TR/COC form in accordance with SOP TFM-115, "Traffic Report/Chain of Custody Preparation". Also document in field logbook.

SOP TFM-110
Decontamination of Sampling Equipment

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Decontamination of Sampling Equipment

Document Number: SOP TFM-110

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for decontamination of equipment used to collect samples for chemical analysis.

Scope: This procedure covers:
- Administrative controls
- Equipment used to decontaminate sampling tools
- Decontamination process

Procedure:

1.0 Administrative Control

1.1 The requirements for decontamination of sampling equipment are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Decontamination

2.1 Decontamination equipment may include the following:

- Deionized water
- Control rinse water (distilled)
- Wash bottles
- Buckets (non-metallic)
- Scrub brushes
- Non-phosphate laboratory grade detergent
- Garbage bags

2.2 Decontamination of equipment that contacts samples may include the following:

2.2.1 Fill a bucket with approximately six inches of potable water and mix with non-phosphate detergent. The concentration should be approximately one tablespoon of detergent to one gallon of water.

2.2.2 Scrub sampling equipment with a brush and the detergent solution.

2.2.3 Use a separate bucket to collect all rinses.

2.2.4 Rinse sampling tool thoroughly with the control rinse water.

2.2.5 Double rinse with deionized water.

2.2.6 Place equipment on a clean location and allow it to air dry prior to next use.

2.2.7 Wrap equipment with aluminum foil or plastic wrap to prevent contamination during transport, if necessary.

2.3 Decontamination for equipment that does not contact samples may include the following:

2.3.1 Clean all equipment with a portable power washer or steam-cleaning machine. Hand wash the equipment with a scrub brush and non-phosphate detergent solution as an alternative method. The exposed exterior and interior surfaces of augers, drill rods, and backhoe buckets should be cleaned until all visible soil material is removed.

2.3.2 Rinse the equipment with potable water.

2.3.3 Allow equipment to air dry prior to next use.

2.4 Document decontamination of sampling equipment in the field logbook.

SOP TFM-111
Investigation-Derived Waste

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Investigation-Derived Waste

Document Number: SOP TFM-111

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for the handling of investigation-derived waste (IDW) to ensure proper disposal.

Scope: When sampling surface water, this procedure covers:

- Administrative controls
- Soil IDW handling
- Liquid IDW handling

Procedure:

1.0 Administrative Control

1.1 The requirements for the waste management procedure for IDW are based on the requirements specified in Title 40 of the CFR, Part 262 (40 CFR 262) Standards Applicable to Generators of Hazardous Waste; applicable portion of the Oklahoma Hazardous Waste Management Rules (OAC 252:205), and good engineering judgement. Any deviations from or additions to the procedures listed within this SOP will be noted in the field logbook.

2.0 Solid IDW Handling

2.1 Solid IDW, including soil cuttings and excess soil sample material generated during drilling and direct-push activities, will be containerized and disposal options evaluated based upon laboratory and site historical data.

2.2 Soil removed during trenching activities will not be containerized as IDW. All soil generated during trenching activities will be backfilled into excavated trench, restoring the ground surface to original conditions, as much as possible.

2.3 Soil IDW generated from sampling activities conducted in the vicinity of the former residential garage will be containerized in separate drums, as needed.

2.4 Solid personal protective equipment (PPE) IDW consisting of used PPE, disposable equipment (bailers, rope, acetate liners, etc.), and other trash that may have come into contact with contamination will be handled as follows:

2.4.1 Remove gross contamination from PPE IDW.

2.4.2 All gross contamination removed from the PPE IDW will be placed with the appropriate IDW.

2.4.3 The PPE IDW will be double bagged and disposed as solid waste.

2.5 Containerization, Labeling, and Storage

2.5.1 The soil IDW, consisting of soil cuttings and excess soil sample material generated during drilling and direct-push sampling, will be segregated into 55-gallon drums.

2.5.1.1 Label the top or sides of drums to indicate the source and nature of the waste material as follows:

- Container number(s) (sample group area(s) plus a sequential number)
- Facility name
- Monitoring well, direct push, or probehole number
- Date of generation
- Container contents
- Estimated quantity
- DEQ point of contact.

For example:

Container Number:	IDW-01
Facility Name:	Tulsa Fuels and Manufacturing
Well or Probehole Number:	SP-01 to SP-20
Dates(s) of generation (MM-DD-YY):	06-05-05
Container Contents:	Drill Cuttings
Estimated Quantity:	50 gallons
DEQ Contact Name:	George Thomas
Contact Phone Number:	(405) 702-5126

2.5.1.2 Mark drums with 2-inch letters and numbers using a waterproof paint pen.

2.5.1.3 Store drums on pallets.

2.5.2 Maintain IDW Inventory Worksheet (Appendix A) to facilitate the identification and tracking of solid IDW for appropriate disposal. This inventory will include the above information and the location of each drum.

2.5.3 Note the amount of solid IDW generated in the field logbook daily.

2.5.4 Cover and secure containers except when adding to or disposing of the contents.

2.5.5 Temporarily store containers of the solid IDW at the site until characterized.

2.5.6 Do not allow containers to remain in storage for longer than necessary to determine the regulatory status of the waste through laboratory testing and to evaluate disposal options.

2.5.7 Re-label containers of solid IDW determined to be hazardous waste or non-hazardous waste in a manner consistent with applicable state and federal requirements including, but not limited to, the RCRA and the DOT (40 CFR 171-179).

2.6 Solid IDW Evaluation

2.6.1 Collect a composite sample from soil IDW generated during the field activities. Five drums may be composited per sample.

2.6.2 Composited samples may be submitted for analysis of the following parameters depending upon the requirements of the disposal option:

- pH by SW-846 Method 9040
- Paint Filter Test by Method 9095A
- Ignitability by SW-846 Method 1010
- Corrosivity by SW-846 Method 1110
- TCL SVOCs by SW-846 Method 8270C
- TCL VOCs by SW-846 Method 8260B
- TCL PCBs by SW-846 Method 8082

- TAL metals by SW-846 Methods 6000 and 7000 Series
- Cyanide by SW-846 Method 9000 Series
- TEL by Core SOP HP-ATM-P109 or HML Method 939-M

For soil IDW, toxicity characteristic leaching procedure (TCLP) extraction by SW-846 Method 1311 may be required for one or more of the above analyses as well.

2.6.3 Review analytical results and determine if the soil IDW is non-hazardous waste, special (non-hazardous contaminated), or hazardous waste.

2.6.4 Determine the appropriate management option and report the information to DEQ.

2.7 Solid IDW Disposal

Depending on the classification of the soil IDW, the following options are available for disposal:

2.7.1 Spread non-hazardous solid IDW (waste soil) on the ground surface near the point of origin when possible. When the soil cannot be spread near the point of origin due to reasons including pavement, aesthetics, or having been composited, spread the soil on the ground in an area approved by DEQ and USEPA.

2.7.2 Dispose of non-hazardous solid IDW (used PPE, disposable equipment, and trash) in an appropriate solid waste container on the site.

2.7.3 Manage and dispose of soil IDW classified as special waste according to 40 CFR 261 and the Oklahoma Hazardous Waste Management Rules (OAC 252:205).

2.7.4 No solid IDW is anticipated to be deemed as hazardous based on available information.

3.0 Liquid IDW Handling

3.1 Containerization, Labeling, and Storage

3.1.1 Temporarily store decontamination, development, and purge water from activities on the site in 55-gallon, DOT-approved drums.

3.1.2 Label the top or sides of drums to indicate the source and nature of the waste material as follows:

- Container number(s) (sample group area(s) plus a sequential number)
- Facility name
- Monitoring well, direct push, or probehole number
- Date of generation
- Container contents
- Estimated quantity
- DEQ point of contact.

For example:

Container Number:	IDW-01
Facility Name:	Tulsa Fuels and Manufacturing
Well or Probehole Number:	MW-1 through MW-5
Dates(s) of generation (MM-DD-YY):	06-05-05
Container Contents:	Purge Water
Estimated Quantity:	50 gallons
DEQ Contact Name:	George Thomas
DEQ Contact Phone Number:	(405) 702-5126

3.1.3 Mark drums with 2-inch letters and numbers using a waterproof paint pen.

3.1.4 Maintain IDW Inventory Worksheet (Appendix A) to facilitate the identification and tracking of liquid IDW for appropriate disposal. This inventory will include the above information and the location of each drum.

3.1.5 Note the amount of liquid IDW generated in the field logbook daily.

3.1.6 Cover and secure containers except when adding to or disposing of the contents.

3.1.7 Temporarily store containers of the liquid IDW at the site until characterized.

3.1.8 Containerize liquid IDW, including decontamination, development, and purge waters, resulting from the installation of a new monitoring well, on a per well basis.

3.1.9 Containerize decontamination and/or purge waters resulting from direct-push activities or other field activities based on the area being investigated.

3.1.10 Do not allow containers to remain in storage for longer than necessary to determine the regulatory status of the waste through laboratory testing and to evaluate disposal options.

3.1.11 Re-label containers of liquid IDW determined to be hazardous waste or non-hazardous waste in a manner consistent with applicable state and federal requirements including, but not limited to, the RCRA and the DOT (40 CFR 171-179).

3.2 Liquid IDW Evaluation

3.2.1 Collect one sample from each container of IDW when the liquid IDW is to be characterized for VOCs.

3.2.2 Composite samples for the remaining parameters on a per monitoring well basis or on a per area basis for other field activities.

3.2.3 Composite samples will be collected as one aliquot from five containers of liquid IDW.

3.2.4 Analyze the IDW samples for the same constituents analyzed for the samples from that specific site investigation.

3.2.5 Store and analyze IDW anticipated to contain elevated concentrations of contaminant in separate containers.

3.2.6 Composited samples may be submitted for analysis for the following parameters depending upon the requirements of the disposal option:

- pH by SW-846 Method 9040
- Total suspended solids by USEPA Method 160.2
- Ignitability by SW-846 Method 1010
- Corrosivity by SW-846 Method 1110
- TCL SVOCs by SW-846 Method 8270C

- TCL VOCs by SW-846 Method 8260B
- TCL PCBs by SW-846 Method 8082
- TAL metals by SW-846 Methods 6000 and 7000 Series
- Cyanide by SW-846 Method 9000 Series
- TEL by Core SOP HP-ATM-P109 or HML Method 939-M

3.2.7 Compare analytical results with the maximum contaminant level (MCL) and toxicity characteristic leaching procedure (TCLP) values. After review of the analytical results, BMcD will determine the appropriate management option and report the information to DEQ as part of the associated sampling report. Depending on the characterization/ classification status, DEQ may consult with the USEPA during the determination process to secure any necessary approvals.

3.2.8 Determine if the liquid IDW is non-hazardous waste, special waste, or hazardous waste.

3.2.9 Determine the appropriate management option and report the information to DEQ.

3.3 Liquid IDW Disposal

Depending on the classification of the soil IDW, the following options are available for disposal:

3.3.1 Discharge non-hazardous liquid IDW (below MCLs and TCLP thresholds) directly to the ground with DEQ and USEPA approval.

3.3.2 Discharge non-hazardous liquid IDW (special waste above MCLs, but below TCLP thresholds) to the City of Collinsville wastewater treatment system after receiving authorization.

3.3.3 Determine the most appropriate treatment technology to treat the liquid IDW prior to disposal via the wastewater treatment system if necessary.

3.3.4 No liquid IDW is anticipated to be deemed as hazardous based on available information.

SOP TFM-112
Logbook Documentation

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Logbook Documentation

Document Number: SOP TFM-112

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for documenting field activities in the field logbook.

Scope: This procedure covers:
- Administrative controls
- Field logbook documentation requirements

Procedure:

1.0 Administrative Control

1.1 The specific activities requiring field documentation are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Work Plan (BMcD, 2005b) and the RI/FS Field Sampling Plan (FSP). Any deviations from or additions from these procedures will be noted in the field logbook.

2.0 Field Logbook Documentation

2.1 Logbook Requirements

2.1.1 Logbooks shall be bound with consecutively numbered, water-resistent pages.

2.1.2 Each page shall be signed and dated by field personnel.

2.1.3 All logbook entries shall be made in indelible ink.

2.1.4 The time and date of each entry will be noted in the logbook.

2.1.5 Logbooks will be kept in the field personnel's possession or a secure place during the investigation.

2.1.6 Logbooks will become part of the project file following the investigation.

TFM-0000441

2.2 Logbooks typically contain the following information:

- Date
- Weather conditions
- Names of field personnel
- Calibration record of field equipment
- Name and location of area of investigation
- Location of sample (may include a sketch)
- Type of sample (soil, groundwater, sediment, etc.)
- Time (military) of sample collection
- Sample identification number
- Interval and depth of sample
- Field screening results
- Sample collection procedure/equipment
- Sample description (color, odor, etc.)
- Field observations of sampling event
- Parameters requested for analyses
- Field measurements
- Duplicate sample information
- Equipment decontamination procedures
- Sample shipment information

- Number assigned to chain of custody (COC)
- Monitoring well number
- Water level and total depth measurements with technique
- Well purge equipment and technique
- Purge volume and time
- Field measurements for each well volume of groundwater removed
- Sample withdrawal procedure/equipment
- Management of IDW
- Air monitoring results
- Level of personal protective equipment

SOP TFM-113
Sample Numbering and Documentation

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Sample Numbering and Documentation

Document Number: SOP TFM-113

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for sample numbering and documentation.

Scope: This procedure covers:
- Administrative control,
- Sample numbering, and
- Sample documentation

Procedure:

1.0 Administrative Control

1.1 The requirements for the sample numbering and documentation are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Sample Numbering (Samples Submitted to SEL or Private Laboratory)

2.1 Identify samples with a unique sample number which will be used on all sample labels, Traffic Report/Chain of Custody (TR/COC) forms, field logbooks, and all other applicable documentation.

2.2 Identify samples as follows:

2.2.1 Sample Point

2.2.1.1 Consists of a unique two to three character designation that identifies the sampling class (i.e., types of soil sample collection, types of surface soil collected, background, air quality, etc).

2.2.1.2 Sample group character designations are provided on Table SOP TFM-113-1.

2.2.1.3 Sequential sample numbers for each sample point may range from 00 to 999. Samples are sequentially numbered within each sample point class.

2.2.1.4 For example, the sample point designation OSL-01 would indicate the first sampling point established for the Off-Site Surface Soil Collection at Location 01. Likewise, the sample point designation PD1-03 would indicate the third sampling point established in Pond 1.

2.2.2 Sample Designator

2.2.2.1 Consists of a four to eight digit character designation composed of a two-digit matrix abbreviation and a sequential two digit number to indicate the depth interval for soil matrices or the sampling round in which the sample was collected for all other matrices.

2.2.2.2 The abbreviations used for the matrices are provided below:

Abbreviation	Matrix
SS	Soil Sample
SD	Sediment
SW	Surface Water
GW	Groundwater
AR	Air
BR	Berries
LV	Leaves
RT	Roots

2.2.2.3 The soil depth interval may range for 01 to 99, with 01 representing a surface soil interval (0-6”) and subsequent numbers 02 to 99 representing increasing depth. For example, a soil boring with samples collected at 0-6”, 6”-2’, and 2-4’ would have designators of SS01 for the surface soil sample, SS02 for the 6”-2’ sample, and SS03 for the 2-4’ sample.

2.2.2.4 The use of the designators SS01, SS02, and SS03 should be limited to only those soil samples collected to a depths of 0-6”, 6”-2’, and 2-4’, respectively. For samples collected below 4’, designators will be applied sequentially.

2.2.2.5 The sample round may range from 01 to 99.

2.2.2.6 For example, the sample designation “TR-04/SS-03" would represent a soil sample from trench sampling point 04 and sampled in the third depth interval (i.e., two other samples closer to the ground surface were collected). Similarly, the sample designation “BG-02/SW01” would represent a background surface water sample from location 02 collected during the first sampling round.

2.2.2.7 The “GW” designation is often not used for routine groundwater sampling activities.

2.2.2.8 Previously existing wells will maintain their existing well names for the sample group.

2.2.3 Quality Assurance / Quality Control (QA/QC) Designators

2.2.3.1 Sample designators for “blind” field duplicates for the contract laboratory will consist of a unique sample number that is consistent with the sampling scheme. It should not be apparent to the contract laboratory receiving these samples that they are QC duplicate samples or that these samples are in any way different from the rest of the sample population. Identity of the duplicate pair should be noted in the field logbook.

2.2.3.2 Other QA/QC samples, including rinsates, trip blanks, matrix spike / matrix spike duplicate (MS/MSD) samples and samples submitted to the laboratory for laboratory QC, will be identified in the exact same manner as the associated field sample. However, a QA/QC suffix will be added. The following suffixes will be used:

Abbreviation	QA/QC Sample Type
X	MS/MSD
QC	Laboratory QC
CF	Confirmation Sample

In addition, a note will be made in the "remarks" section of the COC, indicating the type of QA/QC sample submitted.

2.2.3.3 Trip blanks will be placed in each cooler containing volatile organic compound (VOC) samples. Trip blanks will be signified by the document control number from the COC for that cooler followed by a trip blank designator (TB-01).

2.2.3.4 One temperature blank will be placed in each cooler, prior to shipment overnight to the laboratory. The temperature blank will be labeled with "TEMP BLANK".

2.2.3.5 For example, the sample designation "PZ-04/GW-01X would represent a groundwater sample from location 04 (i.e., Piezometer 04) collected during the first sampling round and designated for use as the MS/MSD.

3.0 Sample Documentation (Samples Submitted to SEL or Private Laboratory)

3.1 Sampling personnel must adhere to the following protocol when shipping samples to the SEL or a private laboratory:

- Complete the COC Record, making sure to note in the remarks column any QC samples, such as MS/MSDs or confirmation samples;
- Complete and attach sample labels;
- Complete and attach custody seals to the cooler;
- Complete field logbook records, as necessary.

3.2 Traffic Report/Chain of Custody Records

3.2.1 Prepare a COC in accordance with SOP TFM-115, "Traffic Report/Chain of Custody Preparation".

3.3 Sample Labels

3.3.1 Identify each sample removed from the Tulsa Fuels Manufacturing and transferred to a laboratory for analysis with a sample label containing specific information regarding the sample.

3.3.2 Securely fasten each completed sample identification label to the sample container.

3.3.3 Complete sample labels to include the following information:

- Date
- Time (military) of sample collection
- Type of analyses requested
- Sample number
- Sample collection depth
- Location of sample collection
- Indication if it is a MS, MSD or Confirmation Sample
- Type of preservative
- Signature of sampler

3.4 Custody Seals

3.4.1 Place custody seals on coolers from the time the coolers are packed until they are opened in the laboratory or custody is transferred on the COC.

3.4.2 Attach custody seals so that it is necessary to break the seals to open the cooler.

3.4.3 Cover the custody seals with clear tape.

3.4.4 Use custody seals to seal opposite sides of coolers or appropriate shipping containers for all samples shipped to a laboratory.

3.4.5 As long as the TR/COCs are sealed inside the sample container and custody seals remain intact, commercial carriers and laboratory couriers are not required to sign the custody form.

4.0 CLP Sample Numbering (Samples Submitted to a CLP Lab)

4.1 Identify samples with a unique sample number which will be used on all sample labels, Traffic Report/Chain of Custody (TR/COC) forms, field logbooks, and all other applicable documentation.

4.2 Identify samples as follows:

4.2.1 Identify the sample by the CLP Sample Number.

4.2.1.1 The CLP Sample Number will be provided by Regional Sample Control Center (RSCC) Coordinator prior to sample collection.

4.2.1.2 A CLP Sample is defined as one sample matrix, at one concentration level, from one station location for each individual or set of analytical fractions – provided the fractions are all requested for the same CLP analytical service (i.e., organic or inorganic).

4.2.1.3 For USEPA Region 6 and this project, the letter code for organic analysis is "F" and for inorganic analysis is "MF".

4.2.2 Sample Point

4.2.2.1 Consists of a unique two to three character designation that identifies the sampling class (i.e., types of soil sample collection, types of surface soil collected, background, air quality, etc).

4.2.2.2 Sample group character designations are provided on Table SOP TFM-113-1.

4.2.2.3 Sequential sample numbers for each sample point may range from 00 to 999. Samples are sequentially numbered within each sample point class.

4.2.2.4 For example, the sample point designation OSL-01 would indicate the first sampling point established for the Off-Site Surface Soil Collection at Location 01. Likewise, the sample point designation PD1-03 would indicate the third sampling point established in Pond 1.

4.2.3 Sample Designator

4.2.3.1 Consists of a four to eight digit character designation composed of a two-digit matrix abbreviation and a sequential two digit number to indicate the depth interval for soil matrices or the sampling round in which the sample was collected for all other matrices.

4.2.3.2 The abbreviations used for the matrices are provided below:

Abbreviation	Matrix
SS	Soil Sample
SD	Sediment
SW	Surface Water
GW	Groundwater
AR	Air
BR	Berries
LV	Leaves
RT	Roots

4.2.3.3 The soil depth interval may range for 01 to 99, with 01 representing a surface soil interval (0-6”) and subsequent numbers 02 to 99 representing increasing depth. For example, a soil boring with samples collected at 0-6”, 6”-2’, and 2-4’ would have designators of SS01 for the surface soil sample, SS02 for the 6”-2’ sample, and SS03 for the 2-4’ sample.

4.2.3.4 The use of the designators SS01, SS02, and SS03 should be limited to only those soil samples collected to a depths of 0-6”, 6”-2’, and 2-4’, respectively. For samples collected below 4’, designators will be applied sequentially.

4.2.3.5 The sample round may range from 01 to 99.

4.2.3.6 For example, the sample designation “TR-04/SS-03" would represent a soil sample from trench sampling point 04 and sampled in the third depth interval (i.e., two other samples closer to the ground surface were collected). Similarly, the sample designation “BG-02/SW01” would represent a surface water

sample from location 02 collected during the first sampling round.

4.2.3.7 The "GW" designation is often not used for routine groundwater sampling activities.

4.2.3.8 Previously existing wells will maintain their existing well names for the sample group.

4.2.4 Quality Assurance / Quality Control (QA/QC) Designators

4.2.4.1 Sample designators for "blind" field duplicates for the contract laboratory will consist of a unique sample number that is consistent with the sampling scheme. It should not be apparent to the contract laboratory receiving these samples that they are QC duplicate samples or that these samples are in any way different from the rest of the sample population. Identity of the duplicate pair should be noted in the field logbook.

4.2.4.2 Other QA/QC samples, including rinsates, trip blanks, matrix spike / matrix spike duplicate (MS/MSD) samples and samples submitted to the laboratory for laboratory QC, will be identified in the exact same manner as the associated field sample. However, a QA/QC suffix will be added. The following suffixes will be used:

Abbreviation	QA/QC Sample Type
X	MS/MSD
QC	Laboratory QC
CF	Confirmation Sample

4.2.4.3 Trip blanks will be placed in each cooler containing volatile organic compound (VOC) samples. Trip blanks will be signified by the document control number from the COC for that cooler followed by a trip blank designator (TB-01).

4.2.4.4 One temperature blank will be placed in each cooler, prior to shipment overnight to the laboratory. The temperature blank will be labeled with "TEMP BLANK".

4.2.4.5 For example, the sample designation "PZ-04/GW-01X would represent a groundwater sample from location 04 (i.e., Piezometer 04) collected during the first sampling round and designated for use as the MS/MSD.

5.0 CLP Sample Documentation (Samples Submitted to a CLP Lab)

5.1 Sampling personnel must adhere to the following protocol when shipping samples to a CLP lab:

- Record the CLP sample number on each sample bottle that is shipped to a CLP lab;
- Record the SMO-assigned case number on each sample bottle and all associated sample documentation that is shipped to a CLP lab;
- Complete the Traffic Report (TR)/COC Record using the Field Operations Records Management System Lite (FORMS II Lite) software, making sure to indicate on the form if a Method Flexibility Clause (CLP-modified analysis)was used;
- Complete and attach sample labels;
- Complete and attach sample tags;
- Complete and attach custody seals;
- Complete field operations records, as necessary.

5.2 CLP Sample Number

5.2.1 Use CLP sample numbers to track samples throughout the sampling and analytical processes and record on sampling documentation (e.g., TR/COC Records, sample labels, and sample tags).

5.2.2 Obtain the CLP sample numbers from the RSCC Coordinator and utilize them as appropriate during the sampling event.

5.3 SMO-Assigned Case Number

5.3.1 Use SMO-assigned case numbers to track groups of samples throughout

the sampling and analytical processes and record on sampling documentation (e.g., TR/COC Records, sample labels, and sample tags).

5.3.2 Obtain the SMO-Assigned case number for their sampling event from the RSCC Coordinator.

5.4 Traffic Report/Chain of Custody Records

5.4.1 Prepare a TR/COC for each cooler shipped or transported to the laboratory in accordance with SOP TFM-115, "Traffic Report/Chain of Custody Preparation".

5.5 Sample Labels

5.5.1 Identify each sample removed from the Tulsa Fuels Manufacturing and transferred to a laboratory for analysis with a sample label containing specific information regarding the sample.

5.5.2 Securely fasten each completed sample identification label to the sample container.

5.5.3 Complete sample labels to include the following information:

- CLP sample number
- SMO-assigned case number
- Date
- Time (military) of sample collection
- Type of analyses requested
- Sample number
- Sample collection depth
- Location of sample collection
- Type of preservative
- Signature of sampler

5.6 Sample Tags

5.6.1 Identify each sample removed from the Tulsa Fuels Manufacturing and transferred to a laboratory for analysis with a sample tag containing

specific information regarding the sample.

5.6.2 Securely fasten each completed sample tag to the sample container.

5.6.3 Complete sample tags to include the following information:

- CLP sample number
- SMO-assigned case number
- Sample bottle number (i.e., "1 of 3")

5.7 Custody Seals

5.7.1 Place a custody seals on each sample bottle, container, or bag (as appropriate), when shipping samples to a CLP lab.

5.7.2 Place custody seals on coolers from the time the coolers are packed until they are opened in the laboratory or custody is transferred on the TR/COC.

5.7.3 Attach custody seals so that it is necessary to break the seals to open the cooler.

5.7.4 Cover the custody seals with clear tape.

5.7.5 Use custody seals to seal opposite sides of coolers or appropriate shipping containers for all samples shipped to a laboratory.

5.7.6 As long as the TR/COCs are sealed inside the sample container and custody seals remain intact, commercial carriers and laboratory couriers are not required to sign the custody form.

Table SOP-TFM-113-1
Sample Point Designations

Remedial Investigation/Feasibility Study Field Sampling Plan
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Sample Point Designations	Identification
Soil Sampling Points (On-Site)	
SP	Sample Point for a Soil Boring
TR	Trench Location
PZ	Piezometer Location
Soil Sampling Points (Off-Site)	
OSL	Off-Site Surface Soil Location from Grid or Distance
TRB	Tribal Member Surface Soil Location
TSL	Targeted Off-Site Surface Soil Location
Surface Water and Sediment Sampling Points	
CST	Cistern
MSR	Mid-Site Ravine
PD1	Pond 1
PD2	Pond 2
PD3	Pond 3
PD4	Pond 4
PD5	Pond 5
SMP	Strip Mine Pit
OFF	Off-Site Sampling Location
Groundwater Sampling Points	
MW	Monitoring Well Location
PZ	Piezometer Location
Background Sampling Points	
BG	Background Sampling Location
Air Quality Sampling Points	
AQ	Air Quality Sampling Location
Ecological Sampling Points	
EC	Ecological Sampling Location

SOP TFM-114
Sample Packaging and Shipping

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Sample Packaging and Shipping

Document Number: SOP TFM-114

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for sample packaging and shipping.

Scope: This procedure covers:
- Administrative control,
- Sample packaging and shipping general requirements, and
- Sample packaging and shipping procedure

References: United States Environmental Protection Agency (USEPA) specifications and United States Department of Transportation (DOT) regulations (49 Code of Federal Regulations [CFR] Parts 172 and 173)

Procedure:

1.0 Administrative Control

1.1 The requirements for the sample packaging and shipping are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Sample Packaging and Shipping General Requirements

2.1 Pack and ship samples according to requirements for low hazard-level samples.

2.2 Package and ship samples within 24 hours of collection, unless holding the samples is necessitated due to the sample receipt requirements discussed in the RI/FS FSP.

2.3 If the Department of Environmental Quality (DEQ) Project Manager hand deliver coolers to the State Environmental Laboratory (SEL), overnight shipment would

not be necessary. In these instances, the sample packaging and shipping procedures may be modified; often less-stringent shipment procedures are necessary in these situations.

3.0 Sample Packaging and Shipping Procedure

The following procedure will be used to pack samples being shipped by overnight carrier:

3.1 Arrange sample containers in groups by sample number. Group aqueous volatile organic compound (VOC) samples so they can be placed into common shipping containers.

3.2 At the time of sampling, wipe the outside of each sample container with a paper towel and place a label on each container. Each label will be taped and each glass container will be wrapped with bubble wrap. Place each sample bottle in an individual, sealable plastic bag and place a custody seal securely on each plastic bag. All VOC vials for the same sample shall be placed in the same plastic bag. Trip blanks will be packed in the same manner as the VOC samples.

3.3 Remove as much air as possible from the plastic bag prior to sealing.

3.4 Tape drains shut on shipping cooler.

3.5 Place an absorbent pad in the bottom of the cooler, followed by a layer of bubble wrap.

3.6 Insert a plastic trash bag into the cooler.

3.7 Conduct an inventory of the contents of the shipping container against the corresponding Traffic Report/Chain of Custody (TR/COC) to ensure that the proper number of sample containers have been collected for each analysis of the samples, that the required QC samples and temperature blanks are included, and that the correct sample numbers and fractions have been assigned to each sample.

3.8 Place the sample containers inside the trash bag inside the cooler in an upright position so they do not touch. Group all aqueous VOC samples into one common cooler and all soil VOC samples into another common cooler. Place one trip blank set in each cooler containing aqueous VOC samples. Place one temperature blank in each cooler.

3.9 Add ice (double packaged in sealable plastic bags).

3.10 Ensure that the site name or other site-identifying information does not appear on any documentation being sent to the laboratory.

3.11 Sign the TR/COC and indicate the time and date the cooler is sealed. Record the time in the field logbook.

3.12 Separate the copies of the TR/COCs. Seal the top form (original) in a large, sealable, plastic bag and tape them to the inside of the cooler lid along with the cooler return documentation.

3.13 Complete shipping paperwork (if applicable). Include air bill number and name of carrier on the TR/COC, and record the information in the field logbook.

3.14 Attach a completed shipping label to the top of the cooler. Use two strips of clear tape to securely fasten the shipping label to the cooler so that the label will not peel off even if the coolers are stacked during shipment. The clear tape should extend across the entire top of the cooler. Coolers will be shipped to the various analytical laboratories as discussed in the Section 2.0 of the RI/FS FSP. The addresses of the laboratories are listed in Section 2.0 of the RI/FS FSP.

3.15 Close the lid and latch the cooler. Tape the cooler shut on both ends, make several revolutions with the strapping tape. The strapping tape should cover the ends of the clear tape used to secure the shipping label but should not cover the label.

3.16 Affix signed custody seals over lid openings (opposite corners of the cooler). Cover the seals with clear, plastic tape.

3.17 Notify Regional Sample Control Center (RSCC) Coordinator or Contract Laboratory Program (CLP) Sample Management Office (SMO), as appropriate if samples are shipped to a CLP laboratory, that samples are being shipped. Under no circumstances shall the CLP laboratory be contacted directly. If shipping samples after 5:00 pm, the RSCC Coordinator or CLP SMO, as appropriate, must be notified by 8:00 am the following business day. For Saturday delivery at the laboratory, samplers will contact the RSCC Coordinator or CLP SMO, as appropriate, such that the CLP SMO will receive the delivery information by 3:00 pm on the Friday prior to delivery. When notifying the RSCC Coordinator or CLP SMO, samplers must provide the following information:

- Name and phone number at which they can easily be reached (preferably closest on-site phone number if still in the field);
- SMO-assigned case number
- Number, concentration, matrix, and analysis of samples being shipped;
- Name of laboratory (or laboratories) to which the samples were shipped;
- Airbill number(s);
- Date of shipment;
- Case status (i.e., whether or not the case is complete);
- Problems encountered, special comments, or any unanticipated issues;
- When to expect the next anticipated shipment; and
- An electronic export of the TR/COC Record (must be sent within five days of sample shipment).

3.18 Federal Express will be contacted at 1-800-GOFEDEX (1-800-463-3339) to arrange pick-up of the coolers. The closest overnight delivery office is located at:

Federal Express
1510 South Memorial Dr
Tulsa, Oklahoma 74112

SOP TFM-115
Traffic Report / Chain of Custody Preparation

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Traffic Report / Chain of Custody Preparation

Document Number: SOP TFM-115

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for the completion of the Traffic Report Chain of Custody (TR/COC).

Scope: This procedure covers:
- Administrative control,
- TR/COC general requirements,
- Required information, and
- Corrections to the TR/COC

Procedure:

1.0 Administrative Control

1.1 The requirements for the completion of TR/COC forms are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 COC General Requirements (Samples Submitted to SEL or Private Laboratory)

2.1 Prepare a COC for each set of samples shipped to the laboratory. If multiple coolers are submitted, note on the COC the number of coolers that the laboratory should receive.

2.2 Record transferred possession of samples on the COC by having both the person relinquishing and the person receiving the samples by signing, dating, and noting the time the transfer of possession took place.

2.3 A document control number consisting of the date and consecutive alphabetic suffix will be completed in the space provided on the COC. For example, if a

shipment of samples is prepared on July 25, 2005, that contains two COCs, the document control numbers will be 072505A and 072505B.

2.4 For samples submitted to the Oklahoma State Environmental Lab (SEL), log-in forms that are provided by the laboratory for each sample and analysis type, should be completed and submitted with the COC.

2.5 Enclose the original COC and SEL sample log in forms, if applicable, in a plastic bag following completion and secured the plastic bag to the inside of the cooler lid with the cooler return documentation.

3.0 Required Information (Samples Submitted to SEL or Private Laboratory)

3.1 The following information is to be included on the COC:

- Laboratory Name, Contact, and Address
- Point of Contact for Burns & McDonnell
- Project Name and Number
- Identification of sample point and sample designator
- Sample Depth, if feet (if applicable)
- Date of collection
- Time (military) of collection
- Sample matrix (solid, liquid, etc.)
- Number of containers
- Parameters requested for analysis
- Remarks indicating if sample is a QA/QC sample, such as a MS, MSD, or confirmation sample.
- Signature(s) of field personnel that collected the sample
- Signature of person(s) involved in the chain of possession
- Inclusive dates and times of possession
- Document control number

4.0 Corrections to the COC (Samples Submitted to SEL or Private Laboratory)

4.1 If the COC has been completed and deletions or edits need to be made by the sampler, the following procedures must be followed:

- If making a deletion, cross out the information to be deleted from the COC Record and initial and date the deletion.
- If making an addition, enter the new information and sign and date the newly added information.

Note: All modifications made on a printed COC Record must be initialed and dated.

5.0 TR/COC General Requirements (Samples Submitted to a CLP Laboratory)

5.1 TR/COC forms using the FORMS II Lite software will be prepared when CLP analysis is to be conducted. Keep additional blank copies of TR/COC forms in the field in the event of a software failure or that an error is made or additional samples are collected.

5.2 Record transferred possession of samples on the TR/COC by having both the person relinquishing and the person receiving the samples by signing, dating, and noting the time the transfer of possession took place.

5.3 Prepare a TR/COC for each cooler shipped or transported to the laboratory. Record all samples packed in the cooler on the TR/COC accompanying that cooler.

5.4 A document control number consisting of the date and consecutive alphabetic suffix will be completed in the space provided on the TR/COC. For example, if a shipment of samples is prepared on July 25, 2005, that contains two TR/COCs, the document control numbers will be 072505A and 072505B.

5.5 Indicate the use of a Method Flexibility Clause (modified analysis) by inputting the name of the analysis and its associated abbreviation code (for CLP analysis only).

5.6 Enclose the original TR/COC in a plastic bag following completion and secured the plastic bag to the inside of the cooler lid with the cooler return documentation.

6.0 Required Information (Samples Submitted to a CLP Laboratory)

6.1 The following information is to be included on the TR/COC:

- CLP sample numbers
- SMO-assigned case number

- Signature(s) of field personnel
- Date of collection
- Time (military) of collection
- Sample matrix (solid, etc.)
- Identification of sampling point (including depth)
- Number of containers
- Preservative used
- Parameters requested for analysis
- Signature of person(s) involved in the chain of possession
- Inclusive dates and times of possession
- Notations regarding the possible compromise of sample integrity
- Notation regarding sample temperature
- Document control number
- Associated inorganic or organic sample number
- Shipment complete indication
- Sample(s) to be used for laboratory QC indication
- COC seal number
- Custody seal intact indication
- Shipment iced indication
- Sampler name
- Turnaround time
- Concentration type (low, medium, high)
- Sample type (grab or composite)
- Method Flexibility Clause indication

The site name should never appear on the TR/COC or on any other documentation being sent to the laboratory.

7.0 Corrections to the TR/COC (Samples Submitted to a CLP Laboratory)

7.1 If the TR/COC has been completed and deletions or edits need to be made by the sampler, the following procedures must be followed:

- If making a deletion, cross out the information to be deleted from the TR/COC Record and initial and date the deletion.
- If making an addition, enter the new information and sign and date the newly added information.

Note: All modifications made on a printed TR/COC Record must be initialed and dated.

Burns & McDonnell
SINCE 1898

Request for Chemical Analysis and Chain of Custody Record

Burns & McDonnell Engineering
9400 Ward Parkway
Kansas City, Missouri 64114
Phone: (816) 333-8787 Fax: (816) 822-3463

Attention:

Laboratory:

Address:

City/State/Zip:

Telephone:

Document Control No:

Lab. Reference No. or Episode No.:

Project Number:

Sample Type

Client Name:

Matrix

Sample Number			Sample Event		Sample Depth (in feet)		Sample Collected		Matrix			Number of Containers	Analysis						Remarks
Group or SWMU Name	Sample Point	Sample Designator	Round	Year	From	To	Date	Time	Liquid	Solid	Gas								

Sampler *(signature)*:

Sampler *(signature)*:

Special Instructions:

Relinquished By *(signature)*: 1.

Date/Time

Received By *(signature)*:

Date/Time

Ice Present in Container: Yes ☐ No ☐

Temperature Upon Receipt:

Relinquished By *(signature)*: 2.

Date/Time

Received By *(signature)*:

Date/Time

Laboratory Comments:

052501 Form WCD-KC1

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SOP TFM-116
Logging Procedures

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Logging Procedures

Document Number: SOP TFM-116

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a procedure for logging boreholes.

Scope: This procedure covers:

- Administrative controls,
- Drilling log form, and
- Soils classification.

Procedure:

1.0 Administrative Control

1.1 The requirements for completing drilling logs are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Drilling Log Form

2.1 Prepare a geologic log for each borehole in the field by a qualified geologist or engineer. The logs will be hand printed using an appropriate scale. The logs will be prepared based upon the unconsolidated and consolidated material samples and cuttings collected.

2.2 Follow the procedures and requirements listed below:

2.2.1 Log borings at the drill rig as the holes are drilled. The boring logs will be prepared directly on BMcD Forms WCD-KC-2-1 and WCD-KC-2-2.

2.2.2 Complete the forms as much as possible where appropriate and applicable

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data are available.

2.2.3 Note the size and type of sampler or coring bit and barrel and record in the *Type of Penetration Test* box or the *Remarks* column. Logs will show borehole and sample diameters and depths at which sampling methods or equipment change in the *Remarks* column.

2.2.4 Log soil and bedrock will be logged per the criteria presented below. Stratigraphic or lithologic changes encountered within the boring will be shown in the *Description* column as a solid line. Gradational changes in stratigraphy and lithology will be shown as a dashed line. The bottom of the borehole will be represented as a solid double line with the notation "Bottom of Hole."

2.2.5 When sampling is performed using the downhole rig hammer, the number of repetitions the hammer was dropped with the advance rate (of the split spoon or sampler) shall be recorded in the *Blow Count* column.

2.2.6 The depth interval over which samples are collected for lithologic analysis will be noted and recorded in the *Recovery* column. The length of the core or soil sample (recovery) will be measured using a tape measure to the nearest 0.1 foot and recorded in the *Recovery* column. Intervals of lost bedrock core or soil sample (noting both intact and lost intervals) will be also recorded in the column.

2.2.7 During the course of drilling, water levels and time of measurement should be collected as often as possible and noted in the *Remarks* column. The depth to water at the time when the first water zone is encountered and after the completion of drilling will be recorded in the *Remarks* column. Depth to water measurements will be recorded after additional time has elapsed and groundwater has returned to static conditions in the *Depth to Water* and *Date Measured* Boxes.

2.2.8 Drill fluid volume, loss or gain, brand, product name, and the source of the water used for coring or piezometer installation will be recorded in the *Remarks* column (if appropriate).

2.2.9 The depth and type of any temporary casing used during the piezometer

installation procedure will be recorded in the *Remarks* column.

2.2.10 Difficulties during drilling (e.g., changes in drilling speed, rates, or downhole torque) and any special sampling problems also will be noted the *Remarks* column, including descriptions of problem resolutions.

3.0 Soils Classification

3.1 Log unconsolidated material using the Unified Soil Classification System. All items in this section are noted in the *Description* column of the Drilling Log Form.

3.2 Note the moisture content, in relative terms (i.e., dry, moist, wet/saturated).

3.3 The standardized color of the unconsolidated material will be logged using the Munsell Soil Color Chart.

3.4 The angularity, grain size, and grading of soil classified as coarse will be logged. An estimate, by percent of quantities of components (e.g., sand versus silt, silt versus clay, etc.), will be logged.

3.5 The consistency of materials classified as fine (e.g., ML or CH) and the density of materials classified as coarse (e.g., SW or GM) will be noted.

3.6 Bedding characteristics, evidence of bioturbation, root holes, and fractures will be noted and logged.

3.7 The depositional type (i.e., alluvium, till, loess) will be noted.

SOP TFM-117
Surveying Using Global Positioning System Procedures

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Surveying Using Global Positioning System Procedures

Document Number: SOP TFM-117

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective To establish a procedure for surveying sampling points using Global Positioning System (GPS) procedures.

Scope: This procedure covers:

- Administrative controls,
- GPS equipment, and
- GPS surveying procedure.

Procedure:

1.0 Administrative Control

1.1 The requirements for surveying sampling points using GPS are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 GPS equipment may include:

2.1 GPS sub-meter system includes:

2.1.1 Trimble ProXRS GPS Receiver and Antenna

2.1.2 Trimble TSC 1 Data Collector running on Asset Surveyor firmware

2.1.3 Trimble Pathfinder Office Post Processing software

2.2 GPS survey grade system includes:

2.2.1 Trimble 5700 RTK GPS Base and Rover

2.2.2 Trimble TSC 1 Data Collector running Survey Controller firmware

2.2.3 Trimble Geomatics Office Data Processing software

3.0 GPS Surveying Procedure

3.1 Collect various locations at the site using the GPS unit by standing directly above or next to the point that needs to be collected.

3.2 Once positioned at the location, allow the GPS unit to process the point for a minimum of 30 seconds.

3.3 While the unit is collecting the location, a location ID will be entered into the appropriate field on the data collector for that point.

3.4 An entry will also be made in the field book for each point.

3.5 A flag is labeled with the location ID number (BLOCK-EAST-SOUTH) and placed so that the sampling team following at a later time can take soil samples.

3.6 After flags have been placed, a request for sampling materials is placed with the lab. The lab prints labels corresponding to the number of samples needed down to the depth specified by the sampling criteria.

3.7 Once all locations have been collected and the field crew has returned to the office, the data points will be downloaded to the data processing software and exported into a format that will be imported into the GIS for the site.

3.8 As additional data is received from the sampling effort, data will be added to the GIS database for analysis and reporting.

SOP TFM-118
Sediment Thickness and Depth Estimation Methods

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Sediment Thickness and Depth Estimation Methods

Document Number: SOP TFM-118

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for estimating sediment thickness using direct push methods and depth using a weighted tape.

Scope: When using direct push methods to estimate sediment thickness and a weighted tape to measure sediment depth, this procedure covers:

- Administrative controls,
- Equipment,
- Sediment depth measurement, and
- Sediment thickness measurement.

Procedure:

1.0 Administrative Control

1.1 The requirements for estimating sediment thickness and depth using direct push methods are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Equipment may include:

2.1 Field logbook

2.2 Indelible marking pen

2.3 Paper towels

2.4 Utility knife

2.5 Direct push sampling tools equipped with liners.

2.6 Photographic equipment

2.7 Plastic sheeting

2.8 Gloves

2.9 Decontamination equipment

2.10 Folding ruler

2.11 Weighted tape

2.12 Boat

3.0 Sediment Depth Measurement

3.1 Drop weighted tape into pond or stream location from a boat (if appropriate).

3.2 Take a total depth reading from the surface of the water body to the bottom of the pond or stream.

3.3 Record the total depth measurement from the water surface and any additional observations in the field logbook.

3.4 Decontaminate the weighted tape between locations as specified in SOP TFM-110, "Sampling Equipment Decontamination".

4.0 Sediment Thickness Measurement

4.1 Insert a liner into the sampling tool and push the tool to the specified depth or until the bottom of the sediment is reached. Extract the sampling tool from the probehole.

4.2 Remove the liner with the sediment from the sampling device. Either cut the liner longitudinally from top to bottom, or extrude the sample onto clean plastic.

4.3 Based on the lithology of the core, determine and measure the sediment thickness using a folding ruler.

4.4 Record the sediment thickness to the nearest 0.1 inch and any additional observations made in the field logbook.

4.5 Decontaminate sampling equipment between locations as specified in SOP TFM-110, "Sampling Equipment Decontamination".

SOP TFM-119
Slug Testing Procedures

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Slug Testing Procedures

Document Number: SOP TFM-119

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for slug testing to determine the hydraulic conductivity of the water-bearing media immediately surrounding the well.

Scope: This procedure covers:

- Administrative control,
- Slug test equipment,
- Rising head (slug-out) slug test procedure, and
- References

Procedure:

1.0 Administrative Control

1.1 The requirements for a rising head slug test are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Slug Test Equipment

2.1 Rising head slug test equipment may include the following:

2.1.1 Well completion diagrams

2.1.2 Boring logs

2.1.3 Field logbook

2.1.4 Indelible marking pen

2.1.5 Electronic water level indicator

2.1.6 Decontamination equipment

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2.1.7 Electronic data logger

2.1.8 Plastic sheeting

2.1.9 Duct tape

2.1.10 Transducer and cable

2.1.11 Solid cylinder of known volume

3.0 Rising Head Slug Test Procedure

3.1 The procedures for conducting a rising head (slug-out) slug test are described below.

3.1.1 Allow the measured water level to return to static level prior to testing.

3.1.2 Decontaminate transducer and cable.

3.1.3 Record pertinent information (e.g., well diameter, reference level, etc.) into the electronic data logger before beginning the slug test.

3.1.4 Determine the static groundwater level in the well by measuring the depth to water approximately four times over 30 minutes before beginning the test.

3.1.5 Cover sharp edges of well casing or cover to protect the transducer cables.

3.1.6 Install the transducer and cable in the well to a depth below the target drawdown estimated for the test, but a minimum of two feet above the bottom of the well. Check that the depth of submergence is within the design range stamped on the transducer.

3.1.7 Tape the transducer cable to the well to maintain a constant depth.

3.1.8 Connect the transducer cable to the electronic data logger.

3.1.9 Enter the initial groundwater level and transducer design range into the recording device according to the manufacturer's instructions.

3.1.10 Introduce a solid cylinder of known volume to displace and raise the water level in the well. Allow the water level to stabilize and return to static condition as indicated by the transducer. Rapidly remove the cylinder from the well.

3.1.11 Consider the instant of slug removal as time zero. The data-logger will measure and store the depth of the water and the time at each reading at pre-set intervals.

3.1.12 Continue measuring the depth/time measurements with the data logger until the groundwater level returns to equilibrium or a sufficient number of readings has been recorded to clearly show a trend on a semilogarithmic plot of time versus depth.

3.1.13 If the aquifer is coarse grained with a short recovery period (e.g., less than 30 minutes), repeat the test to verify the initial recovery rates.

3.1.14 Stop the logging sequence.

3.1.15 Review the field forms for completeness.

3.1.16 For wells with relatively slow recharge, water levels may be obtained manually using an electronic water level indicator instead of a transducer. Following removal of the slug, water level measurements begin immediately and continue at predetermined intervals until the water level returns to at least 90 percent of its static position, relative to the first measurement collected following removal of the slug.

3.2 Do not add water to the well during the slug test.

3.3 Decontaminate all equipment used prior to the slug test and between wells to avoid cross-contamination.

3.4 Store all data internally on computer diskettes or tape if the slug test is conducted using an electronic data-logger and pressure transducer. Transfer the information to a computer and analyze the data. Keep a printout of the raw data in the project files for documentation.

3.5 Select a method for data analysis and interpretation where the assumptions of the method closely match that of the actual field conditions. Methods of analysis for slug test field data include Bouwer and Rice (1976, 1989), Hvorslev (1951), and Cooper, Bredehoeft, & Papadopulos (1967).

4.0 References

Bouwer & Rice, 1989, Herman Bouwer. *The Bouwer and Rice Slug Test - An Update*. Groundwater. Vol. 27, No. 3. pp. 304-309. May-June.

Cooper, Bredehoeft, & Papadopulos, 1967, Hilton H. Cooper, Jr., John D. Bredehoeft, and Istavros S. Papadopulos. *Response of a Finite-Diameter Well to and Instantaneous Charge of Water*. Water Resources Research. Vol. No. 3. pp. 263-269.

Hvorslev, 1951, M. Juul Hvorslev. *Time Lag And Soil Permeability In Ground-Water Observations.* Bulletin No. 36, Waterways Experiment Station Corps of Engineers, U.S. Army. April.

SOP TFM-120
Low Flow Groundwater Sampling

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Low Flow Groundwater Sampling

Document Number: SOP TFM-120

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a procedure for sampling groundwater using low-flow procedures.

Scope: This procedure covers:

- Administrative controls,
- Groundwater sampling equipment,
- Instrument calibration procedures,
- Monitoring well purging, and
- Groundwater sampling.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting groundwater samples for chemical analysis using low-flow procedures are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Groundwater purging and sampling equipment may include:

- Field logbook
- Traffic Report (TR) / Chain of custody (COC) form
- Indelible marking pen
- Field parameter forms
- Sample according to Table 4-1 in the Field Sampling Plan (FSP)
- Sample labels
- Calibration forms

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- Custody seals
- Bladder pump
- Oil/water interface probe or clear bailers
- Electronic water level indicator
- Specific conductivity meter with standard solutions
- Hach ferrous iron meter and calibration buffer solutions
- Flow-through cell
- Turbidity meter
- Dissolved oxygen (DO) meter
- Oxidation-reduction potential (ORP) meter
- Photoionization detector (PID)
- YSI Multi Probe, or equivalent
- Thermometer
- Five-gallon buckets
- Disposable gloves
- Calculator
- Decontamination equipment
- Container for collection of purge water (e.g., 55-gallon drum or plastic tank)
- Garbage bags

3.0 Instrument Calibration Procedures

3.1 Log all instrument calibration information on the daily calibration log.

3.2 Record instrument readings each morning as part of the instrument calibration or calibration-check.

3.3 Check and log instrument calibration in the evening following the completion of field sampling activities at a minimum.

3.4 Refer to SOP TFM-106, "Field Equipment Calibration" for further instructions.

4.0 Sample Methods and Collection

4.1 Sampling Method For High And Low Recharge Wells Screened Below The Water Table

4.1.1 Unlock the casing protector and remove the well cap. Monitor the air near the cap and in the casing using a PID. Record these readings in the field logbook.

4.1.2 Measure the depth to water and total well depth to within 0.01 feet relative to the measuring point at the top of the well casing (TOC). Measure the thickness of any floating or settled immiscible liquid in the well using an oil/water interface probe or clear bailer. Record the thickness and the depths to both fluids on the field parameter form and/or in the field logbook.

4.1.3 Slowly submerge the pump and tubing into the well to a depth within the screened interval.

4.1.4 Set the initial pumping rate at 100 milliliters per minute (mL/min).

4.1.5 If a stabilized water elevation is obtained (constant or increasing water elevation), increase the flow rate up to a maximum flow rate of 500 mL/min as long as a stabilized water elevation continues to be maintained.

4.1.6 If field parameters stabilize (see below for stabilization criteria) over at least three consecutive readings while a stabilized water elevation is maintained, record the final set of field parameters, collect a sample for field ferrous iron determination (see below), disconnect the flow-through cell, and collect samples for the lab at a pump rate at or below the rate where water elevation stability was obtained. Reduce the pump rate to 100 mL/min when collecting samples for volatile organic compound (VOC) analysis.

4.1.7 If a stabilized water elevation cannot be obtained at 100 mL/min, the flow rate is increased (up to approximately 2.5 L/min) and the water level in the

well lowered to a level not less than one foot above the top of the screen. The rate is then reduced to less than 500 mL/min to determine if a stabilized water elevation can be obtained at the lower water elevation. If a stabilized water elevation is obtained and the field parameters stabilize, a final set of water quality parameters are recorded, a sample is collected for field ferrous iron, the flow-through cell is disconnected, and samples for the lab are collected at a pump rate at or below the rate where water elevation stability was obtained. The pump rate will be reduced to 100 mL/min when collecting samples for VOC analysis.

4.1.8 If a stabilized water elevation is not obtained at the lowered water elevation, the pumping rate is increased to either run the well dry or to purge three well volumes. If three well volumes can be purged and the field parameters are stable, a final set of field parameters are recorded, the flow-through cell is disconnected, a sample for field ferrous iron is collected, and samples for lab analysis are then collected. If field parameters are not stable, the flow rate is decreased as feasible to see if field parameter stabilization can be obtained at a lower flow rate. If field parameter stabilization occurs at the lower flow rate, a final set of field parameters are recorded, a sample for field ferrous iron is collected, the flow-through cell is disconnected, and samples for lab analysis are then collected. If the field parameters do not stabilize at the lowered flow rate, the well is purged dry. Once dry, the well is allowed to recharge, a set of field parameters is recorded, a final set of field parameters are recorded, a sample for field ferrous iron is collected, the flow-through cell is disconnected, and samples for lab analysis are collected at a pump rate at or below the rate where water elevation stability was obtained. The pump rate will be reduced to 100 mL/min when collecting samples for VOC analysis.

4.1.9 Stabilization of parameters will be based on the following stabilization criteria. These criteria will be met when taken over three readings taken at least five minutes apart.

- ± 0.1 pH units for pH measurements
- ± 10 % for conductivity measurements
- ± 10 % for temperature measurements
- ± 10 % for DO measurements above 0.5 mg/L, and within 0.1 mg/L below 0.5 mg/L
- ± 10 mV for ORP measurements
- <50 NTUs for turbidity or ±10% if turbidity levels consistently remain above 50 NTUs

4.1.10 Record field parameters and water elevations every five minutes on the field groundwater sampling report along with the date, time, and other pertinent sampling information during monitoring well purging and sampling.

4.1.11 Record on the log sheet a final water level after completion of sampling.

4.1.12 Perform field tests for ferrous iron just prior to analytical sample collection.

4.1.12.1 Obtain water for this test directly from the discharge of the flow-through cell at the time that final field parameters are measured.

4.1.12.2 Record the results on the sample collection log sheet.

4.1.13 If using a pump to sample, discharge from the pump directly into the sample bottles.

4.1.14 Enter the appropriate information on the TR/COC form.

4.1.15 Decontaminate sampling equipment between monitoring wells.

4.1.16 In general, fill sample containers in the following order: VOCs, methane, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), inorganic (metals and cyanide), and water quality parameters. Visually check the VOC sample bottle to ensure no bubbles are present.

4.1.17 If free product is on the water table and a groundwater sample is to be collected, continue sampling using a bailer as discussed in SOP TFM-108, "Groundwater Sampling".

4.1.18 Place purge water into a storage container and label as "Investigation-Derived Waste" (IDW). Disposal of purge water shall be performed in accordance to TFM-111, "Investigation-Derived Waste".

4.2 Sampling Method for High and Low Recharge Wells Screened Across the Water Table

4.2.1 Set the initial pumping rate at 100 mL/min.

4.2.2 If a stabilized water elevation is obtained (constant or increasing water elevation) with a drawdown of less than 0.3 feet, increase the flow rate up to a maximum flow rate of 500 mL/min as long as a stabilized water elevation and a drawdown of less than 0.3 feet continue to be maintained.

4.2.3 If field parameters stabilize (see below for stabilization criteria) over at least three consecutive readings while a stabilized water elevation is maintained with less than a 0.3 foot drawdown, record the final set of field parameters, collect a sample for field ferrous iron determination (see below), disconnect the flow-through cell, and collect samples for the lab at a pump rate at or below the rate where water elevation stability was obtained. Reduce the pump rate to 100 mL/min when collecting samples for VOC analysis.

4.2.4 If a stabilized water elevation within a 0.3 foot drawdown cannot be obtained, continue to pump in an attempt to stabilize the water elevation at a drawdown level greater than 0.3 feet.

4.2.5 If a stabilized water elevation is obtained (constant or increasing water elevation), increase the flow rate up to a maximum flow rate of 500 mL/min as long as a stabilized water elevation continues to be maintained.

4.2.6 If field parameters stabilize (see below for stabilization criteria) over at least three consecutive readings while a stabilized water elevation is

maintained, record the final set of field parameters, collect a sample for field ferrous iron determination (see below), disconnect the flow-through cell is disconnected, and collect samples for the lab at a pump rate at or below the rate where water elevation stability was obtained. Reduce the pump rate to 100 mL/min when collecting samples for VOC analysis.

4.2.7 If a stabilized water elevation cannot be obtained at any drawdown, continue to either run the well dry or to purge three well volumes. If three well volumes can be purged and the field parameters are stable, a final set of field parameters are recorded, the flow-through cell is disconnected, a sample for field ferrous iron is collected, and samples for lab analysis are then collected.

4.2.8 If field parameters are not stable, increase the flow rate and purge the well dry.

4.2.9 Once dry, the well is allowed to recharge, a set of field parameters is recorded, a final set of field parameters are recorded, a sample for field ferrous iron is collected, the flow-through cell is disconnected, and samples for lab analysis are collected at a pump rate at or below the rate where water elevation stability was obtained. The pump rate will be reduced to 100 mL/min when collecting samples for VOC analysis.

4.2.10 Stabilization of parameters will be based on the following stabilization criteria to be used in the sampling round. These criteria will be met when taken over three readings taken at least five minutes apart.

- ± 0.1 pH units for pH measurements
- ± 10 % for conductivity measurements
- ± 10 % for temperature measurements
- ± 10 % for DO measurements above 0.5 mg/L, and within 0.1 mg/L below 0.5 mg/L
- ± 10 mV for ORP measurements

- <50 NTUs for turbidity or ±10% if turbidity levels consistently remain above 50 NTUs

4.2.11 Record field parameters and water elevations every five minutes on the field groundwater sampling report along with the date, time, and other pertinent sampling information during monitoring well purging and sampling.

4.2.12 Record on the log sheet a final water level after completion of sampling.

4.2.13 Perform field tests for ferrous iron just prior to analytical sample collection.

4.2.13.1 Obtain water for this test directly from the discharge of the flow-through cell at the time that final field parameters are measured.

4.2.13.2 Record the results on the sample collection log sheet.

4.2.14 Discharge from the pump directly into the sample bottles.

4.2.15 Enter the appropriate information on the TR/COC form.

4.2.16 Decontaminate sampling equipment between monitoring wells.

4.2.17 In general, fill sample containers in the following order: VOCs, methane, SVOCs, PCBs, inorganic (metals and cyanide), and water quality parameters. Visually check the VOC sample bottle to ensure no bubbles are present.

4.2.18 If free product is on the water table and a groundwater sample is to be collected, continue sampling using a bailer as discussed in SOP TFM-108, "Groundwater Sampling".

TABLE 1. VOLUME OF WATER TO BE PURGED FROM VARIOUS SIZED MONITORING WELLS

Feet of Water	Number of Gallons To Evacuate One Casing Volume					Number of Gallons To Evacuate Two Casing Volumes					Number of Gallons To Evacuate Three Casing Volumes				
	2”	3”	4”	5”	6”	2”	3”	4”	5”	6”	2”	3”	4”	5”	6”
1.0	0.16	0.37	0.65	1.02	1.47	0.32	0.74	1.30	2.04	2.94	0.48	1.11	1.95	3.06	4.41
2.0	0.32	0.74	1.30	2.04	2.94	0.64	1.48	2.60	4.08	5.88	0.96	2.22	3.90	6.12	8.82
3.0	0.48	1.11	1.95	3.06	4.41	0.96	2.22	3.90	6.12	8.82	1.44	3.33	5.85	9.18	13.23
4.0	0.64	1.48	2.60	4.08	5.88	1.28	2.96	5.20	8.16	11.76	1.92	4.44	7.80	12.24	17.64
5.0	0.80	1.85	3.25	5.10	7.35	1.60	3.70	6.50	10.20	14.70	2.40	5.55	9.75	15.30	22.05
6.0	0.96	2.22	3.90	6.12	8.82	1.92	4.44	7.80	12.24	17.64	2.88	6.66	11.70	18.36	26.46
7.0	1.12	2.59	4.55	7.14	10.29	2.24	5.18	9.10	14.28	20.58	3.36	7.77	13.65	21.42	30.87
8.0	1.28	2.96	5.20	8.16	11.76	2.56	5.92	10.40	16.32	23.52	3.84	8.88	15.60	24.48	35.28
9.0	1.44	3.33	5.85	9.18	13.23	2.88	6.66	11.70	18.36	26.46	4.32	9.99	17.55	27.54	39.69
10.0	1.60	3.70	6.50	10.20	14.70	3.20	7.40	13.00	20.40	29.40	4.80	11.10	19.50	30.60	44.10
15.0	2.40	5.55	9.75	15.30	22.05	4.80	11.10	19.50	30.60	44.10	7.20	16.65	29.25	45.90	66.15
20.0	3.20	7.40	13.00	20.40	29.40	6.40	14.80	26.00	40.80	58.80	9.60	22.20	39.00	61.20	88.20
25.0	4.00	9.25	16.25	25.50	36.75	8.00	18.50	32.50	51.00	73.50	12.0	27.75	48.75	76.50	110.25
30.0	4.80	11.10	19.50	30.60	44.10	9.60	22.20	39.00	61.20	88.20	14.40	33.30	58.50	91.80	132.3

SOP TFM-121
Surface Water Flow Estimation

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Surface Water Flow Estimation

Document Number: SOP TFM-121

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for estimating surface water flow in ponds and streams.

Scope: When estimating surface water flow, this procedure covers:

- Administrative controls,
- Surface water flow estimation equipment, and
- Surface water flow estimation procedure.

Procedure:

1.0 Administrative Control

1.1 The requirements for estimating surface water flow are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Surface Water Flow Estimation Equipment

2.1.1 Marsh-McBirney flow meter

2.1.2 Conductivity meter

2.1.3 Temperature meter

2.1.4 pH meter

2.1.5 Rubber boots

2.1.6 Boat or canoe, if necessary

2.1.7 Waders, if necessary

2.1.8 Applicable decontamination equipment

2.1.9 Applicable safety equipment

2.1.10 Vinyl, nitrile, or latex gloves

2.1.11 Field logbook

2.1.12 Indelible marking pen

2.1.13 Decontamination equipment

2.1.14 Garbage bags

3.0 Surface Water Flow Estimation Procedure

3.1 Record the characteristics of the surface water body (e.g., size, depth, flow direction) in the field logbook.

3.2 Divide each stream or pond discharge into surface water flow sampling stations (perpendicular to direction of flow) approximately one foot apart.

3.3 Measure the temperature, pH, and specific conductance of the surface water body at each surface water flow sampling location. Record the results in the field logbook.

3.4 Determine the surface water depth at each surface water flow sampling station and record the results in the field logbook.

3.5 Place flow meter directly in the path of the surface water flow at 3/5ths of the total depth.

3.6 Calculate the average velocity at each specific surface water flow sampling station by measuring the total flow past the point over a 40-second time interval at 3/5ths of the total depth.

3.7 Record surface water flow readings and any additional observations in field logbook.

3.8 Decontaminate the flow meter and other equipment (including personal protective equipment [PPE]) between locations according to SOP TFM-110, "Decontamination of Sampling Equipment".

SOP TFM-122
Excavation Slag Sampling

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Excavation Slag Sampling

Document Number: SOP TFM-122

Revision Number: 1

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for sampling slag using excavation methods.

Scope: This procedure covers:
- Administrative control,
- Equipment used to sample slag, and
- The sample collection process.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting slag samples for chemical analysis using excavation methods are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Slag Sampling

2.1 Slag sampling equipment may include the following:
- Sample containers as per Table 4-2 in the Field Sampling Plan (FSP)
- Sample labels
- Munsell color charts (rock)
- Soil boring logs
- Field logbook
- Traffic Report (TR)/Chain of Custody (COC) form
- Indelible marking pen
- Decontamination equipment
- Hand lens

- Utility knife
- Paper towels
- Vinyl, nitrile, or latex gloves
- Rock hammer
- Laths, stakes, and/or flags for marking excavation locations
- Spray paint for marking sample locations
- Garbage bags

2.2 Sample Collection Procedure

2.2.1 Describe the lithology of the excavated material (in accordance with ASTM D 2488), including soil classification, soil sample location, field screening measurements, and other observations made. Describe the lithologic characteristics of the excavation "wall", including vertical slag thickness. Record this information on the soil boring log - BMcD Forms WCD-KC-2-1 and WCD-KC-2-2 in accordance with SOP TFM-116, "Logging Procedures".

2.2.2 Slag samples will be collected by gathering loose pieces of slag when possible or by chipping pieces from the slag within the excavation using a rock hammer.

2.2.3 Wearing clean, disposable gloves, transfer the slag samples directly from the excavator bucket or sidewall into the appropriate sample container, avoiding sticks, rocks, and other debris.

2.2.4 Upon filling the sample container with slag pieces, label, and place immediately in a cooler.

2.2.5 Enter the appropriate information on the TR/COC form.

2.2.6 After completion of trenching activities, backfill the trench and tamp with the excavator bucket. The filled trench may then be compacted with a rolling device at the discretion of the field supervisor.

SOP TFM-123
Excavation Soil Sampling

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Excavation Soil Sampling

Document Number: SOP TFM-123

Revision Number: 1

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for sampling subsurface soil using excavation methods.

Scope: This procedure covers:
- Administrative control,
- Equipment used to sample soils, and
- The sample collection process.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting subsurface soil samples for chemical analysis using excavation methods are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Subsurface Soil Sampling

2.1 Soil sampling equipment may include the following:
- Sample containers as per Table 4-2 in the FSP
- Sample labels
- Munsell color charts (soil)
- Soil boring logs
- Field logbook
- Traffic Report (TR)/Chain of Custody (COC) form
- Resealable bags for headspace analysis
- Indelible marking pen
- Decontamination equipment

- Hand lens
- Utility knife
- Paper Towels
- Vinyl, nitrile, or latex gloves
- Real-time monitoring instruments (e.g., photoionization detector (PID), combustible gas indicator (CGI), or other instruments)
- Laths, stakes, and/or flags for marking excavation locations
- Garbage bags

2.2 Sample Collection Procedure

2.2.1 Describe the lithology of the excavated material (in accordance with ASTM D 2488), including soil classification, soil sample location, field screening measurements, and other observations made. Describe the lithologic characteristics of the excavation "wall", including slag thickness. Record this information on the soil boring log - BMcD Forms WCD-KC-2-1 and WCD-KC-2-2 in accordance with SOP TFM-116, "Logging Procedures".

2.2.2 Samples must be collected from soil within the excavator bucket that has not contacted the sides of the bucket to minimize cross-contamination.

2.2.3 If volatile organic contamination is a possibility, obtain PID readings from material in the excavator bucket or stockpiled material beside the trench to identify possible zones of volatile organic contamination. Record readings on the soil boring log.

2.2.4 Wearing clean, disposable gloves, transfer the soil sample directly from the excavator bucket into the appropriate sample container, avoiding sticks, rocks, and other debris. If possible, collect soil from a minimum of three different areas of the excavator bucket to provide a representative sample. Label each sample, and place immediately in a cooler. Samples collected for VOC analysis, if appropriate, should immediately be placed on ice.

2.2.5 Enter the appropriate information on the TR/COC form.

2.2.6 After completion of trenching activities, backfill the trench and tamp with the excavator bucket. The filled trench may then be compacted with a rolling device at the discretion of the field supervisor.

SOP TFM-124
X-Ray Fluorescence Procedures

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: X-Ray Fluorescence Procedures

Document Number: SOP TFM-124

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for screening soils using x-ray fluorescence (XRF).

Scope: When using XRF methods, this procedure covers:
- Administrative controls,
- XRF sampling equipment, and
- XRF procedure.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting direct-push soil samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 XRF sampling equipment may include:

- Sample cups with Mylar film
- Sample labels
- Stainless steel trowel
- Mallet
- Field logbook
- Traffic Report (TR)/Chain of Custody (COC) form
- Indelible marking pen
- Decontamination equipment
- Paper towels

- Utility knife
- Stainless steel knife, spoon, and composting bowl
- Photographic equipment
- Laths, stakes, and/or flags for marking probehole locations
- Gloves

3.0 XRF Procedure

3.1 Follow specific manufacturer's instructions.

3.2 Allow XRF instrument to warm up for 15 to 30 minutes before analyzing samples to alleviate drift or energy calibration problems.

3.3 XRF instruments can be operated in two modes – in situ and intrusive. The two modes of analysis are discussed below.

3.3.1 The in situ mode involves the analysis of an undisturbed soil sample.

3.3.1.1 Select an area for sampling that is not saturated with water, as XRF does not work well for saturated soils.

3.3.1.2 Remove any large or nonrepresentative debris from the soil surface before analysis.

3.3.1.3 Smooth the surface of the soil with a stainless steel trowel so the probe window will have good contact with the soil surface.

3.3.1.4 Tamp the surface of the area to be sampled with a mallet to increase soil density and compactness for better repeatability and representativeness.

3.3.1.5 Place probe window firmly against compacted soil for 30 to 120 seconds, as per the specific manufacturer's instructions, as source count times vary among instruments.

3.3.2 The intrusive analysis involves the collection and preparation of a soil sample before analysis.

3.3.2.1 Remove any large or nonrepresentative debris from the soil surface before analysis.

3.3.2.2 Collect a composite soil sample and place in a stainless steel bowl.

3.3.2.3 Thoroughly homogenize the soil by mixing the sample in the bowl with a spoon, by hand (wearing clean disposable gloves), or by mechanical means (e.g., mixer or blender).

3.3.2.4 Place a sample of the homogenized soil into a 31.0-millimeter polyethylene cup (or equivalent) for analysis. The cup should be at least one-half to three-quarters full. Cover the sample cup with t 2.5-micrometer (um) Mylar (or equivalent) film for analysis.

3.3.2.5 Analyze as per the specific manufacturer's instructions, as source count times vary among instruments.

3.4 Decontaminate all equipment that comes in contact with the sample.

3.5 Although most XRF instruments have software capable of storing all analytical results and spectra, results should be recorded in the field logbook.

SOP TFM-125
Vegetation Sampling

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Vegetation Sampling

Document Number: SOP TFM-125

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To obtain vegetation samples for chemical analysis.

Scope: When sampling vegetation, this procedure covers:

- Administrative controls,
- Sampling equipment, and
- Sample collection.

Procedure:

1.0 Administrative Controls

1.1 The requirements for collecting vegetation samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Vegetation Sampling Equipment

2.1 Indelible marking pen

2.2 Field log book

2.3 Gallon-sized resealable polyethylene sample bags

2.4 Quart-sized resealable polyethylene sample bags

2.5 Sample labels

2.6 Sample tags

2.7 Plastic colander

2.8 Duct tape (or equivalent)

2.9 Leather or cotton gloves

2.10 Disposable gloves

2.11 Shovel, hedge shears, grass clippers, utility knife, or other appropriate equipment

2.12 Traffic Report (TR)/Chain of Custody (COC) form

2.13 Garbage bags

2.14 Decontamination equipment

3.0 Vegetation Sample Collection

3.1 Note observations such as vegetation density, the presence of dew, plant condition, etc, in the field log book.

3.2 Fill two quart-sized resealable bags at least half full of berries at each selected location. Seal the bags securely with duct tape (or equivalent). Label each sample bag with the station name and date.

3.3 Fill two gallon-sized bags of berry bush leaves at each selected location. Seal the bags securely with duct tape (or equivalent). Label each sample bag with the station name and date.

3.4 Using a shovel, uncover the roots and fill one quart-sized bad at each selected location. Place the vegetation into the sample bag and seal the container securely with duct tape (or equivalent). Seal the bags securely with duct tape (or equivalent). Label each sample bag with the station name and date.

3.5 Decontaminate all sampling equipment between samples in accordance with SOP TFM-110 "Sampling Equipment Decontamination".

3.6 Enter the appropriate information on the TR/COC form in accordance with SOP TFM-113, "Sample Numbering and Documentation".

3.7 Place all samples in a cooler.

3.8 When returning to the job site trailer, remove one of the bags of berries, one of the bags of leaves, and the bag of roots from each sample location from the cooler so they can be washed. Note in the field logbook which samples were selected for washing.

3.9 One at a time, place the contents of each sample bag into the plastic colander and rinse thoroughly. Place the washed sample into a new resealable bag and re-label and retag. Place the washed samples back into the cooler.

3.10 Decontaminate the colander between samples in accordance with SOP TFM-110 "Sampling Equipment Decontamination".

SOP TFM-126
Direct Push Groundwater Sampling

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Direct Push Groundwater Sampling

Document Number: SOP TFM-126

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for groundwater sampling using direct-push methods.

Scope: When using direct-push methods, this procedure covers:
- Administrative controls,
- Subsurface groundwater sample collection, and
- Probehole abandonment

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting direct push soil samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Direct-push Groundwater Sampling

2.1 Direct-push groundwater sampling equipment may include:
- Sample containers as per Table 4-2 in the Field Sampling Plan (FSP)
- Sample labels
- Munsell color charts (soil)
- Field logbook
- Traffic Report (TR)/Chain of Custody (COC) form
- Resealable bags for headspace analysis
- Indelible marking pen
- Decontamination equipment

- Paper towels
- Utility knife
- Direct push groundwater sampling tools
- Photographic equipment
- Real-time monitoring instruments (e.g., photoionization detector [PID], combustible gas indicator [CGI], or other instruments)
- Laths, stakes, and/or flags for marking probehole locations
- Gloves

2.2 Sample Procedures and Collection

2.2.1 Equip the direct-push sampling rods with a mill-slotted screen, or equivalent, and advance the screen to the desired sample depth.

2.2.2 Wait several minutes for the groundwater to enter the rods through the screen.

2.2.3 Place a decontaminated stainless steel check valve in the end of a flexible small diameter polyethylene tubing (disposable).

2.2.4 Lower the tubing into the direct-push rods until it reaches the screened interval.

2.2.5 If a check valve is used, raise and lower the tubing using an up and down motion at the surface to fill the tubing with groundwater.

2.2.6 Purge a minimum of five tubing volumes of water prior to collection of groundwater samples. All purge water will be handled in accordance with SOP TFM-111, "Investigation-Derived Waste".

2.2.7 Retract tubing and decant groundwater into the appropriate sample containers, label, and immediately place in cooler on ice.

2.2.8 Collect samples in order of decreasing volatility. In general, the following order will be used: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and inorganic (metals and cyanide) samples.

3.0 Probehole Abandonment

3.1 Backfill each probeholes with cement/bentonite, or equivalent, to the ground surface.

3.2 Repair the area as practical to return the site to its original condition.

SOP TFM-127
Temporary Piezometer Installation

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Temporary Piezometer Installation

Document Number: SOP TFM-127

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for the installation of temporary piezometers using direct-push methods.

Scope: This procedure covers:
- Administrative control,
- Installation equipment,
- Specifications,
- Temporary piezometer installation, and
- Temporary piezometer abandonment.

Procedure:

1.0 Administrative Control

1.1 The requirements for temporary piezometer installation and abandonment are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Installation Equipment

2.1 Temporary piezometer installation equipment may include the following:
- Polyvinyl chloride (PVC) casing
- PVC screen
- Bentonite powder and pellets
- Camera
- Boring logs
- Field logbook

TFM-0000515

- Indelible marking pen
- Fiberglass tape
- Electronic water level indicator
- Decontamination equipment

3.0 Specifications – Temporary Piezometers

3.1 All temporary piezometers will be installed using direct-push methods.

3.2 All temporary piezometers will be installed in accordance with Oklahoma Water Resources Board (OWRB) rules OAC 785:35, as close as possible. A variance approval will be obtained, if needed, from the Oklahoma Water Resources Board (OWRB) prior to installation of the temporary piezometers.

3.3 Temporary piezometers will be installed in open boreholes (if possible) or within direct-push probe rods.

3.4 All temporary piezometers will be constructed with PVC with flush-threaded casings. No cement, glue, or tape will be used in temporary piezometer installation.

3.5 A machine slotted PVC screen will be used for each temporary piezometer.

3.6 Filter pack material will extend at least two feet above the top of the screen unless this distance would create a pathway for vertical migration of surface water or other contamination into the piezometer.

3.7 A bentonite pellet seal at least two feet thick will be placed on top of the filter pack.

3.8 A thick cement/bentonite grout or bentonite pellets will be placed on top of the bentonite seal to within two feet of the ground surface. Grout placed to depths exceeding twenty feet must be pumped from the bottom of the annular space upward through a tremie pipe.

3.9 A waterproof cap must be placed on the top of the riser pipe.

4.0 Temporary Piezometer Installation

4.1 Inspect piezometer material to ensure it meets specifications and is clean and free of foreign matter prior to use.

4.2 Record all piezometer completion information on the field boring log.

4.3 Lower piezometer screen and casing into the borehole or probe rods, recording the depth of the top and bottom of the piezometer screen to within 0.1 feet below grade.

4.4 Pour the filter pack material slowly into the annulus to prevent bridging. Calculate the estimated amount of sand needed to help determine if bridging is occurring. Use a fiberglass tape with a weight attached to the end to determine the top of the filter pack. Measure the depth to the top of the filter pack to within 0.1 foot.

4.5 Pour bentonite pellets slowly down the annulus to prevent bridging. Measure the depth to the top of the bentonite seal to within 0.1 feet with the weighted tape. Ensure that the bentonite seal is at least two feet thick. If the seal is above the water table, pour several gallons of clean (potable) water down the annulus to hydrate the bentonite seal.

4.6 Fill the annulus with a thick cement/bentonite grout or bentonite pellets to within two feet of the ground surface.

4.7 Cut a notch or place a mark on the top of the piezometer casing as a reference point for Top of Casing (TOC) elevation and depth to water measurements.

5.0 Surveying Requirements

5.1 Temporary piezometers will be surveyed to within 1.0 feet horizontally, and the top of casing and ground elevations will be surveyed to within 0.01 feet and 0.1 feet above mean sea level (MSL), respectively. More stringent survey requirements may be required by the project hydrogeologist or manager.

6.0 Temporary Piezometer Abandonment

6.1 Either pull or overdrill the casing.

6.2 Backfill the borehole with cement/bentonite grout, or bentonite pellets from total depth to less than four feet below grade.

6.3 Backfill the uppermost four feet with clean soil.

6.4 If a piezometer is not located in contaminated material, and it is not practical to remove the piezometer casing, fill the piezometer casing with a cement/bentonite grout, or bentonite pellets from total depth to grade level.

6.5 Document all piezometer abandonment procedures in field logbook.

SOP TFM-128
Particulate Matter Sampling

TULSA FUEL AND MANFUACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: Particulate Matter Sampling

Document Number: SOP TFM-128

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To obtain particulate matter in air samples for chemical analysis.

Scope: When air sampling, this procedure covers:

- Administrative controls,
- Sampling equipment, and
- Sample collection.

References: Compendium Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (TSP) and PM_{10} using High Volume (HV) Sampler

Procedure:

1.0 Administrative Controls

1.1 The requirements for particulate matter sampling are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 Air Sampling Equipment

2.1 High-Volume Samplers for TSP and PM_{10} including equipment needed for setup

2.2 Sampling media, supplies and filter cassettes

2.3 Tools required for sampler operation and maintenance

2.4 Field logbook, log sheets and other necessary paperwork

2.5 Procedure or instruments for collecting meteorological data

2.6 Field logbook

2.7 Leather or cotton gloves

2.8 Nitrile gloves

2.9 9/16” or adjustable wrench

2.10 Traffic Report (TR) / Chain of custody (COC) form

3.0 Sampling Procedures

Operational procedures vary according to the sampler model and optional equipment selected for use in the monitoring program. Consult the instrument manual prior to use.

3.1 Sampler Setup

3.1.1 Assemble the sampler according to manufacturer specifications.

3.1.2 Set up the sampler at a height and distance from obstructions in accordance with the proper regulation.

3.1.3 Secure the sampler in such a way that it cannot be tipped over.

3.2 Sampler Calibration

3.2.1 Multi-point calibration

3.2.1.1 In general, compare the sampler meter with an orifice meter (working standard) that has been calibrated against a primary or master standard.

3.2.1.2 Record multiple comparison points and construct a calibration curve.

3.2.1.3 Use the calibration curve and seasonal site meteorological conditions to calculate a sampler meter set point.

3.2.2 Single-point calibration check

3.2.2.1 Perform the single-point calibration check as often as required by the method.

3.2.2.2 Compare the sampler meter with the orifice meter at one data point to insure the calibration curve is still valid or the sampler is running within specified tolerance.

3.3 Sample Collection

3.3.1 Record the sample information on the log sheet.

3.3.2 Place sampling media in the filter cassette and sampler according to the manufacturer and method's instructions.

3.3.3 Record all the sample information on the log sheet and flow recorder chart.

3.3.4 Turn on the sampler and set the flow recorder to the calculated set point.

3.4 Filter Recovery Procedures

3.4.1 Stop the sampler after it has run for the allotted amount of time and record the important information.

3.4.2 Remove the flow recorder chart and sample cassette according to manufacturer and method instructions.

3.4.3 If setting up another sample, repeat the steps in sections 3.3 and 3.4.

3.4.4 Remove the filter from the cassette and place it in an envelope for transportation to the analysis facility.

3.4.5 Ensure that all important information is recorded on the field log sheets and in the field logbook and fill out all required paperwork.

APPENDIX C

DEQ 2004 Ecological Sampling Event

1

Blackberry Sampling Event
6-16-04
Arrived at Oxley Nature Center 0930
~~Controll blackberry bush sampling is located on south side of walking trail that is located at the SW corner of the Nature Center parking lot. Step into th over the west wood rail and west on walking trail about~~ No
Controll blackberry bush sampling is located on NE corner off pond dam. The pond is located east of the Nature Center Parking lot The Oley Nature Center is located at Mohawk Park off 36th Street North off Hwy 75 North, Tulsa,
Collected 7 samples as follows:
washed roots = OX-WBB-R
washed berries = OX-WBB
unwashed green berries = OX-UGB
washed leaves = OX-WBB-L
unwashed berries = OX-UBB
unwasted leaves = OX-UBB-L
soil = OX-BB-S
~~Placed on orange location flag at sample spot.~~
Then traveled to the TFM site to sample blackberries from the railroad R-O-W located on the eastern edge of the site. Sampled from the old rail loading area located about 200 yds south of the railroad crossing. Collected 8 samples at noon as follows:

2

washed roots = TFM-WBB-R-1
* washed berries = TFM-WBB-1
unwashed green berries = TFM-UGB-1
washed leaves = TFM-WBB-L-1
unwashed berries = TFM-UBB-1
unwashed leaves = TFM-UBB-L-1
soil = TFM-BB-S-1
waste = TFM-BB-W-1

* Denotes that most of the blackberries in this sample are pink to red in color. Not many black colored berries at this sample location.

Placed an orange sample flag at this location.

Then traveled to Barry Moore property located at the southwest corner of 136th Street and 108th Street. He lives in the rock house. To get to the sample location turn into his drive and travel behind the shed on your right as you set in his driveway facing south. Go south on pasture edge road to south end of 13-acre pasture. Turn with road to the east and travel to the east end of pasture. Now turn and travel south down through the draw and up into next area. Blackberry sample area is on the right about 150-yards into this area.

(3)

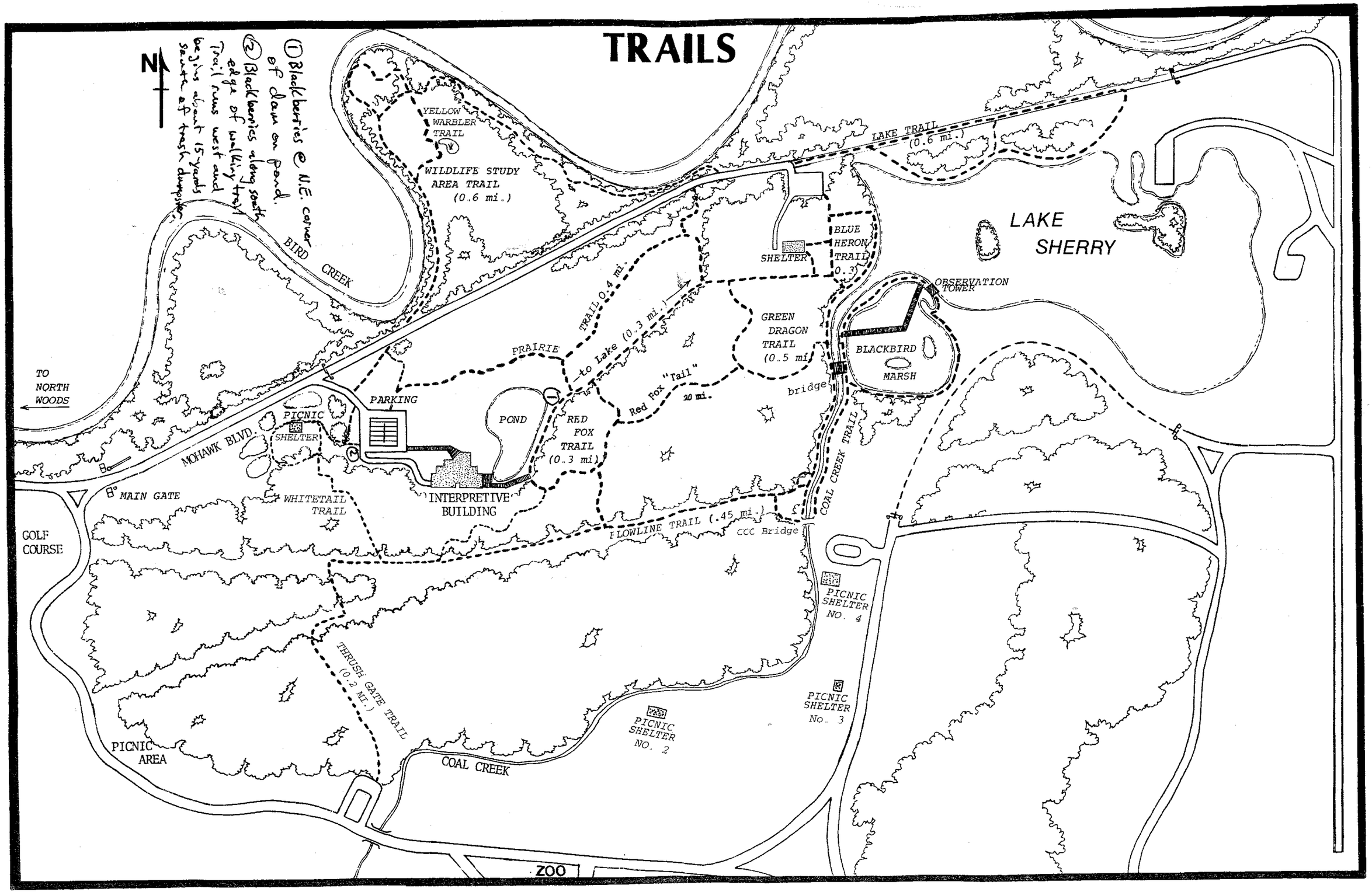
located on north side of pasture road. Collected 7 samples at 12:35 pm as follows;

washed roots: BM-WBB-R
washed berries: BM-WBB
unwashed green berries: BM-UGB
washed leaves: BM-WBB-L
unwashed berries: BM-UBB
unwashed leaves: BM-UBB-L
Soil: BM-BB-S

NOTES; During the above 6-16-04 sampling event, blackberry maturity is estimated at 80% green, 15% black, 5% red. It is also noted that the blackberry bushes on the TFM right-of-way appeared to be less mature than those at Oxley Nature Center and Barry Moore property

---

TRAILS



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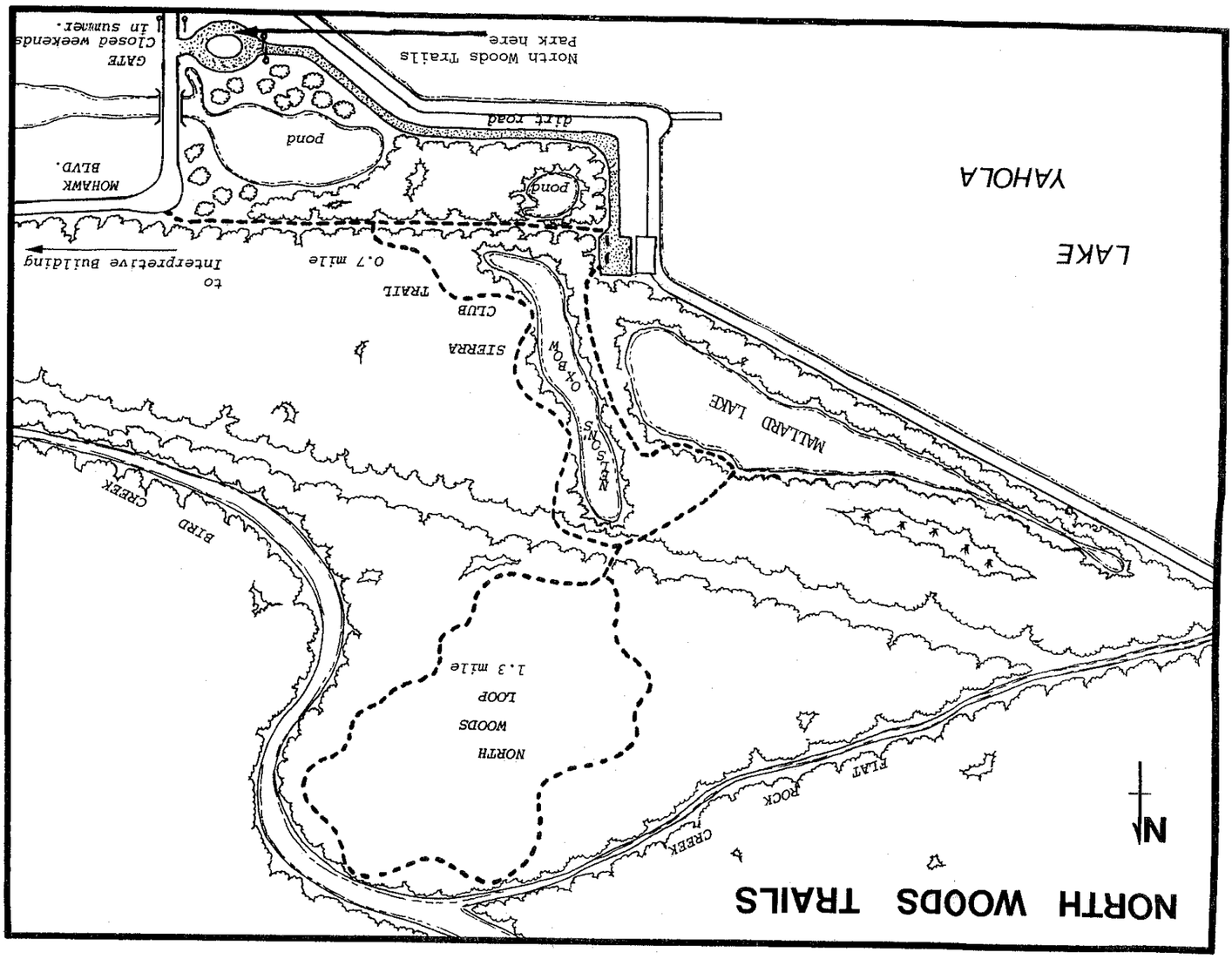
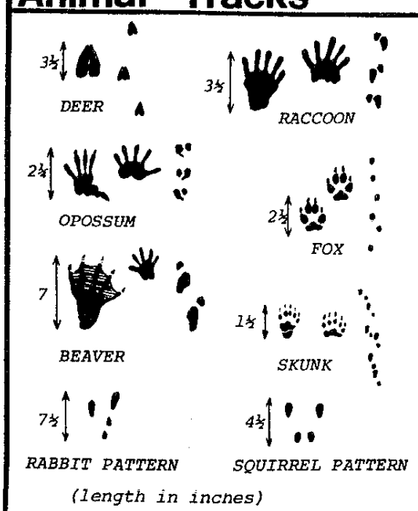


Common Animal Tracks



Regulations

1. Pets, bicycles and motorized equipment are prohibited on trails. This includes horses.
2. Firearms and fireworks are prohibited in the park.
3. Plants, wildlife, and all natural features are protected. Hunting and trapping are not permitted.
4. Be considerate of others. Keep noise low.

Parking Area Closed at 5:00 p.m.

Trail Descriptions

* RED FOX TRAIL 0.3 mile
A multipurpose wooded trail designed for a sensory awareness experience.

GREEN DRAGON TRAIL 0.5 mile
An undeveloped trail that wanders through the deep woods and along Coal Creek.

* BLUE HERON TRAIL 0.3 mile
A multipurpose, self-guided trail with bird blinds overlooking Lake Sherry.

BLACKBIRD MARSH (0.7 mile from building)
A 600 foot boardwalk extends over the marsh allowing "hands-on" investigations of aquatic plants and animals.

WILDLIFE STUDY AREA TRAIL 0.6 mi.
A trail though diverse wildlife habitat where many tracks and signs of wildlife may be found.

The following trails begin at the North Woods Parking Area.

NORTH WOODS LOOP 1.3 mile
This trail wanders through the old North Woods, the Nature Center's "wilderness" area.

SIERRA CLUB TRAIL 0.7 mile
A trail which circles Nelson's Oxbow, home for many water animals and birds.

* Trail guides available.

918-1069-6644

Oxley Nature Center TRAIL MAP

5701 E. 34th St. N.
Tulsa, OK
74115

TULSA PARKS

TFM-0000528

FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
SAMPLING AND ANALYSIS PLAN
TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA

VOLUME II

QUALITY ASSURANCE PROJECT PLAN

July 2005

Prepared for

Oklahoma
Department of Environmental Quality

Burns & McDonnell Project No. 36478
Burns & McDonnell Engineering Company
Engineers-Architects-Consultants
Kansas City, Missouri

QUALITY ASSURANCE PROJECT PLAN APPROVAL

Remedial Investigation / Feasibility Study
Tulsa Fuel and Manufacturing
Collinsville, Oklahoma

Prepared by:

Burns & McDonnell Engineering Company, Inc.

for

Oklahoma Department of Environmental Quality

This document has been prepared in accordance with the *EPA Requirements for Quality Assurance Project Plans for Environmental Operations, EPA QA/R-5* (March 2001).

APPROVAL:

Oklahoma Department of Environmental Quality Project Manager, George Thomas	Date
United States Environmental Protection Agency, Region 6 Project Manager, Michael Torres	Date
United States Environmental Protection Agency, Region 6 Project Quality Assurance Manager, Walt Helmick	Date
Burns & McDonnell Engineering Company, Inc. Project Manager, Tracy Cooley	Date
Burns & McDonnell Engineering Company, Inc. Quality Control Director, Bill Halliburton	Date

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BMcD	Burns & McDonnell Engineering Company, Inc.
CCE	CC Environmental
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIH	Certified Industrial Hygienist
CLP	Contract Laboratory Program
COC	Chain-of-Custody
COD	Chemical Oxygen Demand
COPC	Contaminants of Potential Concern
CVAA	Cold Vapor Atomic Absorption
DEQ	Oklahoma Department of Environmental Quality
DMP	Data Management Plan
DQI	Data Quality Indicator
DQO	Data Quality Objective
ESAT	Environmental Services Assistance Team
ESB	USEPA Region 6 Environmental Services Branch
FS	Feasibility Study
FSM	Field Site Manager
FSP	Field Sampling Plan
ft	feet
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	Health and Safety Manager
HSP	Health and Safety Plan
ICP	Inductively Coupled Plasma
ILM05.3	*CLP Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration*
IO Methods	*Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air*
ITEC	Inter-Tribal Environmental Council
J*	Qualified as estimated based on the data review
J+	Qualified as estimated due to potential high bias based on the data review
J-	Qualified as estimated due to potential high bias based on the data review
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate

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LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

MDL	Method Detection Limit
mg/kg	milligrams per kilogram
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NELAP	National Environmental Laboratory Accreditation Program
NFGI	*Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*
NFGO	*Contract Laboratory Program National Function Guidelines for Organic Data Review*
OLC03.2	*CLP Statement of Work for Analysis of Low Concentration Organics*
OLM04.3	*CLP Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration*
OSDH	Oklahoma State Department of Health
PCB	polychlorinated biphenyl
PE	Performance Evaluation
PID	Photoionization Detector
PPE	personal protective equipment
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
R	Qualified as unusable based on the data review
REC	Percent Recovery
RI	Remedial Investigation
RI/FS DMP	*Remedial Investigation/Feasibility Study Data Management Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma*
RI/FS FSP	*Remedial Investigation/Feasibility Study Field Sampling Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma*
RI/FS HSP	*Remedial Investigation/Feasibility Study Health and Safety Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma*
RI/FS Work Plan	*Remedial Investigation/Feasibility Study Work Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma*
RLS	Registered Land Surveyor
ROD	Record of Decision
RPD	Relative Percent Difference
RSCC	Regional Sample Control Center
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SEL	Oklahoma State Environmental Lab
SHSS	Site Health and Safety Supervisor
SM Methods	*Standard Methods for the Examination of Water and Wastewater*
SOP	Standard Operating Procedure
SVOC	Semivolatile Organic Compound
SW-846 Methods	*Test Methods for Evaluating Solid Waste*

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LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

TAL	Target Analyte List
TBC	to-be-considered
TCLP	toxicity characteristic leaching procedure
TFM	Tulsa Fuel and Manufacturing Site located in Collinsville, Oklahoma
TOC	Total Organic Carbon
TSP	Total Suspended Particulate
U*	Qualified as undetected based on the data review
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
XRF	X-Ray Fluorescence Spectroscopy

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DOCUMENT DISTRIBUTION

USEPA Region 6
- Michael Torres, Project Manager
- Christy Warren, Region 6 Laboratory
- Myra Perez, Region 6 CLP Coordinator
- Walt Helmick, Region 6 QA Coordinator

Oklahoma Department of Environmental Quality
- George Thomas, Project Manager
- Susan Elmenhorst, Laboratory QA Officer

Burns & McDonnell Engineering Company, Inc.
- Tracy Cooley, Project Manager
- Bill Halliburton, QC Director
- Field Site Manager
- Project Chemist

* * * * *

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of the quality assurance project plan (QAPP) is to establish the policies, organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities for managing the sampling events to be performed at the Tulsa Fuel and Manufacturing site (TFM) located in Collinsville, Oklahoma as part of a remedial investigation (RI) / feasibility study (FS). The scope of the QAPP was developed from United States Environmental Protection Agency (USEPA) protocols outlined in *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5* (USEPA, 2001).

1.2 QUALITY ASSURANCE PROJECT PLAN ORGANIZATION

This RI/FS QAPP has been prepared by Burns & McDonnell Engineering Company, Inc. (BMcD) as part of the Sampling and Analysis Plan (SAP) for the TFM. The SAP is presented in the following volumes:

- Volume I, Field Sampling Plan (FSP) (BMcD, 2005a)
- Volume II, QAPP

This document is organized as follows:

- Section 1.0 – Introduction
- Section 2.0 – Project Management
- Section 3.0 – Data Generation and Acquisition
- Section 4.0 – Assessment and Oversight
- Section 5.0 – Data Validation and Usability
- Section 6.0 – References

The QAPP references information that is presented in the following documents and is not repeated here to avoid unnecessary duplication:

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- *Draft Remedial Investigation/Feasibility Study Work Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma* (RI/FS Work Plan) (BMcD, 2005d)

- *Remedial Investigation/Feasibility Study Sampling and Analysis Plan, Volume I, Field Sampling Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma* (RI/FS FSP) (BMcD, 2005a)

- *Remedial Investigation/Feasibility Study Data Management Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma* (RI/FS DMP) (BMcD, 2005b)

- *Remedial Investigation/Feasibility Study Health and Safety Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma* (RI/FS HSP) (BMcD, 2005c)

* * * * *

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2.0 PROJECT MANAGEMENT

2.1 PROJECT/TASK ORGANIZATION

Planning, field investigation, and reporting will be conducted by BMcD and coordinated with the Oklahoma Department of Environmental Quality (DEQ). Key project personnel and other parties involved with this program are outlined in this section. Figure 2-1 presents an organizational chart for the program. Specific QA/QC responsibilities and relationships for organizations involved in analytical activities are discussed in this section. A more detailed discussion of project management, project coordination, and project team activities is provided in Section 7.0 of the RI/FS Work Plan (BMcD, 2005d).

2.1.1 Oklahoma Department of Environmental Quality

The DEQ is the lead agency for the TFM and has entered into a Cooperative Agreement with the USEPA to conduct an RI/FS of the TFM. The DEQ will direct overall project efforts. DEQ and USEPA will be responsible for final approval of environmental data and decisions based on data related to the facility. Mr. George Thomas will serve as the DEQ Project Manager. The primary responsibilities for the DEQ Project Manager are as follows:

- overall responsibility for project coordination
- review and approve the project documents and subsequent revisions
- ensure implementation of project documents
- coordinate sample analysis with Oklahoma State Environmental Lab (SEL)
- coordinate involvement of USEPA Region 6
- coordinate involvement of the Inter-Tribal Environmental Council (ITEC)

Contact information for DEQ is as follows:

DEQ	Primary Point of Contact
Oklahoma Department of Environmental Quality Land Protection Division 707 N. Robinson Oklahoma City, OK 73102	Mr. George Thomas phone: (405) 702-5126 email: George.Thomas@deq.state.ok.us

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2.1.1.1 Oklahoma State Environmental Lab

Primary analytical services for the RI/FS will be provided by the SEL. The SEL is charged with analyzing samples that are collected to aid in evaluation of project data. SEL's primary analytical responsibilities will be for analysis of metals, toxicity characteristic leaching procedure (TCLP) metals, and general water chemistry parameters. Susan Elmenhorst serves as the laboratory QA Manager. The primary responsibilities for the Laboratory QA Manager are as follows:

- actively support the implementation of the SEL QAPP
- maintain accurate standard operating procedures and enforce their use in the laboratory
- maintain a work environment that emphasizes the importance of data quality
- provide appropriate management support

Contact information for the SEL is as follows:

SEL	Primary Point of Contact
Oklahoma Department of Environmental Quality State Environmental Lab 707 N. Robinson Oklahoma City, OK 73102	Susan Elmenhorst phone: (405) 702-1038 email: Susan.Elmenhorst@deq.state.ok.us

2.1.2 United States Environmental Protection Agency

The DEQ has entered into a Cooperative Agreement with the USEPA to conduct the RI/FS of the TFM. USEPA is providing regulatory oversight of the RI/FS. USEPA has review responsibilities for the project plans, RI Report, and FS that are being developed as part of this project. Mr. Michael Torres will serve as the USEPA Region 6 Project Manager. The primary responsibilities for the USEPA Project Manager are as follows:

- review and approve the project documents and subsequent revisions
- coordinate involvement of USEPA Region 6 Lab and Contract Laboratory Program (CLP) lab(s)
- develop Record of Decision (ROD) for TFM following the RI/FS

Contact information for the USEPA Project Manager is as follows:

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USEPA Region 6	Primary Point of Contact
United States Environmental Protection Agency Superfund – Louisiana/Oklahoma 1445 Ross Avenue, Suite 1200 Dallas, TX 75202-2733	Mr. Michael Torres phone: (214) 665-2108 email: Torres.Michael@epa.gov

2.1.2.1 USEPA Region 6 Environmental Services Branch Laboratory

While SEL is providing the primary analytical services for this project, additional laboratories are presented in this QAPP to address unforeseen circumstances at the SEL (i.e., sample overload, power outage, etc.) or expanded investigation needs. To address these situations, the USEPA Region 6 Environmental Services Branch (ESB), also known as the Houston Laboratory, may provide certain analytical services for the RI/FS. The ESB is charged with analyzing samples that are collected to aid in evaluation of project data. In the event that these services are needed, it is anticipated that ESB would be charged with analysis of samples for one or more of the following: target compound list (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), TCL pesticides, TCL polychlorinated biphenyls (PCBs), target analyte list (TAL) metals, and cyanide. Christy Warren serves as the Sample Control Manager for the Sample Management Team. The primary responsibilities for the Sample Control Manager are as follows:

- management of the Region 6 Regional Sample Control Center (RSCC)
- coordination of transfer of samples to the CLP laboratories
- scheduling, receiving, and tracking all samples through the Houston Laboratory

Contact information for USEPA's Region 6 Sample Control Manager is as follows:

USEPA Region 6 Laboratory	Primary Point of Contact
United States Environmental Protection Agency Region 6 Laboratory 10625 Fallstone Road Houston, TX 77099	Christy Warren phone: (281) 983-2137 email: Warren.Christy@epa.gov

Depending upon the analytical needs, samples may also be transferred to a CLP laboratory instead of to the ESB for analysis. Myra Perez serves as the Region 6 CLP RSCC Coordinator. The primary responsibilities of the CLP Coordinator are as follows:

- technical oversight of the CLP contracts

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- perform CLP sample scheduling through management of the RSCC
- oversight of contractor data verification and validation activities determining contractor generated data usability for client programs

Contact information for USEPA's Region 6 CLP RSCC Coordinator is as follows:

Region 6 CLP RSCC Coordinator	Primary Point of Contact
United States Environmental Protection Agency Region 6 Laboratory 10625 Fallstone Road Houston, TX 77099	Myra Perez phone: (281) 983-2130 email: Perez.Myra@epa.gov

2.1.3 Inter-Tribal Environmental Council

The mission of the ITEC is to protect the health of Native Americans, their natural resources, and their environment as it relates to air, land, and water. Since the TFM lies within the jurisdictional boundaries of the Cherokee Nation and tribal members are known to live within one-half mile of the TFM, ITEC has interest in the RI/FS. As such, ITEC is providing technical management assistance for environmental matters related to the TFM. Mr. Frank Harjo will serve as the ITEC representative. The primary responsibilities for the ITEC representative are as follows:

- Identify and communicate any tribal concerns regarding activities on the TFM
- Communicate TFM activities and findings to tribal members within the community

Contact information for the ITEC representative is as follows:

ITEC Representative	Primary Point of Contact
Inter-Tribal Environmental Council of Oklahoma Cherokee Nation Office of Environmental Services 115 W. North Street Tahlequah, OK 74465	Mr. Frank Harjo Jr. phone: (918) 458-5496 email: fharjo@cherokee.org

2.1.4 Burns & McDonnell Engineering Company, Inc.

DEQ has contracted BMcD to support DEQ's Cooperative Agreement with USEPA in conducting the RI/FS. BMcD will report directly to the DEQ Project Manager. BMcD will have primary responsibility

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to prepare and execute project plans, investigations, and reports for the RI/FS of the TFM. Responsibilities specific to BMcD are discussed in the following sections.

2.1.4.1 Quality Control Director

The QC Director serves as the senior reviewer, providing technical QC, oversight, and direction for all aspects of the planning, execution, analyses, and reporting of the RI/FS at the TFM. The QC Director, Mr. Bill Halliburton, has ultimate authority and responsibility to verify that the analyses specified and procedures established by BMcD for the RI/FS satisfy the data quality objectives (DQOs) discussed in Section 4.0 of the RI/FS Work Plan. Contact information for the BMcD QC Director is as follows:

BMcD QC Director	Primary Point of Contact
Burns & McDonnell Engineering Company, Inc. 9400 Ward Parkway Kansas City, MO 64114	Mr. Bill Halliburton phone: (816) 822-3545 email: bhalli@burnsmcd.com

2.1.4.2 Project Manager

The Project Manager serves as a direct liaison between the DEQ and BMcD project team and coordinates all BMcD activities for the TFM. Mr. Tracy Cooley will serve as the Project Manager for BMcD. The BMcD Project Manager for the RI/FS will provide guidance, direction, and support to the project team and will be ultimately responsible to the DEQ for all BMcD project-related activities. The BMcD Project Manager will be the primary point of contact between BMcD, the DEQ Project Manager, and all contracted services (e.g., laboratories, drillers, etc.). Responsibility for coordination with contracted services may be delegated by the Project Manager to a project team member such as the Project Chemist, Field Site Manager (FSM), or other qualified individual. Project Manager responsibilities include implementing adequate internal controls and review procedures to eliminate conflicts, errors, and omissions, and verifying technical accuracy. Contact information for the BMcD Project Manager is as follows:

BMcD Project Manager	Primary Point of Contact
Burns & McDonnell Engineering Company, Inc. 9400 Ward Parkway Kansas City, MO 64114	Mr. Tracy Cooley phone: (816) 822-3369 email: tcooley@burnsmcd.com

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2.1.4.3 Health and Safety Manager

The Health and Safety Manager (HSM) is a Certified Industrial Hygienist (CIH) who will provide professional support by reviewing all health and safety programs as they apply to this project. The HSM will approve the RI/FS HSP and all modifications to the plan as they affect the health and safety of field personnel. The HSM is responsible for providing professional health and safety support and oversight management to the site health and safety supervisor (SHSS). The HSM will review and provide support in all concerns regarding the health and safety of field personnel assigned to this project. Periodic field audits of the project work site may be conducted by the HSM to evaluate the adequacy of the program and implement any necessary changes. Contact information for the BMcD HSM is as follows:

BMcD HSM	Primary Point of Contact
Burns & McDonnell Engineering Company, Inc. 9400 Ward Parkway Kansas City, MO 64114	Mr. Eric Wenger phone: (816) 822-3894 email: ewenger@burnsmcd.com

2.1.4.4 Field Site Manager

Mr. Michael Gossett will serve as the FSM for field activities. The FSM is responsible for supervising all field investigation activities. The FSM reports directly to the BMcD Project Manager. The FSM will have direct responsibility for field activities and for continued daily adherence to the quality standards set forth in the RI/FS FSP and QAPP. Contact information for the BMcD FSM is as follows:

BMcD FSM	Primary Point of Contact
Burns & McDonnell Engineering Company, Inc. 9400 Ward Parkway Kansas City, MO 64114	Mr. Michael Gossett phone: (816) 333-9400, Ext. 2652 email: mgossett@burnsmcd.com

2.1.4.5 Site Health and Safety Supervisor

A SHSS will be identified prior to the start of field activities. Responsibilities of the SHSS are discussed fully in Section 2.0 of the RI/FS HSP (BMcD, 2005d). The SHSS will be responsible for decisions regarding the immediate safety of investigation personnel, and will report to BMcD's HSM, FSM, and Project Manager. In some instances, the FSM may also serve as the SHSS.

The SHSS is responsible for overseeing personnel on the TFM, maintaining proper medical surveillance, providing hazard communication information, training employees in safe operating procedures, and advising the HSM and Project Manager on matters concerning the health and safety of employees or the

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public. The SHSS may be required to perform various types of area or personnel monitoring to verify worker exposure and ensure the proper selection of personal protective equipment (PPE). The SHSS should be consulted before any changes in the recommended procedures or levels of protective clothing are made.

2.1.4.6 Project Chemist

The BMcD project chemist will oversee the activities involving the field procedures for chemical samples, laboratory analyses, chemical sample documentation procedures, and tracking of chemical samples. The chemist also coordinates data validation of analytical laboratory deliverables.

The project chemist often serves as the point of contact for subcontracted analytical laboratories with responsibilities as described below:

- verify appropriate analyses to achieve project DQOs
- estimate costs for analytical services for any subcontracted lab services
- prepare purchase orders/authorizations for any subcontracted lab services
- schedule analytical services and order adequate/appropriate sample containers
- confirm sample receipt and laboratory log-in
- answer questions from the laboratory concerning sample anomalies and coordinate resolution of data evaluation issues between BMcD and the laboratory
- track the receipt of deliverables
- inform the BMcD QC Director and BMcD Project Manager of the project status and any potential lab problems that may jeopardize the quality of project data

Ms. Sharon Shelton will serve as the Project Chemist for field activities. Contact information for the BMcD Project Chemist is as follows:

BMcD Project Chemist	Primary Point of Contact
Burns & McDonnell Engineering Company, Inc. 9400 Ward Parkway Kansas City, MO 64114	Ms. Sharon Shelton phone: (816) 822-3168 email: sshelton@burnsmcd.com

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2.1.4.7 Project Team

The BMcD Project Team will be experienced in site investigations and will have shown technical proficiency in their respective professional areas of expertise. They will be familiar with internal review processes and specific details for this project.

Members of the BMcD Project Team are responsible for conducting project work in the field or in the office. Their responsibilities include:

- prepare planning documents and reports
- conduct field work
- report progress and problems to the Project Manager
- implement and/or recommend corrective actions regarding project activities to the Project Manager
- review and correct their own work prior to submittal to the Project Manager

The members of the BMcD Project Team have authority to take the following actions:

- require or perform "on-the-spot" corrections of deficiencies found during project execution
- implement and/or recommend corrective actions regarding project activities to the Project Manager

2.1.5 CC Environmental

CC Environmental (CCE) will serve as a local subcontractor to BMcD. CCE will provide local knowledge and technical expertise in support of project activities. CCE will report to the BMcD Project Manager. The point of contact for CCE is Geoff Canty, Ph.D., and contact information is as follows:

CC Environmental	Primary Point of Contact
CC Environmental 155 Triad Village Drive Norman, OK 73071	Geoff Canty, Ph.D. phone: (405) 321-8181 email: geoffc@ccenviro.net

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2.1.6 Analytical Laboratories

As previously presented, the majority of the analytical data for the RI/FS will be generated by the Oklahoma SEL. Additionally, support for additional investigation activities or backup in the event of unforeseen circumstances at the SEL will be provided by the USEPA Region 6 Lab, and/or CLP lab(s). Contracting and certification of these laboratories is handled by the appropriate DEQ or USEPA contact (see above).

For analysis of certain constituents (i.e., vegetation, air analyses, etc.), BMcD will need to subcontract analytical services. Subcontracted laboratories are expected to meet the certification requirements for DEQ and/or the National Environmental Laboratory Accreditation Program (NELAP).

Potential subcontracted laboratories and the primary point of contact for each laboratory is as follows:

Laboratory	Primary Point of Contact	Lab Specialty
Midwest Laboratories 13611 B Street Omaha, NE 68144	Seth Frishman phone: (402) 334-7770 seth@midwestlabs.com	Vegetation
STL Burlington 208 South Park Drive, Suite 1 Colchester, VT 05446	Don Dawicki phone: (802) 655-1023 email: DDawicki@stl-inc.com	Air Vegetation

Information on laboratory organization, key personnel and responsibilities will be provided in the individual laboratory QAPPs and/or Standard Operating Procedures (SOPs), which will be provided as labs are contracted. The laboratory is expected to have a QA program consistent with a national accreditation program and will be capable of achieving project-required method reporting limits, as well as project DQOs for accuracy, precision, and bias to the extent that this is technically feasible using standard technology.

2.1.7 Direct-Push and Drilling Contractor

The contractor responsible for the direct-push and drilling services will have the capabilities and knowledge to perform the direct-push and drilling services required for the TFM. The contractor will meet health and safety requirements necessary for operating on hazardous waste sites. Additionally, for monitoring well installation, the drilling contractor must be a licensed Well Driller by the State of Oklahoma. The direct-push and drilling contractor will report directly to the FSM. Contact information for the direct-push contractor is as follows:

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Direct-Push and Drilling Contractor	Primary Point of Contact
CRC & Associates (Cherokee America Drilling) 916 West 23rd Street Tulsa, OK 74107	Kevin Wilke phone: (918) 582-9110

2.1.8 Trenching Contractor

The contractor responsible for the trenching services will have the capabilities and knowledge to perform the trenching services required for the TFM. The trenching contractor will meet health and safety requirements necessary for operating on hazardous waste sites. The trenching contractor will report directly to the FSM. Contact information for the trenching contractor is as follows:

Drilling Contractor	Primary Point of Contact
Bingham Resources, Inc. 4515 East 105th Street Tulsa, OK 74137	Jeff Bingham phone: (800) 750-3704

2.1.9 Surveyor

An Oklahoma State Registered Land Surveyor (RLS) will be used to establish an on-site benchmark and survey coordinates (including elevations) for monitoring wells and piezometers. The surveyor will report directly to the FSM. Contact information for the RLS is as follows:

Surveyor	Primary Point of Contact
L.W Survey Company 2156 West Albany Street Tulsa, OK 74012	David Arnold phone: (918) 251-1035

BMcD staff will perform all other surveys using Global Positioning System (GPS) techniques and provide survey data necessary for completion of investigative activities as detailed in the RI/FS FSP.

2.2 PROBLEM DEFINITION/BACKGROUND

The TFM history, background, results of previous investigations, and scope of work for this project are presented in the RI/FS Work Plan. The following paragraphs provide a summary of this information and briefly outline the objectives of the RI/FS.

BMcD under contract with the Oklahoma Department of Central Services Construction and Properties Division on behalf of the DEQ will conduct a RI and FS at the TFM. The RI/FS is 100 percent federally funded through a Cooperative Agreement between the DEQ and the USEPA.

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During World War I, zinc was in great demand. It was used to galvanize armaments to prevent rust. A zinc smelter and lead roaster were at the TFM location from 1914 through 1925. Historically, the smelter was known as the Prime Western Smelter. The TFM was also misnamed as Acme Brick Strip Mines site, since it was immediately adjacent to a strip mine on its southern boundary (DEQ, 2005). Use of the land prior to the smelting operation is unknown (Oklahoma State Department of Health [OSDH], 1992).

The smelting operation utilized nine furnaces, approximately 150 feet in length by 60 feet wide, which were believed to be fueled by nearby natural gas wells. Other main structures of the smelter included a mechanical kiln building approximately 240 feet (ft) by 80 ft in size, a condenser room approximately 75 ft by 50 ft in size, and a laboratory (See Figure 1-2 of the RI/FS FSP). A 2-million gallon capacity reservoir was used in conjunction with the condenser room during smelting operations. In addition, large amounts of ore were stored on the site in the area northeast of the waste piles (Figure 1-2 of the RI/FS FSP). Little is known about waste management at the smelter during its operation. Due to the time period in which the smelter operated, it is unlikely that air emission control devices were used (DEQ, 1994 and OSDH, 1992).

Strip mining occurred in the surrounding area. Immediately south of the site was a strip mining operation approximately 40 acres in size, which was known as the Acme Brick Strip Mine (OSDH, 1992). A water-filled surface impoundment (i.e., strip mine pit), which acts as a southern boundary to the TFM, is currently associated with the former strip mine. It has been reported that this impoundment serves as a local fishery (DEQ, 2005). Another strip mine area operated just east of the TFM, and one was located in northeast Collinsville (Figure 1-1 of the RI/FS FSP).

The Collinsville Smelter, which is being evaluated through DEQ's Voluntary Cleanup Program, is located approximately ¼ mile to the east-northeast of the TFM (Figure 1-1 of the RI/FS FSP). The Bartlesville Zinc Company owned and operated this zinc smelter between 1911 and 1918. The Bartlesville Zinc Company owned 220 acres of land surrounding the smelter area, but only 40 of those acres is currently under review. In 1987, the Collinsville Smelter was reclaimed and regraded by the Oklahoma Conservation Commission in conjunction with reclamation of the adjacent coal strip mine (Exponent, 2001).

The majority of the structures have been demolished, but several foundations and building footings remain on the TFM. On September 28, 1928, the 120-foot tall and 11-foot diameter smokestack was imploded. A residence (Figures 1-2 and 1-3 of the RI/FS FSP), which was occupied from 1935 through February 2002, was located on the TFM near the former office building (paymaster hut). The on-site

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residence was destroyed by a fire and is currently unoccupied. The residence has a water well that was used in the past for drinking water but is no longer in use. No other residential structures are located on the site; however, a garage and a few storage sheds remain in place adjacent to the former residence.

Although the TFM is partially fenced, there is evidence of trespassing. There is abundant evidence of fishing and hunting activity around the ponds on the TFM, and fishing in the ponds has been reported on several occasions. In addition, individuals have been observed picking blackberries along the eastern fenced boundary and evidence of off-road vehicle traffic is present. The area in the vicinity of the on-site residence, including the garage and storage sheds and along the access road/driveway, has become a trash dump. Broken appliances, used exercise equipment, junked cars, and assorted trash/debris were observed during the March 29, 2005 site tour.

At other smelter sites in Oklahoma, slag or waste material was transported off the site and used as fill in driveways, gardens, and school running tracks. Since the TFM was abandoned in the 1920s and large amounts of slag material were left behind, this could have occurred in the past. Other than an investigation of the former Collinsville Strip Mine (Fluor Daniel, Inc., 1997), no sampling data have been taken to evaluate that possibility. During a February 14, 2001 DEQ site visit, DEQ located what appears to be a slag-based parking lot at 123 W. 5th Street in Collinsville, Oklahoma. Additionally, a local newspaper article from 1936 states that a rock crusher was placed at the TFM for the manufacturing of road base for area roads (DEQ, 2005).

In September 1994, the DEQ conducted a focused Site Investigation (SI) at the TFM. In May of 1999, the USEPA completed a *Removal Assessment Report*. Samples collected from the waste materials indicated elevated concentrations of arsenic, cadmium, cobalt, copper, lead, manganese, nickel, silver, and zinc. Sediment and surface water samples collected from the southern impoundment and eastern wetlands indicate releases of arsenic, cadmium, copper, lead, silver, and zinc from the waste to the surface water. The results presented in the *SI Report, Removal Assessment Report*, and the nature of smelter sites across Oklahoma allowed DEQ to preliminarily identify the following contaminants of potential concern (COPC) at TFM (DEQ, 2005):

- arsenic, cadmium, lead, and zinc

These contaminants were found on the TFM in concentrations more than three times background concentrations. Only eight surface soil samples were collected off the site, mostly to the north, and may not be representative of other areas around the site. Although some of the off-site metal concentrations

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were above background values, they were much lower than TFM concentrations. In the eight samples collected, maximum concentrations of arsenic, cadmium, lead, and zinc were slightly above background values. No residential properties were sampled during USEPA's Removal Assessment (DEQ, 2005).

The objectives of RI/FS are to describe current TFM conditions and outline future investigation and planning activities necessary to assess and address potential threats to human health and the environment associated with the TFM. The RI/FS Work Plan presents and evaluates existing data and defines the objectives and scope of work for the RI/FS. Objectives of the RI are:

- Quantify the nature and extent of on-site contamination;
- Quantify the volume of waste material present on the TFM;
- Determine the nature and extent of any off-site contamination;
- Characterize the physical and chemical nature of the TFM, including fate and transport mechanisms;
- Determine ecological and human health risk; and
- Obtain information necessary to evaluate remedial alternatives in the FS.

Objective of the FS is:

- Develop and evaluate remediation alternatives.

2.3 PROJECT/TASK DESCRIPTION

To accomplish the objectives of the RI/FS, samples will be collected throughout the TFM and at selected areas off-site. On-site sampling will be conducted using a systematic gridded sampling method that has been modified to overcome potential challenges to subsurface investigation. In areas where waste materials are sparse, direct push sampling techniques will be used. Areas where waste materials are dense and expected to present subsurface investigation difficulties will be investigated using trenching sampling techniques. Samples and associated QC samples will be collected from surface water, sediment, soil, groundwater, air, and vegetation. Table 2-1 provides a sample collection summary for this RI/FS. The following details are provided in other project documents.

- Sample Collection Information - Section 4.0 RI/FS FSP (i.e., SAP Volume I)

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- Sample Identification Tables - Tables 4-2 through 4-6 of the RI/FS FSP (i.e. SAP Volume I)
- Sample Locations - Figures 4-1 through 4-4 of the RI/FS FSP (i.e., SAP Volume I)
- Sampling Rationale – Section 5.3 of the RI/FS Work Plan

Given the nature of this study, all samples can be considered critical data points for achievement of project objectives. Sampling activities will be conducted in accordance with the procedures outlined in the RI/FS FSP and its attachments. No special personnel or nonstandard equipment are required for the sampling.

Samples will be analyzed for the list of constituents indicated on Table 2-2 as "Primary Analyses". Identification as a parameter for "Primary Analysis" was based on results of previous investigation activities and expected constituents at former smelter sites. However, critical parameters are arsenic, cadmium, lead, and zinc which have historically been found in smelter environments and have been preliminarily identified by DEQ as COPCs (DEQ, 2005). These constituents are considered acceptable indicator parameters to evaluate the presence of smelter waste. Therefore, actions taken to address these metals will address other metals also present at the site.

Expanded investigation activities may be required during Phase II of the RI field activities. As mentioned in Section 2.2, the area in the vicinity of the former residence has become a trash dump. It may be determined this area requires additional sampling for an expanded list of constituents such as TCL VOCs, SVOCs, pesticides, PCBs, and TAL metals. Therefore, Table 2-2 also presents "Potential Analyses" and parameter lists that encompass constituents that may be analyzed in the event of an expanded investigation.

Typical laboratory reporting limits for the analyses are presented on Table 2-3. Ideally, these reporting limits should meet or be lower than the potential chemical-specific applicable or relevant and appropriate requirements (ARARs) or to-be-considered (TBC) concentrations. However, it should be recognized that certain ARARs and/or TBCs are not achievable using current analytical methodology. Additionally, interference and/or elevated concentrations of target and non-target constituents could necessitate sample dilution to mitigate these effects and minimize damage to laboratory instruments. This dilution could result in elevated reporting limits that are largely outside of the control of the analytical laboratory.

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Sampling is currently planned to occur during June through September 2005. Data will initially be reported in a *Preliminary Phase I Data Report* that is due 45 days after receipt of all results from the analytical laboratory(ies). The remaining deliverables are outlined in Sections 5.0 and 7.3.5 of the RI/FS Work Plan, and include the following:

- Remedial Investigation Report
- Feasibility Study Report
- Treatability Study Report, if applicable
- Monthly Progress Reports

Section 9.0 of the RI/FS FSP presents the project schedule.

2.4 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

DQOs are qualitative and quantitative statements that clarify study objectives, define the type of data needed, and establish error limits for the quality and quantity of data needed to support decisions. DQOs are used to establish performance criteria, or measurement quality objectives, that take into account the purpose of data collection, the types of data needed, and tolerable limits for making decision errors (USEPA, 2000b). DQOs are developed through a six-step process:

- Step 1: State the Problem
- Step 2: Identify the Decision
- Step 3: Identify Inputs to the Decision
- Step 4: Define the Study Boundaries
- Step 5: Develop a Decision Rule
- Step 6: Specify Limits on Decision Errors

DQOs are revised and/or expanded, as needed, based on review of each data collection and analysis activity. Over the course of the RI/FS, it is anticipated that these DQOs will be revisited and adjusted as information not available at project outset is used to assist in their refinement. Additional discussion of

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the DQOs for the project is presented in Section 4.1 of the RI/FS Work Plan. The following sections present a discussion of DQO development as applied to the TFM.

2.4.1 DQO Step 1: State the Problem

BMcD under contract with the Oklahoma Department of Central Services Construction and Properties Division on behalf of the DEQ will conduct a RI and FS at the TFM. Details regarding the project organization and decision makers were presented in Section 2.1 of this QAPP. Primary data users include DEQ, USEPA, ITEC, and BMcD. Secondary data users include the U.S. Fish and Wildlife Service; City of Collinsville, Oklahoma; Tulsa County, Oklahoma; and other stakeholders. Background regarding the TFM and the RI/FS objectives were presented in Section 2.2 of this QAPP. The background and initial evaluation of the TFM are presented in greater detail in Sections 2.0 and 3.0 of the RI/FS Work Plan, respectively. A summary of the project and relevant deadlines was presented in Section 2.3 of this QAPP.

2.4.2 DQO Step 2: Identify the Decision

The purpose of this step is to identify the decision(s) that require the collection of new information. The primary goals are to identify the key questions(s) of the study; define alternative actions that could result from resolution of the study question(s); and combine the study questions and alternative actions into decision statement(s) (USEPA, 2000a). The primary decisions to be addressed during the RI/FS include:

- Determining whether the nature and extent of on-site contamination has been adequately defined, or if further investigation is necessary.
- Determining whether the extent of any off-site contamination has been adequately characterized, or if further investigation is necessary.
- Determining whether contaminant concentrations exceed ARARs or TBC values and require further action, or if further actions are not necessary.
- Determining whether TFM contamination poses an unacceptable risk to human health or the environment (i.e., human health and ecological risk assessment) and requires further action, or if further actions are not necessary based upon the results of the risk assessments.
- Assessing remedial alternatives to determine whether remedial goals can be achieved, or if other alternatives should be considered.

2.4.3 DQO Step 3: Identify Inputs into the Decision

Step 3 identifies information that is needed to support the decision statements made in Section 2.4.2, and also identifies areas that will require environmental data collection. To adequately address the decision statements, the following types of inputs are needed:

- Visual inspection to evaluate possible source locations at the TFM.
- Analytical laboratory data (primarily for arsenic, cadmium, lead, and zinc) to evaluate the nature and extent of contamination in groundwater, surface water, sediment, vegetation, air, and soil both on-site and off-site.
- Physical and chemical properties of wastes and contaminated media.
- Demographic characteristics and physical properties of the TFM.

2.4.4 DQO Step 4: Define the Study Boundaries

Step 4 clarifies the characteristics that the collected environmental data are intended to represent. The following activities are performed to define the study boundaries: define the population of interest; define the geographic area; as needed, divide the population into relatively homogeneous strata; determine the time frame to which the decision applies; determine the data collection time frame; define the scale of decision making; and identify any constraints on the data collection. The following paragraphs address each of these items.

Population of Interest

Surface soil, subsurface soil, groundwater, surface water, sediment, vegetation, and air are all media of interest for the TFM. The primary potential contaminants of interest in these media include metals. Parameters will be reported as indicated on Table 2-2 and discussed in Section 2.3 of this QAPP. Critical parameters will be arsenic, cadmium, lead, and zinc. Characterization of fate and transport mechanisms, including any intermedia transfer, is also of interest.

Geographic Area

The geographic area under consideration is the TFM, which is located in Tulsa County south of downtown Collinsville, Oklahoma. Additionally, off-site areas adjacent to the TFM are also of interest. Figure 1-1 of the RI/FS FSP provides a site location map relative to the city of Collinsville.

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Stratify the Site

There are several unique matrices based upon previous activities at the TFM. Due to the similarity in expected contamination within each matrix, these matrices are considered together in discussions of the TFM and present a means to stratify the TFM. The stratification of areas is outlined on Table 2-1 and includes:

- Waste Material
- Off-Site Surface Soil
- Groundwater
- Background Samples
- On-Site Surface Soil
- Surface Water and Sediment
- Ecological Samples
- Air Samples

Time Frame

Phase I of data collection is planned from June through September 2005. Based upon the results of Phase I, a second phase of data collection may be necessary to meet project objectives. If needed, Phase II data collection is planned from February to March 2006. Submittal of the RI Report and associated human health and ecological risk assessments are planned for June 2006, and submittal of the FS Report is planned for September 2006 (See Figure 9-1 of the RI/FS FSP).

Scale of Decision Making

The most appropriate scale for each media of concern was determined to be as follows:

- Surface Soil – Surface soil will be considered separately, as on-site surface soil and off-site surface soil.
- Subsurface Soil – Subsurface soil will be considered separately on-site, as areas where previous waste deposition is evident and areas where waste is not visually present.
- Groundwater – Groundwater will be considered on a site-wide basis.
- Air – Air will be considered on a site-wide basis.
- Surface Water and Sediment – Surface water and sediment will be considered separately, as on-site locations and off-site locations.
- Vegetation – Vegetation will be considered on the eastern TFM boundary.

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Constraints on Data Collection

Sampling may be delayed by excessive periods of rain that would limit accessibility to certain locations on the TFM. Additionally, refusal during boring activities may limit the ability to collect samples at depth.

2.4.5 DQO Step 5: Develop a Decision Rule

In Step 5, a decision rule is developed that defines the conditions that would cause the decision maker to choose among alternative actions. Activities involved in Step 5 include: specify the statistical parameter that characterizes the population; specify an action level for the decision; confirm that detection limits will allow reliable comparison with the action level; and state the decision rule.

Statistical Parameters

Different data uses will result in the potential need to examine multiple statistical parameters for a given media and/or location. Depending on the end use of the data (i.e., source identification, determination of extent of contamination, risk assessment, etc.), any one of several statistical parameters could prove useful. For example, the use of the maximum concentration of a constituent in a given population is useful for identification of source areas. The difference between the maximum concentration of a constituent at an area boundary versus background can be used for definition of the extent of contamination. Similarly, risk assessors often use the mean or 95 percent upper confidence limit of the concentrations of a constituent collected over a given area for purposes of their evaluation (See Section 5.6.2.2 of the RI/FS Work Plan).

Action Level

Given the multiple uses of the data, any one of several numerical values may prove useful to answer questions regarding the TFM. Collection of background data in the vicinity of the TFM is planned, and this data will be useful for determining the nature and extent of TFM-related contamination. Additionally, preliminary identification of ARARs and TBCs was performed for the RI/FS Work Plan (See Section 3.4 and Tables 3-1 through 3-5 of the RI/FS Work Plan), and these values may serve as action levels for various activities during the RI/FS. For example, comparison to industrial worker scenarios would be applicable to the human health risk assessment, and comparison to ecological screening levels would be applicable to the ecological risk assessment. In contrast, comparison to surface water quality standards will be useful for determining impacts of contamination to streams and ponds. To assist the reader, Tables 3-1 and 3-5 of the RI/FS Work Plan are reprinted in Appendix A of this QAPP.

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Confirm Detection Limits

To the extent that it is technically feasible using routine analytical techniques, the reporting limits for critical parameters should meet the potential chemical-specific ARAR or TBC concentrations indicated on Tables 3-1 to 3-5 of the RI/FS Work Plan (See Appendix A). Typical reporting limits for the parameters of interest are indicated on Table 2-3 of this QAPP. Parameters that exhibit reporting limits in excess of chemical-specific ARAR or TBC concentrations, including identification of the ARAR or TBC that is exceeded, are also indicated on Table 2-3 of this QAPP. In particular, many risk-based TBCs (in particular, ecological screening values) are concentrations that were calculated without consideration of the technical feasibility of achieving such a reporting limit in an environmental matrix using standard analytical methodology. Additionally, interference and/or elevated concentrations of target and non-target constituents could necessitate sample dilution to mitigate these effects and minimize damage to laboratory instruments. This dilution could result in elevated reporting limits that are largely outside of the control of the analytical laboratory. Therefore, automatic data rejection will not occur should a parameter's reporting limit exceed an ARAR or TBC. Instead, the magnitude of the exceedence will be considered in conjunction with the intended use of the data to determine its overall impact upon decision making.

Decision Rule

Given the many objectives of the RI/FS, several decision rules are appropriate for the project, as follows:

- If a parameter is not detected in a given area, it will be excluded from further characterization at that location. Exceptions are considered when elevated reporting limits are encountered. In these situations, an evaluation of the feasibility of improving analytical performance will be made.

- If the concentrations for a parameter are above background concentrations at the periphery of a given area, the extent of contamination will require further evaluation; otherwise, further evaluation is not necessary.

- If the concentration of a parameter exceeds ARARs or TBCs for a given population, further evaluation will be required; otherwise, no further evaluation is necessary.

- If the concentration of a parameter is shown to pose risk during the baseline risk assessment (See Section 5.6 of the RI/FS Work Plan), further evaluation and/or remedial actions will be required; otherwise, no further evaluation is necessary.

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- If a remedial alternative is not able to achieve parameter concentrations that are less than ARARs or TBCs, further evaluation will be required; otherwise, no further evaluation is necessary but may be performed to assess other available options.

2.4.6 DQO Step 6: Specify Limits on Decision Errors

Step 6 quantifies performance criteria for decision rules by expressing the probability limits on potential errors in decision making. The probability limits on decision errors specify the level of confidence desired in making conclusions regarding the Site data. The possibility of a decision study error exists due to the inherent variability in the sample collection and analysis process. The two main components of the "total study error" include the following:

- Sampling Design Error – Sampling design error is influenced by the sampling design, the number of samples collected, and the inherent variability of the media to be sampled. Sampling design error occurs when the collection program does not account for the variability within the media.

- Measurement Error – Measurement error is influenced by the sampling and analysis system. Errors are introduced into the system during sample collection, handling, preparation, analysis, and data reduction.

Two types of decision errors are common in environmental measurements. The first type of error is known as a false acceptance error. False acceptance errors occur when the data lead the end user to conclude that the baseline condition (for example, the site is contaminated) is true when it is really false. In contrast, false rejection errors occur when the data lead the end user to conclude that the baseline condition (for example, the site is contaminated) is false when it is really true. For purposes of the RI/FS, a decision error of 5 percent (or a confidence level of 95 percent) for both false acceptance and false rejection errors has been established.

Additionally, to limit impractical or infeasible sample sizes, a gray region of possible values near the action level where the true value is "too close to call" is selected. It is an area where it is not feasible to control the false acceptance decision error to low levels since the costs of sampling and analysis outweigh the potential consequences of choosing the wrong course of action. For purposes of the RI/FS, the lower boundary of the gray area was selected at 80 percent of the action level and the upper boundary of the gray area was selected as the action level. Table 2-4 presents the decision error limits and corresponding gray region.

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To minimize the possibility of decision errors, the components of the total study error are examined. Sampling design error can be minimized by collecting a larger number of samples, or in the case of resource limitations, using screening technologies to focus sampling on areas of potential concern. Measurement errors can be minimized by replicate analysis of the same sample or by selecting cleanup, preparation, and analysis methods that are best suited to the site matrix. Measurement errors will be assessed by reviewing several data quality indicators (DQIs) including precision, accuracy, representativeness, completeness, and comparability as presented in Section 3.5.

2.4.7 Measurement Quality Objectives

The overall objective of the QAPP is to establish QA criteria for project activities so that the data generated are scientifically valid and usable for the project objectives. To support this overall objective, the following management objectives have been established for the investigation:

- Sample analysis will be completed in accordance with the methods, or equivalent procedures, listed on Table 3-1 to provide supportable results.

- Parameters will be reported as indicated on Table 2-2. Critical parameters will be arsenic, cadmium, lead, and zinc based previous site investigations and data from other smelter sites.

- To the extent that it is technically feasible using routine analytical techniques, the reporting limits for critical parameters should meet the potential chemical-specific ARAR or TBC concentrations indicated on Tables 3-1 to 3-5 of the RI/FS Work Plan, which are reprinted in Appendix A. Parameters that typically exhibit reporting limits in excess of chemical-specific ARAR or TBC concentrations are indicated on Table 2-3 of this QAPP.

- Data will be evaluated for achievement of method-specific QA/QC criteria. Data qualifiers, when appropriate, will be added to the data in accordance with the *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* ([NFGI] USEPA, 2004c) and *Contract Laboratory Program National Functional Guidelines for Organic Data Review* ([NFGO] USEPA, 1999b), as appropriate. Data that are rejected during validation due to problems with analytical quality or significant matrix-related interference will not be usable for purposes of the RI/FS.

- Objectives for the DQIs of precision, accuracy, representativeness, comparability, and completeness are summarized on Table 3-2. Detailed discussion of impacts of not meeting control limits for a particular indicator are presented in Section 3.5 of this QAPP.

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- Data will be reported in units consistent with environmental engineering, geologic, hydrogeologic, and analytical laboratory standards applicable for the data being collected. Additionally, the results for soil samples will be presented on a dry-weight basis.

2.5 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

Special training requirements or certifications for this project are limited to the following:

- 40-hour Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) training and annual refreshers for the field crew and drilling contractor
- Certification in the State of Oklahoma and/or NELAP for the lab performing chemical analyses
- Certification in the State of Oklahoma as a Well Driller for monitoring well installation
- RLS for establishment of Site benchmark

The BMcD Project Manager is responsible for assuring that the project team and any subcontractors have the appropriate training and certifications.

2.6 DOCUMENTATION AND RECORDS

Deliverables anticipated for the RI/FS are detailed in Section 5.0 of the RI/FS Work Plan. The project schedule for these deliverables is presented in Section 6.0 of the RI/FS Work Plan and is repeated in Section 9.0 of the RI/FS FSP.

The most current version of this QAPP will be maintained by the BMcD project manager and distributed by the DEQ Project Manager to parties on the distribution list if there are revisions. Revisions to the QAPP may be readily identified by the revision number and date appearing in the header and footer of the document, respectively.

All field data will be entered into bound notebooks or files. Record-keeping and documentation procedures for BMcD are discussed in Section 5.0 of the RI/FS FSP.

Information pertaining to the analytical laboratory documentation, record keeping, and narratives will be provided in the laboratory QAPPs or is outlined in the Statements of Work for the CLP lab(s). QAPPs for laboratories subcontracted by BMcD will be provided as they are contracted. QAPPs for the USEPA Region 6 Laboratory and the Oklahoma SEL are maintained at those facilities. The minimum data anticipated for the laboratory data package are the sample and QC results associated with the analysis.

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Field notebooks, chain-of-custody (COC) records, field data sheets, disks, tapes, and lab reports will be filed and stored at BMcD offices located in Kansas City, Missouri. Further details regarding documentation and filing are provided in Section 5.0 of the RI/FS FSP. After the first six months following completion of the project, these files may be transferred to long-term storage facilities located in Kansas City, Missouri or transferred to DEQ.

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3.0 DATA GENERATION AND ACQUISITION

3.1 SAMPLING PROCESS DESIGN

A summary of activities was discussed in Sections 2.2 and 2.3. Table 2-1, which is a reprint of Table 4-1 from the RI/FS FSP, provides a summary of planned sample collection and their subsequent analyses. Tables 4-2 through 4-6 of the RI/FS FSP, provide details regarding sampling locations, names, and analyses. Figures 4-1 through 4-4 of the RI/FS FSP illustrate the proposed sample locations.

Details regarding the sampling process design and rationale are provided in Section 5.3 of the RI/FS Work Plan. Specific sampling areas were selected using judgmental sampling based on knowledge of past TFM operations and historical data to correlate with known areas of contamination or areas commonly known to be sources of contamination. The following sections discuss the planned samples.

3.1.1 Waste Materials

Trench sampling techniques will be used to collect samples on-site in apparent areas of waste deposition. Emphasis will be placed on collecting samples at the surface (0 to 6 inches below ground surface [bgs]) and the native clay under the waste materials. At 50 percent of the trench locations, a sample of the waste materials will be collected from mid-depth in the trench. At trench sampling locations, samples will be collected and submitted to SEL for analysis of arsenic, cadmium, lead, and zinc using a laboratory X-Ray Fluorescence spectrometer (XRF), and confirmation analysis using inductively coupled plasma (ICP) methodology will be performed for 10 percent of these samples. Additionally, 10 percent of all waste samples will be analyzed for TCLP arsenic, cadmium, and lead. In this manner, biased ranked set sampling will be used to maximize resource allocation (See Section 5.3 of the RI/FS Work Plan).

3.1.2 On-Site Soils

Direct-push sampling techniques will be used to collect samples on-site in areas where slag-like materials are not expected to provide subsurface obstruction. As indicated on Figure 4-1 of the RI/FS FSP, direct-push sampling locations were approximately placed in 200-ft grid pattern. Samples will be collected from the surface (0 to 6 inches bgs), shallow subsurface (6 inches to 2 ft bgs), and deeper subsurface (2 to 4 ft bgs). Additionally, samples will be collected at depth to provide a vertical profile of TFM soils (See Table 2-1) at locations selected for installation of temporary piezometers (See Section 3.1.5). At direct-push sampling locations, samples will be collected and submitted to SEL for analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF. Confirmation analysis using ICP methodology will be

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performed for 10 percent of these samples. Additionally, 10 percent of the direct-push soil samples will be analyzed for TCLP arsenic, cadmium, and lead.

In addition to the direct-push samples, surface soil samples (0 to 6 inches bgs) will be collected at eight on-site sampling locations. These samples will be submitted to SEL for analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF, and confirmation analysis using ICP methodology will be performed for 10 percent of these samples. Additionally, 10 percent of the surface soil samples will be analyzed for TCLP arsenic, cadmium, and lead.

3.1.3 Off-Site Surface Soil

Off-site surface soil samples will be collected as four distinct sets of data. In all cases, surface soil will be collected from 0 to 3 inches bgs. A shallower depth interval was selected for the off-site samples as compared to the on-site surface soil samples to avoid overly diluting disperse aerial deposition of stack emissions. Samples will be collected and submitted to SEL for analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF, and confirmation analysis using ICP methodology will be performed for 10 percent of these samples. Additionally, 10 percent of all off-site surface soil samples will be analyzed for TCLP arsenic, cadmium, and lead.

In order to provide real-time delineation of the off-site surface soil samples, a hand-held XRF will be used during collection of surface soil from off-site locations. Use of the instrument will provide immediate feedback regarding the off-site sampling grid and any need for its expansion (i.e., Results from the XRF indicate that aerial deposition from the TFM smokestack was more dispersed than thought, and additional samples should be collected). However, all samples selected for field XRF analysis will also be submitted to the SEL for analysis of metals in a laboratory setting. The laboratory-analyzed samples will be used to make decisions regarding the TFM. Appendix B provides a reprint of SOP TFM-124 “X-Ray Fluorescence Procedures for Field Analysis” from the RI/FS FSP, which documents field XRF procedures.

Off-Site Surface Soil samples will be collected as the following four distinct sets of data (See Figure 4-2 of the RI/FS FSP):

- Tribal Residence Sampling Location – Based on information obtained from ITEC, surface soil samples will be collected from tribal residence locations that are within ½ mile of the TFM.

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- Targeted Off-Site Sampling Location – A survey was conducted of the surrounding area to target high-interest sampling locations such as parks, schools, play grounds, day care centers, etc. Surface soil samples will be collected from these "targeted" areas.

- Off-Site Grid Sampling Location – As shown on Figure 4-2 of the RI/FS FSP, off-site surface soil sampling locations were placed approximately 500-ft apart in a grid surrounding the site. The grid was oriented in the prevailing north-south wind direction, and was also adjusted based on placement of the Tribal Residence Samples and Targeted Off-Site Samples. For the first two rows of the grid that are immediately north and south of the site, surface soil samples will be collected at each of the grid locations. After these rows, the distance between sampling locations on the grid will be increased such that samples are collected at every other grid location (i.e., approximate 1000-ft grid spacing) as indicated on Figure 4-2 of the RI/FS FSP. If the field XRF indicates the presence of lead at these locations, then the sampling grid will be reduced such that the samples are again collected at 500-ft spacing.

- Distance Sampling – Samples will be collected at distances of ½ mile, 1 mile, and 1 ½ miles from the site to determine the long-range extent of aerial deposition of metals. Prevailing winds in the area are north, north-northwest, south, and south-south east. Surface soil samples will be collected at 1 mile and 1 ½ miles from the TFM in these directions. Since there is less of an easterly or westerly component to winds in this area, surface soil samples in the east and west direction will only be collected at ½ mile and 1 mile from the TFM.

3.1.4 Surface Water and Sediment

Samples will be collected from three large on-site ponds believed to be remnants of the former reservoir, two smaller on-site ponds, an intermittent drainage the travels through the waste deposition area toward the eastern property boundary, the strip mine pit, and 13 off-site locations (see Table 4-4 and Figure 4-3 of the RI/FS FSP). Sediment samples will be submitted to SEL for off-site analysis of arsenic, cadmium, lead, and zinc using a laboratory XRF, and confirmation analysis using ICP methodology will be performed for 10 percent of these samples. Additionally, ten percent of the sediment samples will be analyzed for TCLP arsenic, cadmium, and lead. Surface water samples will be submitted to SEL for analysis of arsenic, cadmium, and lead using ICP methodology. In addition, surface water samples will be analyzed for general water chemistry parameters (total organic carbon [TOC], chemical oxygen demand [COD], alkalinity, nitrate as nitrogen, sulfate, and chloride).

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3.1.5 Groundwater

Direct-push techniques will be used to install 11 temporary piezometers at the TFM. During installation of the piezometers, samples will be collected from the first encountered groundwater. These samples will be submitted to SEL for analysis of arsenic, cadmium, lead, zinc, and general water chemistry parameters (TOC, COD, alkalinity, nitrate as nitrogen, sulfate, and chloride). If field-measured turbidity exceeds 50 nephelometric turbidity units (NTUs), metals samples will be submitted to the lab field-filtered and unfiltered. Once installed, the temporary piezometers will be used to determine groundwater flow in the area.

Following determination of groundwater flow direction, five monitoring wells will be located and installed at the TFM in a manner to evaluate the impact to groundwater, if any, at the TFM boundaries (upgradient and downgradient) and downgradient of suspected sources of contamination. Groundwater samples will be collected from these new wells and the existing residential well and submitted for analysis of arsenic, cadmium, lead, zinc and general water chemistry parameters (TOC, COD, alkalinity, nitrate as nitrogen, sulfate, and chloride). If field-measured turbidity exceeds 50 NTUs, metals samples will be submitted to the lab field-filtered and unfiltered.

3.1.6 Air

Air samples will be collected from two locations to evaluate the air quality in the proximity of human and ecological receptors. Preliminary sampling locations were chosen to provide a representative worst-case scenario at technically feasible sampling locations using criteria such as a combination of winds and low precipitation, proximity to waste source, and access and/or land use to waste source and downwind areas. At the time of sampling, locations will be finalized such that a sample is collected upwind and downwind of the prevailing wind. Samples will be collected over a one-week period. Potential impact of waste materials on ambient air quality will be determined by sampling and analysis for total suspended particulate (TSP), small particulate matter (PM_{10}), and airborne particulate metals (See Section 5.3 of the RI/FS Work Plan).

3.1.7 Ecological

On-site blackberry bushes (blackberries, leaves, and roots) were sampled during the 2004 growing season by DEQ. These samples are currently frozen and will be submitted for analysis of arsenic, cadmium, lead, and zinc. An additional set of samples will be collected during the RI. Individual blackberries, leaves, roots, and soil surrounding the roots will be sampled from two on-site locations. Washed and unwashed samples of the blackberries and leaves will be submitted. Washed samples from the roots will

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be submitted. The samples will be used to evaluate potential metals content within on-site plant material, both due to aerial deposition (unwashed) and plant uptake (washed).

3.1.8 Background

Background sampling will be conducted to evaluate naturally occurring presence of metals in soil, groundwater, surface water, sediment, and vegetation in the area. Samples will be collected from one monitoring well (installed during RI Phase I), two soil borings, two surface soil locations, two surface water locations, two sediment locations, and one blackberry bush location.

3.2 SAMPLING METHODS REQUIREMENTS

Nonstandard sampling activities are not planned. Detailed information regarding sample collection procedures/methods, required equipment, decontamination of sampling equipment, and handling of investigation derived waste is included in Volume I of this SAP (i.e., RI/FS FSP), as follows:

- Sampling Locations and Accessibility – RI/FS FSP Section 4.2
- Subsurface Soil Collection – RI/FS FSP Section 4.4
- Surface Soil Collection – RI/FS FSP Section 4.5
- Surface Water Collection – RI/FS FSP Section 4.6
- Sediment Collection – RI/FS FSP Section 4.7
- Groundwater Collection – RI/FS FSP Section 4.8
- Air Collection – RI/FS FSP Section 4.9
- Ecological Sample Collection – RI/FS FSP Section 4.10
- Field QA/QC Sample Collection – RI/FS FSP Section 4.11
- Investigation-Derived Wastes – RI/FS FSP Section 7.0
- Standard Operating Procedures (SOPs) – RI/FS FSP Appendix B

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In general, sampling activities will follow the protocols established in the *Contract Laboratory Program Guidance for Field Samplers, Final* (USEPA, 2004b). A summary of sample containers, preservatives, and holding times is provided on Table 3-1.

Support facilities for field activities will be the BMcD offices in Kansas City, Missouri. The primary analytical laboratory is the Oklahoma SEL. STL Burlington will analyze the air and ecological samples, and Midwest Laboratories will serve as a backup lab for the ecological sample analysis. Due to unforeseen circumstances at SEL and/or expanded analytical requirements, the USEPA Region 6 Lab and/or CLP Lab(s) may also analyze samples collected from TFM.

If problems are encountered during sampling or field activities are not performed according to specifications in the RI/FS Work Plan, RI/FS FSP, or QAPP, the BMcD project manager and/or FSM will be responsible for initiating corrective actions.

Corrective action for field measurement may include:

- Repeat the measurement to check the error
- Check for all proper adjustments for ambient conditions such as temperature
- Check the batteries
- Check the calibration
- Replace the instrument or measurement device

Corrective action for sampling procedures may include:

- Evaluating and amending sampling procedures
- Resampling

The QC Director will be notified if nonconformance is of program significance or requires special expertise not normally available to the project team.

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3.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Detailed information regarding sample handling, packaging, shipping, custody, and documentation requirements can be found in Sections 5.0 and 6.0 of the RI/FS FSP. Additionally, information regarding the management of investigation-derived waste is provided in Section 7.0 of the of the RI/FS FSP. In general, sampling activities will follow the protocols established in the *Contract Laboratory Program Guidance for Field Samplers, Final* (USEPA, 2004b). When needed (i.e., for shipment of samples to the CLP Labs), Forms II Lite software will be used to generate appropriate documentation (COCs, sample labels, sample tags, etc.). However, less prescriptive procedures will be followed when submitting samples to non-CLP laboratories (i.e., SEL, STL, etc.).

3.4 ANALYTICAL METHODS REQUIREMENTS

Samples will be collected and analyzed as indicated on Table 2-1. The primary constituents of interest for the TFM site are metals. However, critical analytes of interest include only arsenic, cadmium, lead, and zinc. These four will act as indicator parameters for the other metals.

SEL will be primary analytical laboratory for the RI/FS. SEL will analyze all soil and sediment samples for arsenic, cadmium, lead, and zinc using laboratory XRF procedures. The SOP for the laboratory XRF analysis is included as Appendix C to this QAPP. As confirmation, SEL will analyze approximately 10 percent of the soil samples using ICP methodology. Groundwater and surface water samples will be analyzed using ICP methodology.

The analytical parameter list for each class of compounds is provided on Table 2-2. Several classes of compounds are noted as “potential analyses” on this table. This information was included to encompass analysis types that may be needed to fully assess the area in the immediate vicinity of the former residence (i.e., trash dump). Target reporting limits are provided on Table 2-3, and the results for soil samples should be reported on a dry-weight basis. Due to the potential use of multiple laboratories, the analytical method and/or reporting limit may not be identical for each compound class. However, samples analyzed using methods from the following sources should yield data that is comparable:

- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Final Update III* ([SW-846 Methods] USEPA, 1997)
- *USEPA CLP Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration* ([OLM04.3] USEPA, 2003)

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- *USEPA CLP Statement of Work for Analysis of Low Concentration Organic* ([OLC03.2] USEPA, 2000c)
- *USEPA CLP Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration* ([ILM05.3] USEPA, 2004a)
- *Methods for Chemical Analysis of Water and Wastes* (USEPA, 1983)
- *Standard Methods for the Examination of Water and Wastewater, 19th Edition*, prepared by the American Public Health Association, American Water Works Association, and Water Environment Federation ([SM Methods] American Public Health Association, 1995)
- *Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air* ([IO Methods] USEPA, 1999a)

Data deliverables for the SEL should generally be available 45 days following the receipt of the last sample to the SEL. For all labs except the SEL, the analytical turn-around time will be 21 days from receipt of last sample at the laboratory, unless other arrangements are made with the BMcD Project Manager.

The laboratory QAPPs contain information regarding analytical equipment, maintenance, and calibration for analyses performed using these methods. In addition, the laboratory QAPPs detail corrective actions that are to be taken in the event of QC failures. If a condition in the laboratory is discovered which compromises analytical data, the laboratory will contact the appropriate party (USEPA, DEQ, or BMcD - depending upon which party has oversight for lab activities) as soon as practicable. The laboratory QA officer and the appropriate project managers (USEPA, DEQ, and/or BMcD) will address the situation as soon as practicable. Any action taken will be recorded and eventually included in the data submittal for the RI/FS.

3.5 QC REQUIREMENTS

To assess whether QA objectives for this project have been achieved, the following DQIs will be considered: precision, accuracy, representativeness, comparability, and completeness. To monitor the quality of field sampling techniques and potential sample transport anomalies, QC samples (including trip blanks, field blanks, matrix spike [MS]/ matrix spike duplicates [MSDs] and field duplicate samples) will be submitted with the samples collected in the field. A summary of the planned QC samples is provided

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in Section 4.11 of the RI/FS FSP, and is briefly discussed in the following sections. The combined laboratory and field QC procedures will provide an adequate database for evaluation of analytical data. Discussion of laboratory QC Samples (blanks, surrogates, and laboratory control samples [LCS]) and procedures are presented in the laboratory QAPPs. Data will be evaluated for achievement of any method-specific QA/QC criteria. Data qualifiers, when appropriate, will be added to the data in accordance with USEPA's NFGO and NFGI. Table 3-2 presents the achievement objectives (i.e., control limits) for the DQIs. Discussion regarding the DQIs, QC samples and control limits for each indicator, and potential corrective actions for any outliers are provided in the following sections.

3.5.1 Precision

Precision is the level of agreement among individual measurements of the same chemical or physical property. During the data validation process, precision is expressed in terms of relative percent difference (RPD). Chemical concentration data obtained from the analysis of field duplicate, laboratory duplicate, MSD, and/or laboratory control sample duplicate (LCSD) samples will be compared to evaluate analytical precision. The RPD is calculated using the following equation:

$$RPD = \frac{|(D_1 - D_2)|}{(D_1 + D_2)/2} \times 100$$

Where:

RPD = Relative Percent Difference
D_1 = First Duplicate Value
D_2 = Second Duplicate Value

Perfect precision would be indicated by a RPD of 0 percent. In general, RPD values less than 20 percent for water and 35 percent for soil indicate adequate precision for a given analysis. However, the CLP Statements of Work have RPD limits established in each method. For analyses other than CLP, most laboratories establish QC limits at the approximate 99 percent confidence interval using historical data sets. For samples having low chemical concentrations (less than five times the requested reporting limit), a sensitivity test is conducted. If the difference in duplicate sample analytical results is less than one times the reporting limit for water or two times the reporting limit for soil, the sensitivity test is passed, and analytical data for samples having low chemical concentrations are considered acceptable.

3.5.1.1 Laboratory Control Sample/Laboratory Control Sample Duplicate

Certain USEPA methods require the analysis of a LCS in each analytical batch, up to a maximum of 20 samples. For the LCS, an interference-free matrix is spiked with known concentrations of target

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constituents and analyzed. In addition, while not required by the methodology, some laboratories analyze a duplicate preparation of the LCS (called the LCSD). The intent is to measure analytical accuracy and precision of the method in the absence of sample matrix effects. When provided, the results of the LCS/LCSD will be utilized to assess the precision of the preparation and analysis methods. The maximum RPD between the LCS and LCSD is typically 20 percent for aqueous samples and 35 percent for soil samples. However, USEPA methodology allows for statistical determination of the control limits on a parameter-specific basis.

Any RPD outside of control limits for the LCS/LCSD requires evaluation by the lab. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected and the samples reanalyzed. If no instrument problem is found, then the magnitude of the result from control limits should be evaluated. Significant deviance from control limits (i.e., RPDs that exceed control limits by more than 25 percent) may necessitate reanalysis. However, if the corresponding RPD for the MS/MSD sample is within control limits, such reanalysis is not necessary. In some instances, the corrective action will involve flagging the data during data validation (See Section 5.0).

3.5.1.2 Matrix Spike/Matrix Spike Duplicate Samples

MS and MSD analytical results will be utilized to assess the accuracy and precision of the laboratory analytical results in the presence of any potential sample matrix interference. BMcD field staff will collect triplicate samples and designate the samples as field, MS, and MSD samples. The project goal is to collect a minimum of five percent MS and MSD samples during the sampling event with emphasis on collecting MS/MSDs for each unique matrix. The laboratory will spike the MS and MSD samples with known concentrations of target analytes prior to analysis. As a measure of precision, results of the MS and MSD are compared to each other to determine the RPD. Laboratory methodology generally requires the analysis of a MS/MSD pair in each analytical batch, up to a maximum of 20 samples. The maximum RPD between the MS and MSD is typically 20 percent for aqueous samples and 35 percent for soil samples. However, USEPA methodology allows for statistical determination of the control limits on a parameter-specific basis.

Any RPD outside of control limits for the MS/MSD requires evaluation by the lab. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected and the samples reanalyzed. If no instrument problem is found, then the magnitude of the result from control limits should be evaluated. Significant deviance from control limits (i.e., RPDs that exceed control limits

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by more than 25 percent) may necessitate reanalysis. However, if the corresponding RPD for the LCS/LCSD sample is within control limits, such reanalysis is not necessary and the exceedence may be attributable to sample non-homogeneity and/or matrix interference. In some instances, the corrective action will involve flagging the data during data validation (See Section 5.0).

3.5.1.3 Laboratory Duplicate Samples

For samples analyzed using the CLP Inorganic Statement of Work, the methodology calls for analysis of an MS and laboratory duplicate. In these instances, samples are collected in triplicate volume and designated as field, MS, and lab duplicate samples. The laboratory will analyze the field sample and duplicate sample using the same preparation and analytical techniques. To assess precision, the results of the field sample and duplicate are compared. The project goal is to collect a minimum of five percent lab duplicate samples during the sampling event with emphasis on collecting lab duplicates for each unique matrix. When required by the methodology, lab duplicates are generally analyzed in each analytical batch, up to a maximum of 20 samples. The maximum RPD between the sample and duplicate is typically 20 percent for aqueous samples and 35 percent for soil samples. However, USEPA methodology allows for statistical determination of the control limits on a parameter-specific basis.

Any RPD outside of control limits for the lab duplicate requires evaluation by the lab. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected and the samples reanalyzed. If no instrument problem is found, then the magnitude of the result from control limits should be evaluated. Significant deviance from control limits (i.e., RPDs that exceed control limits by more than 25 percent) may necessitate reanalysis. However, if the corresponding RPD for the LCS/LCSD and/or MS/MSD sample is within control limits, such reanalysis is not necessary and the exceedence may be attributable to sample non-homogeneity and/or matrix interference. In some instances, the corrective action will involve flagging the data during data validation (See Section 5.0).

3.5.1.4 Field Duplicate Samples

Field duplicate sample results will indicate the precision and reproducibility of sample collection and analytical results. A field duplicate sample is obtained from a single or composite sample that is split into two similar portions to produce two samples. The project goal is to collect a minimum of 10 percent duplicate samples during the sampling event. Collection of field duplicate samples is presented in Section 4.11 of the RI/FS FSP. The field duplicate samples will be collected in the same manner and analyzed for the same parameters as field samples from the same location. For purposes of review, the maximum

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allowable RPD for field duplicate samples is set at 20 percent for aqueous samples and 35 percent for soil samples. Results less than five times the reporting limit will be compared using a sensitivity test as described in Section 3.5.1.

It should be noted that field duplicate samples are expected to have greater variability than lab duplicates. Any RPD outside of control limits for the field duplicate requires evaluation. The sample collection method should be verified to determine likely sources of sample non-homogeneity. Additionally, the RPD calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, then the lab should be contacted and requested to verify their results. Additionally, any information the laboratory can give regarding apparent homogeneity of the sample within the sample container should be obtained. If analytical holding times have not been exceeded and sufficient sample volume remains, it may be beneficial to have the lab repeat the sample analysis in instances where the field duplicate RPD is significantly outside of control limits (i.e., RPDs that exceed control limits by more than 50 percent). If the corresponding RPD for the LCS/LCSD and/or MS/MSD samples are within control limits, the field duplicate failure may be attributable to sample non-homogeneity. In some instances, the corrective action will involve flagging the data during data validation (See Section 5.0) or rejection of the results for the original and duplicate sample.

3.5.2 Accuracy

Accuracy measures the bias of a measurement system and may be defined as the degree of agreement between a measurement and its accepted or true value. The accuracy of chemical results is assessed by examining the results of spike recovery and blank samples.

3.5.2.1 Blank Samples

Blank (laboratory, field, and trip) results are used to evaluate whether field or laboratory handling may have contaminated samples and adversely impacted analytical accuracy. The results of these analyses allow an evaluation of whether detections may represent chemicals introduced into the samples during handling, sample shipment, or analytical preparation and analysis.

Blanks are expected to have no detections of target constituents. Any blank detection that exceeds the constituent's reporting limit requires corrective action to determine the apparent source of contamination and/or reanalysis of the blank to confirm the detection. Detections between the method detection limit (MDL) and reporting limit do not require corrective action. Results in field samples that are less than five times the corresponding contaminated blank value are generally considered false positives and flagged accordingly during data validation (see Section 5.0). Instances of gross contamination (i.e., blank

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detections exceed applicable screening levels) may require reanalysis and/or resampling if the corresponding field samples have similar detections.

Method Blanks

USEPA methodology generally requires the analysis of a method blank sample in each analytical batch, up to 20 samples. For the method blank, a clean matrix is prepared and analyzed in the same manner as the field samples. Any detection in the method blank indicates potential laboratory contamination of the associated field samples in the analytical batch.

Trip Blanks

Trip blanks are utilized for samples planned for VOC analysis. The laboratory prepares trip blanks and sends them to the field along with the containers for sample collection. They are utilized to determine if any VOCs diffused through the sample container septum due to site, shipping, or laboratory conditions; thereby, causing cross-contamination of samples. One trip blank will be included in each cooler that contains samples for VOC analysis.

Field Blanks

Field blanks for VOCs samples will be prepared in the field on a daily basis by sampling personnel to assess the ambient conditions under which the samples were collected. Field blanks will be prepared by pouring deionized water directly into the VOC sample containers. The field blanks will be submitted to the laboratory for VOC analysis.

3.5.2.2 Spike Recovery Studies

Spike recovery studies (surrogates, LCS/LCSD, and MS/MSD) results are used to evaluate the ability of the laboratory to recover constituents that are intentionally spiked into the samples. Accuracy of spiked samples is expressed as the percent recovery (REC). The REC is calculated using the following equation.

$$REC = \frac{(SSR - SR)}{SA}$$

Where:

REC = Recovery
SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Amount Added

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Perfect accuracy is defined as 100 REC. In general, REC values from 70 to 130 percent indicate adequate accuracy for a given analysis. However, the CLP Statements of Work have REC limits established in each method. For analyses other than CLP, most laboratories establish QC limits at the approximate 99 percent confidence interval using historical data sets. It should also be recognized that not all constituents are capable of recovering within this range. An elevated REC indicates high sensitivity or high bias in detecting a compound; therefore, non-detect results would be considered reliable. A low REC indicates a low sensitivity or low bias in detecting a compound, which leaves the possibility of false negative results.

Surrogates

Surrogates are added to each sample that undergoes organic analyses. Surrogates are compounds that are not normally found in environmental samples that are added (spiked) into field and QC samples and analyzed for REC. Surrogates are utilized to give an indication of the analytical accuracy of the preparation and analysis methods on a per sample basis. In general, REC values from 70 to 130 percent indicate adequate accuracy for a given analysis. However, USEPA methodology allows for statistical determination of the control limits on a parameter-specific basis.

Any surrogate REC outside of control limits requires evaluation by the lab. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected and the samples reanalyzed. If no instrument problem is found, then the sample should be re-extracted and reanalyzed, as applicable, according to method requirements. If the REC is still outside of control limits upon reanalysis, the data should be considered estimated. In some instances, the corrective action will involve flagging the data during data validation (See Section 5.0).

LCS/LCSD

The LCS and LCSD will be prepared and analyzed as described in Section 3.5.1.1. As a measure of accuracy, the results of these two portions are compared against the known analyte concentrations in the spike to determine REC. The purpose of the LCS/LCSD is to determine the performance of the laboratory with respect to analyte recovery, independent of field sample matrix interference. In general, REC values from 70 to 130 percent for organic analyses and 80 to 120 percent for inorganic analyses indicate adequate accuracy for a given analysis. However, USEPA methodology allows for statistical determination of the control limits on a parameter-specific basis.

Any LCS or LCSD REC outside of control limits requires evaluation by the lab. At a minimum, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred,

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instrument performance should be verified. If an instrument problem is found, it should be corrected and the samples reanalyzed. If no instrument problem is found, then the corresponding REC for the MS/MSD should be examined. If the problem is limited to the LCS or LCSD and MS/MSD results are acceptable, then the problem is likely limited to only that sample and further corrective action would not be required. Depending upon the number and magnitude of compounds with LCS and/or LCSD REC failures, corrective action may include reanalysis of only the LCS and/or LCSD or re-extraction and reanalysis of all samples within the batch. In some instances, the corrective action will involve flagging the data during data validation (See Section 5.0).

MS/MSD

MS/MSDs will be collected, prepared, and analyzed as described in Section 3.5.1.2. As a measure of accuracy, the results of the MS and MSD are compared against the known analyte concentrations to determine REC. The purpose of the MS/MSD is to determine analytical performance in the presence of any sample matrix interference. In general, REC values from 70 to 130 percent for organic analyses and 80 to 120 percent for inorganic analyses indicate adequate accuracy for a given analysis. However, USEPA methodology allows for statistical determination of the control limits on a parameter-specific basis.

Any MS or MSD REC outside of control limits requires evaluation by the lab. At a minimum, the data should be compared to the corresponding LCS/LCSD. If the problem is limited to the MS/MSD, the problem is likely attributable to sample matrix interference that is largely outside of the control of the lab. Additionally, calculations should be checked for errors and corrected when necessary. If no calculation errors occurred, instrument performance should be verified. If an instrument problem is found, it should be corrected and the samples reanalyzed. Depending upon the number and magnitude of compounds with MS and/or MSD REC failures, corrective action may include reanalysis of the MS and/or MSD or re-extraction and reanalysis of all samples within the batch. In some instances, the corrective action will involve flagging the data during data validation (See Section 5.0).

3.5.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. The representativeness of the data will be determined by:

- Qualitative comparison of actual sampling procedures to those presented in the RI/FS FSP.

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- Quantitative comparison of analytical results for field duplicates and/or field splits to determine parameter variation at a sampling point.
- Invalidating nonrepresentative data or identifying data to be classified as questionable through qualitative or quantitative data validation procedures.

Nonrepresentative or questionable data are data that do not accurately reflect site conditions. If data are determined to be nonrepresentative, they will not be used in subsequent data reduction, validation, and site characterization. If a critical data point or parameter is determined to be nonrepresentative, the need for additional data collection will be carefully assessed by the BMcD Project Manager in conjunction with DEQ and USEPA Project Managers.

3.5.4 Completeness

Completeness defines the percentage of measurements judged to be valid measurements. Completeness is assessed for both field and laboratory activities.

Field Completeness

Field completeness is assessed by comparing the number of samples collected to the number of samples planned for collection, as follows:

$$\% \text{ Field Completeness} = \frac{\text{Number of samples collected}}{\text{Number of samples planned}} \times 100$$

The field completeness goal for this project is 90 percent. If field completeness falls below 90 percent, the need for additional data collection to meet project objectives will be carefully assessed by the BMcD Project Manager in conjunction with DEQ and USEPA Project Managers.

Laboratory Completeness

Laboratory completeness is assessed by comparing the number of valid sample results to the total number of sample results, as follows:

$$\% \text{ Laboratory Completeness} = \frac{\text{Number of valid results}}{\text{Total number of results}} \times 100$$

The laboratory completeness goal for this project is 95 percent. If laboratory completeness falls below 95 percent for a critical parameter or sampling location, the need for additional data collection will be

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carefully assessed by the BMcD Project Manager in conjunction with DEQ and USEPA Project Managers.

3.5.5 Comparability

Comparability is a qualitative parameter used to express the confidence with which one data set may be compared to another. To produce comparable data, the units specified for analytical results obtained during the field investigations will be consistent throughout this project, and standardized analytical methods will be utilized for each parameter.

3.5.6 QA Split Samples

QA split samples may be collected during the sampling event to determine analytical precision and comparability. The QA split sampling is performed by collecting three samples from a given location. Two of the samples are submitted to the primary analytical laboratory as a field sample and blind duplicate. The third sample (i.e., the QA split) is submitted to a secondary laboratory for analysis. Results of all three samples are then compared to assess analytical precision, similar to field duplicates (See Section 3.5.1.4).

3.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

Details regarding field instrumentation is provided in Section 4.8 of the RI/FS FSP and relevant SOPs for calibration and sampling in Appendix B of the RI/FS FSP. In general, the following field instruments may be used during sampling:

- Photoionization Detector (PID)
- Oxygen/Explosive Gas Meter
- Multimeter capable of measuring
  - pH
  - Temperature
  - Conductivity
  - Turbidity
- XRF Instrument (See Appendix B for field XRF procedure)

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A maintenance, calibration, and operation program will be implemented for routine calibration and maintenance on all field instruments. The FSM and the team members will administer the program. Trained staff members will perform field calibrations, equipment checks, and instrument maintenance prior to using equipment. Each piece of equipment will have a unique serial number for tracking during field use and calibration for maintenance records.

Team members will be familiar with the field calibration, operation, and maintenance of the equipment. They will maintain proficiency in equipment operation, perform the prescribed field operating and calibration procedures outlined in the equipment manuals accompanying the respective instruments, and keep records of all field instrument calibrations and field checks in logbooks. If on-site monitoring equipment should fail, the FSM will be contacted as soon as practicable. The FSM will either provide replacement equipment or have the malfunction repaired as soon as practicable. Section 4.8.8 of the RI/FS FSP, *Equipment Malfunction Procedures*, outlines the actions to be taken in the event of field equipment failure.

The analytical subcontractor shall perform equipment calibration and preventative maintenance as outlined in their QAPP and/or required by analytical methodology. The laboratory is expected to have sufficient spare parts and/or back-up equipment or such items readily available from an external vendor so as to minimize analytical down time.

3.7 INSTRUMENT CALIBRATION AND FREQUENCY

Information pertaining to field instrument calibration and use is detailed in Section 4.8 of the RI/FS FSP, SOP TFM-106 (*Field Equipment Calibration*), and SOP TFM-120 (*Low Flow Groundwater Sampling*), which are included in Appendix B of the RI/FS FSP. All field sampling equipment will be calibrated using known standards supplied by the manufacturer or other reputable vendor. The instruments will be calibrated at the beginning of each day, and calibration checks will be performed at midday, at the end of the day, and any time readings appear abnormal. If calibration checks are not satisfactory based upon the instrument manufacturers' recommendations, then recalibration will be performed. Calibration of the turbidity meter will be checked daily using standards supplied by the manufacturer; however, the turbidity meter will be adjusted only when the measured value of the standard exceeds the actual standard value by more than 10 percent. Each piece of equipment will have a unique serial number for tracking during field use, calibration, and maintenance records. All field calibrations will be documented in the field logbook as outlined in SOP TFM-112 (*Logbook Documentation*), which is included in Appendix B of the RI/FS FSP. Additionally, calibration checks will be recorded on the "Field Calibration Record," which was

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included in Appendix B to the RI/FS HSP and is reprinted as Table 3-3 of this QAPP to assist the reader. Instruments will not be used if calibration criteria are not met.

Laboratory instrumentation calibration, frequency, and records information is outlined in the laboratory QAPP and/or required by analytical methodology.

3.8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Sample containers will be shipped to the field Site office. BMcD will supply sample containers and coolers for samples submitted to CLP and SEL laboratories. The BMcD Project Manager or FSM will verify that sampling materials and containers are consistent with specifications, which are outlined in Table 4-7 of the RI/FS FSP and are repeated in Table 3-1 of this RI/FS QAPP.

3.9 DATA ACQUISITION REQUIREMENTS (NON-DIRECT MEASUREMENTS)

Acquisition of non-direct data is not anticipated for this project.

3.10 DATA MANAGEMENT

The BMcD Project Manager has the overall responsibility for data management. These data management activities include record-keeping, tracking, document control systems, and data handling to process, compile, analyze, and transmit data. Day-to-day oversight of sampling activities, laboratory activities, and data tracking and receipt will be the responsibility of the BMcD Project Manager or a designated project team member.

General record keeping, data storage, and retrieval procedures are outlined in Sections 2.6 and 3.3 of this QAPP. All project teams members are responsible for handling data in a manner consistent with procedures listed in Section 5.0 (*Sample Chain-of-Custody/Documentation*) of the RI/FS FSP which includes information pertaining to field logbooks, photographs, sample numbering, sample documentation, laboratory assignments, documentation (cooler/shipping documentation and filing system), and corrections to documentation. In addition, SOP TFM-112 (*Logbook Documentation*) and SOP TFM-113 (*Sample Numbering and Documentation*) provide further instruction on appropriate documentation procedures for project team members.

The following procedures will be used to ensure that all samples are collected for the required parameters:

- Daily coordination/communication between the BMcD Project Manager and FSM to ensure

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sampling is being conducted as planned.

- COC forms checked daily for accuracy by the FSM, BMcD Project Manager, or designee.
- Laboratory reports reviewed upon receipt by the Project Chemist or project team member to ensure the correct sample numbers and parameters have been entered into the Laboratory Information Management System and that the sample names are correctly recorded.

The RI/FS DMP outlines the database standard, tabular data management (chemical and borehole data), spatial data management, aerial imagery, source data handling, and database security. Day-to-day responsibility for handling the database and electronic deliverables/media falls to a project team member that is well versed in the applicable computer programs.

Analytical data reduction, review, reporting, and storage requirements are outlined in the contract laboratory QAPPs. Checklists and standard forms are provided in the laboratory QAPP and/or standard operating procedures for laboratory activities. The laboratory will provide an electronic deliverable of the data in an Excel® spreadsheet or Access® database format. In general, this electronic deliverable should contain the following information:

Preferred Electronic Deliverable Contents	
Laboratory identification number	Sample analysis date
Sample delivery group number	Analytical result
BMcD sample name	Units of measure (reported as dry-weight for solid samples)
Sample collection date	Method detection limit
Sample matrix	Reporting limit
Sample collection depths, if applicable	Laboratory qualifier(s)
Analytical method code	Dilution factor
Analysis type	Moisture content
Parameter name	QC Batch number
Sample preparation or extraction date, if applicable	

However, at a minimum the electronic deliverable will contain the following information:

Minimum Electronic Deliverable Contents	
Laboratory identification number	Sample name/identification
Sample collection date	Analytical Method
Parameter name	Units of measure
Analytical result	Laboratory qualifier(s)/flag(s)
Sample analysis date	

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4.0 ASSESSMENT AND OVERSIGHT

4.1 ASSESSMENTS AND RESPONSE ACTIONS

4.1.1 Field Performance and System Audits

The BMcD QC Director may schedule audits/reviews of field activities at various times to evaluate the execution of sample identification, sample control, COC procedures, field documentation, and sampling and field measurement operations. Audits will be scheduled with the FSM. The evaluation is based on the extent to which the applicable procedures defined in the RI/FS FSP are followed during field operations.

The person conducting the audit/review will be a senior technical reviewer familiar with technical, procedural, and QC requirements governing field sampling. The auditor will keep a record of the evaluation using field notes and checklists. Following the audit, the auditor will review preliminary results with the person in charge of field sampling. The auditor will also prepare a brief report containing the results of the evaluation and recommendations for corrective actions. Corrective actions if required, will be conducted as described in Section 3.2.

4.1.2 Laboratory Performance and System Audits

Audits/reviews of laboratory activities may be performed to evaluate the execution of sample identification, sample control, COC procedures, sample tracking, sample storage, and sample analysis procedures. The evaluation is based on the extent to which the applicable procedures defined in this QAPP and the laboratory QAPPs are followed. The person conducting the audit/review will be a senior technical reviewer familiar with technical, procedural, and QC requirements governing laboratory activities. Corrective actions, if required, will be conducted as described in Section 3.4 and/or 3.5.

At this time it is not planned to submit blind performance evaluation (PE) samples to the analytical laboratory for analysis. Each laboratory conducts PE sample analysis as part of its program certification requirements. Therefore, an independent PE effort was not deemed necessary at this time.

4.2 REPORTS TO MANAGEMENT

4.2.1 Laboratory Reports

At a minimum, laboratories are expected to provide a data package that includes the following information:

- field sample name and associated laboratory number

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- results for each target analyte with appropriate units
- reporting limits for each non-detect compound, as available
- results of QC sample analysis
- association of QC samples with field samples

4.2.2 Project Reports

Deliverables anticipated for the RI/FS are detailed in Section 5.0 and Section 7.0 of the RI/FS Work Plan, as follows:

- Remedial Investigation Report, RI/FS Work Plan Section 5.8
- Feasibility Study Report, RI/FS Work Plan Section 5.11
- Monthly Progress Reports, RI/FS Work Plan Section 7.3.5

In particular, monthly progress reports will be prepared and submitted to the DEQ Project Manager and BMcD Project Team to document the project status, any problems encountered, the budget expended, percent completion, and anticipated activities for the following month for each task as outlined in the Scope of Work.

The project schedule for these deliverables is presented in Section 9.0 of the RI/FS FSP. In particular, Figure 9-1 of the RI/FS FSP presents the project schedule.

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5.0 DATA VALIDATION AND USABILITY

5.1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

Section 3.5 provided a discussion of the DQIs (precision, accuracy, representativeness, comparability, and completeness) that will be evaluated as part of the data review. The quality of the laboratory results will be assessed through evaluation of the results of the submitted QA/QC samples (trip blanks, field duplicates, MS/MSDs, etc.) and laboratory internal QA/QC samples (blanks, surrogates, duplicates, LCSs, etc.). Data validation will include a review of any method-specific QA/QC criteria as outlined in Section 5.2. Data qualifiers, when appropriate, will be added to the data in accordance with USEPA's NFGO and NFGI. A brief summary is presented in the following paragraphs:

- Analytical Precision – Precision will be evaluated by calculating the RPD for field duplicates and MS/MSD samples. RPD criteria outside of QC limits may result in qualification of data as estimated (J*). Data will not be qualified solely based on RPD criteria not being met. Rather, outlying RPD data will be reviewed with other QC data to assess the overall impact to data quality.

- Analytical Accuracy – Accuracy will be assessed by evaluating the results of spiked samples for REC and blank samples for potential contamination of samples. REC results for spike samples (surrogates, LCSs, and MSs) will be used to assign qualifiers to analytical data. A REC above QC limits suggests the possibility of high bias in the analytical results, and detections will be qualified as estimated (J* or J+) when this occurs. A REC below QC limits suggests the possibility of low bias in the analytical results, and data will be qualified as estimated (J* or J-) or unusable (R) based upon the magnitude of the deviance from QC limits.

  Blank samples will be used to evaluate whether field samples have been cross-contaminated during shipping or handling. Detections in blank samples will be used to qualify similar detections in associated field samples. If a field sample has a detection of a compound that is less than five times (10 times for common laboratory contaminants) the blank concentration, then the field sample result will be qualified as undetected (U*).

- Representativeness – Representativeness will be assessed by examining sample preservation, results of the precision and accuracy evaluation, and adherence to method holding time. Failure of field or laboratory personnel to properly handle samples may result in qualification of the data as estimated or unusable. The representativeness review will qualitatively consider whether precision and/or accuracy are sufficient to characterize the samples. Analytical data for samples that are not analyzed

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within holding times will be qualified as estimated (J* or J-) or unusable (R) based upon the magnitude of the holding time exceedence.

- Completeness – Completeness will be assessed by calculation of field completeness and laboratory completeness as presented in Section 3.5.4.

- Comparability – Comparability will be assessed by evaluating whether samples were collected in a manner similar to previous sampling events and analyzed using the similar analytical methodology as previous events.

5.2 VALIDATION AND VERIFICATION METHODS

The primary laboratory for the RI/FS is the Oklahoma SEL. Additionally, air and vegetation analyses will be subcontracted to a commercial laboratory. The following discussion focuses on the validation of data generated by these laboratories. If analyses are performed by the USEPA Region 6 Lab or CLP lab(s), the Environmental Services Assistance Team (ESAT) at the USEPA Houston Lab provides validation according to their own in-house procedures and protocols and is beyond the scope of this QAPP.

Data validation evaluates the quality of field and laboratory activities and documents the quality of data generated. The goals of data validation are to evaluate achievement of DQOs for the project, to ensure achievement of all project contractual requirements, to determine the impact of DQOs that were not met, and to document the results of data validation. The intent is to evaluate the data against project DQOs and planning documents to ensure that goals are met. Ideally, the end result of validation is a technically sound, statistically valid, legally defensible, and properly documented data set for decision-making purposes. General information pertaining to verification and validation activities is provided in the *Guidance on Environmental Data Verification and Data Validation, EPA QA/G-8* (USEPA, 2002).

Data validation requires knowledge of the type of information that is validated. Therefore, a person familiar with field activities, such as the FSM or site geologist, is typically assigned to the validation of field activities, documents, and records. Likewise, a person familiar with analytical methodology, such as a chemist, is typically assigned to the validation of laboratory documents and records.

BMcD evaluates data quality through the evaluation of both field and laboratory QC data. Validation is initiated at the time of first sample collection. Field documents are reviewed by the FSM or a designee to determine that all samples and analyses were appropriately collected, containerized, labeled, and submitted to the laboratory. These items will be verified daily during sampling activities. Additionally,

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the project chemist or designee will be in communication with the non-CLP labs during sample collection and analysis to verify condition of sample receipt, appropriate sample log-in, etc. If problems are noted at this point, they can easily be corrected or locations resampled, if needed, while the field crews are still mobilized. Following field activities, boring logs, transects, and geotechnical data is peer-reviewed to insure its accuracy and completeness.

Following analysis, the laboratory data submittal is verified by the Project Chemist for conformance with method, procedural, and contractual requirements. The contracted laboratory will be responsible for accurately performing the prescribed methods per USEPA protocols. This includes all procedures, QC checks, corrective actions, and data storage. In general, chemical data is validated by evaluation of the laboratory submittal against any requirements established in the analytical method and QAPP. Following receipt of the analytical data packages, the BMcD chemical validation will include a review of the following items:

- COC appropriately completed
- requested analyses performed
- analysis occurred within holding times
- blank results (method blank, trip blank, and rinsate blank)
- duplicate results (laboratory duplicates, MS/MSD, LCS/LCSD, and field duplicates)
- spike recovery results (surrogate, LCS/LCSD, and MS/MSD)
- achievement of target reporting limits
- completeness (field completeness and laboratory completeness)

The validation will include a review of any method-specific criteria for the items listed. Data qualifiers, when appropriate, will be added to the data in accordance with recommendations in NFGO and NFGI. Results of the BMcD chemical validation review may be presented with the *Phase I Preliminary Data Report* and/or the *RI Report*.

However, data validation extends beyond method, procedural, and contractual compliance to determine the quality of the data set and the types of uncertainty introduced by a failure to meet requirements. It includes a determination, where possible, of the reasons for any failure to meet requirements, and an

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evaluation of the impact of the failure upon the overall data set. In this manner, the effect of any data rejection is presented in terms of its impacts on the overall uncertainty and usability of the data set.

Following verification and validation, the BMcD Project Manager (or other end-user of the data) working with the appropriate data validator will perform a global review of the findings to determine overall usability of the data set for its intended purpose. It is at this point that a final analysis of the data is made, taking into consideration the following:

- Sample collection – Were problems encountered during sample collection that suggest samples were potentially compromised? If so, what is the impact?
- Suitability of methodology - Based upon the chemical data validation, were significant precision or bias problems noted with the data? Were significant matrix interference problems noted?
- Adequacy of reporting limits - Was excessive sample dilution required due to interference or presence of elevated concentrations of target or nontarget compounds? If so, does this adversely impact the ability to draw conclusions regarding any undetected constituents?
- Reasonableness of QC limits – Do the initially established control limits for DQIs still seem appropriate for the data set? If not, is the data exhibiting higher variability than assumed during project planning?
- Patterns in qualified data – Are patterns evident in the type of samples or analyses that required qualification during validation? Do these patterns suggest overall problems in one area or for a particular type of analysis?

5.3 RECONCILIATION WITH USER REQUIREMENTS

After data has been validated, the BMcD Project Manager will evaluate the results by considering the QC parameters of precision, accuracy, representativeness, comparability, and completeness as outlined in Section 3.5. If DQIs do not meet the requirements as outlined or problems are noted with sample collections and/or geotechnical information, the data may be discarded and re-sampling may occur. The BMcD Project Manager will make this decision after consultation with the other key project personnel.

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6.0 REFERENCES

American Public Health Association, 1995. *Standard Methods for the Examination of Water and Wastewater, 19th Edition*. (SM Methods)

Burns & McDonnell Engineering Company, Inc. (BMcD), 2005a. *Remedial Investigation/Feasibility Study Field Sampling Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma.* May 12. (RI/FS FSP)

Burns & McDonnell Engineering Company, Inc. (BMcD), 2005b. *Remedial Investigation/Feasibility Study Data Management Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma*. May 12 (RI/FS DMP).

Burns & McDonnell Engineering Company, Inc. (BMcD), 2005c. *Remedial Investigation/Feasibility Study Health and Safety Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma*. May 12. (RI/FS HSP)

Burns & McDonnell Engineering Company, Inc. (BMcD), 2005d. *Remedial Investigation/Feasibility Study Work Plan, Tulsa Fuel and Manufacturing, Collinsville, Oklahoma.* May 19. (RI/FS Work Plan)

Exponent, 2001. *Focused Remedial Investigation, Collinsville Smelter Site*. Prepared for Phelps Dodge Corporation: Tempe, Arizona. January.

Fluor Daniel, Inc. (FDI), 1997. *USEPA Brownfields Final Report Collinsville Strip Mine Site. Collinsville, Oklahoma.* January 21.

Oklahoma Department of Environmental Quality (DEQ), 1994. *Site Inspection Report, Tulsa Fuel & Manufacturing, Tulsa County, Oklahoma. EPA ID No. OKD987096195*. September 30.

Oklahoma Department of Environmental Quality (DEQ), 2005, *Consultant Scope of Work for the Remedial Investigation/Feasibility Study (RI/FS) for the Tulsa Fuel and Manufacturing Superfund Site,* January 28.

Oklahoma State Department of Health (OSDH), 1992. *Preliminary Assessment, Acme Brick Strip Mines, Collinsville, Oklahoma, Tulsa County.* November 16.

United States Environmental Protection Agency (USEPA, 1983). *Methods for Chemical Analysis of Water and Wastes.* March.

United States Environmental Protection Agency (USEPA), 1997. *Test Method for Evaluating Solid Waste, Physical/Chemical Methods. Final Update III*. July. (SW-846 Methods)

United States Environmental Protection Agency (USEPA), 1999a. *Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air.* June. (IO Methods)

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United States Environmental Protection Agency (USEPA), 1999b. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* October. (NFGO)

United States Environmental Protection Agency (USEPA), 2000a. Final Data Quality Objectives Process for Hazardous Waste Site Investigations. January. (EPA QA/G-4HW)

United States Environmental Protection Agency (USEPA), 2000b. *Guidance for the Data Quality Objectives Process.* August. (EPA QA/G-4)

United States Environmental Protection Agency (USEPA), 2000c. *USEPA CLP Statement of Work for Analysis of Low Concentration Organic.* December. (OLC03.2)

United States Environmental Protection Agency (USEPA), 2001. *EPA Requirements for Quality Assurance Project Plans, Interim Final* (EPA QA/R-5). March.

United States Environmental Protection Agency (USEPA), 2002. *Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8). November.

United States Environmental Protection Agency (USEPA), 2003. *USEPA CLP Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration.* March (OLM04.3)

United States Environmental Protection Agency (USEPA), 2004a. *USEPA CLP Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration.* February. (ILM05.3)

United States Environmental Protection Agency (USEPA), 2004b. *Contract Laboratory Program Guidance for Field Samplers, Final.* August.

United States Environmental Protection Agency (USEPA), 2004c. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. October. (NFGI)

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TABLES

Table 2-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide
On-Site Soil and Groundwater Sampling														
Surface Soil Sample Collection	Surface Soil	0-6"	8		X	10%	10%							
Direct-Push Sample Collection (Includes samples collected during temporary piezometer installation)	Surface Soil	0-6"	48		X	10%	10%							
	Subsurface Soil	6"-2'	48		X	10%	10%							
		2-4'	48		X	10%	10%							
		4-8'	3 [5]		X	10%	10%							
		8-16'	3 [5]		X	10%	10%							
		16'-Refusal	3 [5]		X	10%	10%							
	Groundwater[6]	Top of Bedrock	11 [5]			X[6]		X						
Monitoring Well Sample Collection	Groundwater[6]	Newly Installed Wells	5			X[6]		X						
		On-Site Residential Well	1			X[6]		X						
Waste Sampling														
Trench Sample Collection	Surface Soil	0-6"	21		X	10%	10%							
	Subsurface Soil	Mid-Trench	10		X	10%	10%							
		Clay just below slag	21		X	10%	10%							
Off-Site Surface Soil Sampling														
Tribal Member Properties	Surface Soil	0-3"	10	XRF	X	10%	10%							
Targeted Sampling Locations	Surface Soil	0-3"	8	XRF	X	10%	10%							
Off-Site Grid Sampling Locations														
Planned	Surface Soil	0-3"	49	XRF	X	10%	10%							
Potential	Surface Soil	0-3"	22	XRF	X	10%	10%							

Table 2-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide
Off-Site Surface Soil Sampling (continued)														
"Distance" Sampling Locations														
N, NNW, S, & SSE (1 mi & 1 1/2 mi)	Surface Soil	0-3"	14	XRF	X	10%	10%							
E & W (1/2 mi & 1 mi)	Surface Soil	0-3"	8	XRF	X	10%	10%							
Surface Water and Sediment Sampling														
On-Site Locations	Surface Water		12			X		X						
	Sediment	0-6"	12		X	10%	10%							
Strip Mine Pit	Surface Water		6			X		X						
	Sediment	0-6"	6		X	10%	10%							
Off-Site Locations	Surface Water		13			X		X						
	Sediment	0-6"	13		X	10%	10%							
Background Sampling														
Surface Soil Sample Collection	Surface Soil	0-3"	2		X	10%	10%							
Direct-Push Sample Collection	Surface Soil	0-6"	2		X	10%	10%							
	Subsurface Soil	6"-2'	2		X	10%	10%							
		2-4'	2		X	10%	10%							
Monitroing Well Sample Collection	Groundwater[6]	NA	1			X[6]		X						
Surface Water Sample Collection	Surface Water	NA	2			X		X						
Sediment Sample Collection	Sediment	0-6"	2		X	10%	10%							

Table 2-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide
Background Sampling (continued)														
Ecological Sample Collection	Berries	Washed	1			X								
		Unwashed	1			X								
	Leaves	Washed	1			X								
		Unwashed	1			X								
	Roots	Washed	1			X								
	Soil/Slag	Soil/slag around plant's roots	1			X	10%							
Perimeter Air Monitoring														
Air Quality Sample Collection[7]	Air	NA	14						X					
Ecological Sampling														
DEQ 2004 Samples	Berries	Washed	4			X								
		Unwashed	8			X								
	Leaves	Washed	4			X								
		Unwashed	4			X								
	Roots	Washed	4			X								
	Soil/Slag	Soil/slag around plant's roots	6			X	10%							
Phase I RI Samples	Berries	Washed	2			X								
		Unwashed	2			X								
	Leaves	Washed	2			X								
		Unwashed	2			X								
	Roots	Washed	2			X								
	Soil/Slag	Soil/slag around plant's roots	2			X	10%							

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Sample Collection Summary
Remedial Investigation/Feasibility Study
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Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide
Phase II RI Potential Sampling														
Information needed for	Surface Soil	On-Site = 0-6" or Off-Site=0-3"	20		X	10%	10%							
Treatability Study, RI Report,	Subsurface Soil	>6"	60		X	10%	10%							
and Risk Assessments	Groundwater[5]	NA	3			X[5]		X						
	Surface Water	NA	5			X		X						
	Sediment	0-6"	5		X	10%	10%							
	Ecological	Berries - Washed	1			X								
		Berries - Unwashed	1			X								
		Leaves - Washed	1			X								
		Leaves - Unwashed	1			X								
		Roots - Washed	1			X								
		Soil/slag around plant's roots	1			X	10%							
Waste Sampling	Waste Material	NA	4							X				
Vicinity of Former Residence	Surface Soil	0-6"	5								X	X	X	X[6]
(i.e., Trash Dump Area)	Subsurface Soil	>6"	10								X	X	X	X[6]
	Groundwater[6]	On-Site Residential Well	1								X	X	X	X[6]

Notes:

1 = Sample count only includes field samples and does not include QC samples such as field duplicates, MSs, or MSDs.
Increase count by 10% to account for field duplicates, 5% to account for MSs, and 5% to account for MSDs.

2 = General Water Chemistry analyses as the lab include total organic carbon (TOC), chemical oxgen demand (COD), alkalinity, nitrate as nitrogen, chloride, and sulfate.
Specific conductivity, pH, temperature, and turbidity will be measured in the field.

3 = Air Quality analyses include total suspended particulates (TSP), PM10, and Metals (As, Cd, Pb, and Zn).

4 = During Phase II, waste samples may be analyzed for all 8 RCRA metals and all 8 TCLP metals for purposes of waste characterization and disposal.

5 = Samples will be collected from temporary piezometer locations only.

6 = If sample turbidity is greater than 50 NTUs, groundwater samples for metals analysis will be submitted as filtered and unfiltered samples.

7 = Perimeter air montoring will be performed at 2 locations (one upwind and one downwind) for one week as 24-hour composite samples.
Filters will be changed daily over the course of the week, resulting in 7 samples being collected at each location.

Table 2-1
Sample Collection Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Field Activity	Matrix	Depth Intervals or Other Descriptor	Sample Count[1]	Field Screen	Analyses									
					Lab XRF for As, Cd, Pb, & Zn	ICP for As, Cd, Pb, & Zn	TCLP for As, Cd, & Pb	Water General Chemistry[2]	Air Quality[3]	RCRA Metals & TCLP Metals[4]	TCL VOC	TCL SVOC	TCL Pesticide & PCB	TAL Metals & Cyanide

As = Arsenic
Cd = Cadmium
COD = Chemical Oxygen Demand
DEQ = Oklahoma Department of Environmental Quality
ICP = Inductively Coupled Plasma
MS/MSD = Matrix Spike/Matrix Spike Duplicate
NA = Not Applicable
NTU = Nephlometric Turbidity Unit
Pb = Lead
RCRA Metals = Arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver
RCRA = Resource Conservation and Recovery Act
RI = Remedial Investigation
SVOC = Semivolatile Organic Compound
TAL = Target Analyte List
TCL = Target Compound List
TCLP = Toxicity Characteristic Leaching Procedure
TOC = Total Organic Carbon
VOC = Volatile Organic Compound
XRF = X-Ray Fluorescence Spectroscopy
Zn = Zinc

Laboratories for Phase I RI Samples

Soil and Water Matrices
Oklahoma State Environmental Lab (SEL)
707 N. Robinson
Oklahoma City, OK 73102

Lab QA Manager: Susan Elmenhorst
Phone: (405) 702-1038
Email: Susan.Elmenhorst@deq.state.ok.us

Air and Ecological Matrices
STL Burlington
208 South Park Drive, Suite 1
Colchester, VT 05446

Project Manager: Don Dawicki
Phone: (802) 655-1023
Email: Ddawicki@stl-inc.com

Laboratories for Phase II RI Samples

Non-Organic Analysis for Soil and Water
Oklahoma State Environmental Lab (SEL)
707 N. Robinson
Oklahoma City, OK 73102

Lab QA Manager: Susan Elmenhorst
Phone: (405) 702-1038
Email: Susan.Elmenhorst@deq.state.ok.us

Air and Ecological Matrices
STL Burlington
208 South Park Drive, Suite 1
Colchester, VT 05446

Project Manager: Don Dawicki
Phone: (802) 655-1023
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Organic Analysis of Soil and Water
USEPA Region 6 Laboratory
Contract Laboratory Program Sample Control Manager
10625 Fallstone Road
Houston, TX 77099

Attn: Christy Warren
Phone: (281) 983-2137
Email: Warren.Christy@epa.gov

AND

USEPA Region 6 Laboratory
Contract Laboratory Program Regional Sample Control Center Coordinator
10625 Fallstone Road
Houston, TX 77099

Attn: Myra Perez
Phone: (281) 983-2130
Email: Perez.Myra@epa.gov

Table 2-2
Analytical Parameter List
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

PRIMARY SOIL ANALYSES		
Metal Constituents		
* Arsenic	* Lead	* Zinc
* Cadmium		
Toxicity Characteristic Leaching Procedure (TCLP) Metals		
* Arsenic	* Cadmium	* Lead

PRIMARY WATER ANALYSES		
Metal Constituents		
* Arsenic	* Lead	* Zinc
* Cadmium		
Water Quality		
pH (field measured)	Alkalinity	Sulfate
Specific conductivity (field measured)	Chemical Oxygen Demand	Nitrate as Nitrogen
Temperature (field measured)	Total Organic Carbon	
Turbidity (field measured)	Chloride	

PRIMARY AIR ANALYSES		
Particulate Matter		
PM_{10}	Total Suspended Particulate Matter	
Airborne Particulate TAL Metals		
* Arsenic	* Lead	* Zinc
* Cadmium		

POTENTIAL SOIL AND WATER ANALYSES (Limited Locations RI Phase 2)		
Target Compound List Volatile Organic Compounds (TCL VOCs)		
1,1-Dichloroethane	4-Methyl-2-pentanone	Dichlorodifluoromethane
1,1-Dichloroethene	Acetone	Ethylbenzene
1,1,1-Trichloroethane	Benzene	Isopropylbenzene
1,1,2-Trichloroethane	Bromodichloromethane	Methyl Acetate
1,1,2-Trichloro-1,2,2,-trifluoroethane	Bromoform	Methylene Chloride
1,1,2,2-Tetrachloroethane	Bromomethane	Methylcyclohexane
1,2-Dibromoethane	Carbon Disulfide	Methyl tert-Butyl Ether
1,2-Dichlorobenzene	Carbon Tetrachloride	Styrene
1,2-Dichloroethane	Chlorobenzene	Tetrachloroethene
1,2-Dichloropropane	Chloroethane	Toluene
1,2-Dibromo-3-chloropropane	Chloroform	trans-1,2-Dichloroethene
1,2,4-Trichlorobenzene	Chloromethane	trans-1,3-Dichloropropene
1,3-Dichlorobenzene	cis-1,2-Dichloroethene	Trichlorofluoromethane
1,4-Dichlorobenzene	cis-1,3-Dichloropropene	Trichloroethene
2-Butanone	Cyclohexane	Vinyl Chloride
2-Hexanone	Dibromochloromethane	Xylenes (total)
1,1'-Biphenyl	4-Nitroaniline	Dibenzofuran
2-Chloronaphthalene	4-Nitrophenol	Diethylphthalate
2-Chlorophenol	4,6-Dinitro-2-methylphenol	Dimethylphthalate
2-Methylnaphthalene	Acenaphthene	Di-n-butylphthalate
2-Methylphenol	Acenaphthylene	Di-n-octylphthalate
2-Nitroaniline	Acetophenone	Fluoranthene

Table 2-2
Analytical Parameter List
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

POTENTIAL SOIL AND WATER ANALYSES (Limited Locations RI Phase 2)		
Target Compound List Semivolatile Organic Compounds (TCL SVOCs)		
2-Nitrophenol	Anthracene	Fluorene
2,2'-oxybis(1-chloropropane)	Atrazine	Hexachlorobenzene
2,4-Dichlorophenol	Benzaldehyde	Hexachlorobutadiene
2,4-Dimethylphenol	Benzo(a)anthracene	Hexachlorocyclopentadiene
2,4-Dinitrophenol	Benzo(a)pyrene	Hexachloroethane
2,4-Dinitrotoluene	Benzo(b)fluoranthene	Indeno(1,2,3-cd)pyrene
2,4,5-Trichlorophenol	Benzo(g,h,i)perylene	Isophorone
2,4,6-Trichlorophenol	Benzo(k)fluoranthene	Naphthalene
2,6-Dinitrotoluene	bis(2-Chloroethyl)ether	Nitrobenzene
3-Nitroaniline	bis(2-Chloroethoxy)methane	N-Nitroso-di-n-propylamine
3,3'-Dichlorobenzidine	bis(2-Ethylhexyl)phthalate	N-Nitrosodiphenylamine
4-Bromophenyl-phenylether	Butylbenzlphthalate	Pentachlorophenol
4-Chloro-3-methylphenol	Caprolactam	Phenanthrene
4-Chloroaniline	Carbazole	Phenol
4-Chlorophenyl-phenyl ether	Chrysene	Pyrene
4-Methylphenol	Dibenzo(a,h)anthracene	
Target Compound List Pesticides (TCL Pesticides)		
alpha-BHC	Endosulfan I	4,4'-DDT
beta-BHC	Dieldrin	Methoxychlor
delta-BHC	4,4'-DDE	Endrin Ketone
gamma-BHC (Lindane)	Endrin	Endrin Aldehyde
Heptachlor	Endosulfan II	alpha-Chlordane
Aldrin	4,4'-DDD	gamma-Chlordane
Heptachlor epoxide	Endosulfan sulfate	Toxaphene
Target Compound List Polychlorinated Biphenyls (TCL PCBs)		
Aroclor-1016	Aroclor-1242	Aroclor-1260
Aroclor-1221	Aroclor-1248	
Aroclor-1232	Aroclor-1254	
Target Analyte List Inorganic Compounds (TAL Inorganics)		
Aluminum	Cobalt	Potassium
Antimony	Copper	Selenium
* Arsenic	Iron	Silver
Barium	* Lead	Sodium
Beryllium	Magnesium	Thallium
* Cadmium	Manganese	Vanadium
Calcium	Mercury	* Zinc
Chromium	Nickel	Cyanide
TCLP Metals		
* Arsenic	Chromium	Selenium
Barium	* Lead	Silver
* Cadmium	Mercury	

* Critical parameters

Table 2-3

Analytical Reporting Limits[1]

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Parameter	Reporting Limit											
	Water						Soil					
	Water-NOS	ARARs or TBCs Not Met	Low Water	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met	Soil - NOS	Low Soil	Medium Soil	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met
Target Analyte List Inorganic Compounds (TAL Inorganics)												
	ug/L ICP-AES		ug/L ICP-MS		ug/L		mg/kg				mg/kg ICP-MS	mg/kg XRF	
Aluminum	200	B	--		360	A B	20	--	--		70	--	
Antimony	60	A C	2		60	A C	6	--	--	J N	12	--	J N
* Arsenic	10	C	1	C	50	A C	1	--	--	O	10	10	L M N O
Barium	200	B	10	B	200	B	20	--	--		40	--	
Beryllium	5	A	1		5	A	0.5	--	--		1	--	
* Cadmium	5	B	1	B	5	B	0.5	--	--	J N	1	10	J N
Calcium	5000		--		5000		500	--	--		1000	--	
Chromium	10		2		10		1	--	--		2	--	
Cobalt	50		1		50		5	--	--		10	--	
Copper	25	B	2		25	B	2.5	--	--		5	--	
Iron	100		--		100		10	--	--		20	--	
* Lead	10	B H	1		50	A B C H I	1	--	--		10	20	
Magnesium	5000	B	--		5000	B	500	--	--		1000	--	
Manganese	15		1		15		1.5	--	--		3	70	
Mercury[2]	0.2	H I	--		0.2	H I	0.1	--	--		0.1	--	
Nickel	40		1		40		4	--	--		8	--	
Potassium	5000		--		5000		500	--	--		1000	--	
Selenium	35	B F G	5		60	A B F G	3.5	--	--	J N	12	--	J N
Silver	10	B	1	B	40	B	1	--	--		8	--	J N
Sodium	5000		--		5000		500	--	--		1000	--	
Thallium	25	A C H I	1		60	A B C H I	2.5	--	--	J	12	--	J
Vanadium	50	B C	1		50	B C	5	--	--	J	10	--	J
* Zinc	60	B	2		60	B	6	--	--		12	50	
Cyanide[3]	10	B	--		10	B	2.5	--	--	N	2	--	N
Target Compound List Volatile Organic Compounds (TCL VOCs)												
	ug/L		ug/L		ug/L			ug/kg	ug/kg		ug/kg		
1,1-Dichloroethane	10		0.50		10		--	10	1300		10		
1,1-Dichloroethene	10	A	0.50		10	A	--	10	1300	J	10		J
1,1,1-Trichloroethane	10		0.50		10		--	10	1300		10		

Table 2-3

Analytical Reporting Limits[1]

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Parameter	Reporting Limit											
	Water						Soil					
	Water-NOS	ARARs or TBCs Not Met	Low Water	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met	Soil - NOS	Low Soil	Medium Soil	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met
Target Compound List Volatile Organic Compounds (TCL VOCs) (continued)												
1,1,2-Trichloroethane	10	A C	0.50	C	10	A C	--	10	1300		10	
1,1,2-Trichloro-1,2,2,-trifluoroethane	10		0.50		10		--	10	1300		10	
1,1,2,2-Tetrachloroethane	10	C	0.50	C	10	C	--	10	1300		10	
1,2-Dibromoethane	10	A C	0.50	A C	10	A C	--	10	1300	N	10	N
1,2-Dichlorobenzene	10		0.50		10		--	10	1300		10	
1,2-Dichloroethane	10	A C	0.50	C	10	A C	--	10	1300		10	
1,2-Dichloropropane	10	A C	0.50	C	10	A C	--	10	1300		10	
1,2-Dibromo-3-chloropropane	10	A C	0.50	A C	10	A C	--	10	1300		10	
1,2,4-Trichlorobenzene	10	C	0.50		10	C	--	10	1300		10	
1,3-Dichlorobenzene	10	C	0.50		10	C	--	10	1300		10	
1,4-Dichlorobenzene	10	C	0.50	C	10	C	--	10	1300		10	
2-Butanone (Methylethyl ketone)	10		5.0		10		--	10	1300		10	
2-Hexanone	10		5.0		10		--	10	1300		10	
4-Methyl-2-pentanone	10		5.0		10		--	10	1300		10	
Acetone	10		5.0		10		--	10	1300	N	10	N
Benzene	10	A C	0.50	C	10	A C	--	10	1300		10	
Bromodichloromethane	10	C H	0.50	C	10	C H	--	10	1300		10	
Bromoform	10	C	0.50		10	C	--	10	1300		10	
Bromomethane (Methyl bromide)	10	C	0.50		10	C	--	10	1300		10	
Carbon Disulfide	10	B	0.50		10	B	--	10	1300	N	10	N
Carbon Tetrachloride	10	A B C H	0.50	C	10	A B C H	--	10	1300		10	
Chlorobenzene	10		0.50		10		--	10	1300		10	
Chloroethane	10	C H	0.50		10	C H	--	10	1300		10	
Chloroform	10		0.50		10		--	10	1300	J	10	J
Chloromethane (Methyl chloride)	10	C	0.50		10	C	--	10	1300		10	
cis-1,2-Dichloroethene	10		0.50		10		--	10	1300		10	
cis-1,3-Dichloropropene	10	B C	0.50	C	10	B C	--	10	1300	N	10	N
Cyclohexane	10		0.50		10		--	10	1300		10	
Dibromochloromethane	10	C	0.50	C	10	C	--	10	1300		10	
Dichlorodifluoromethane	10		0.50		10		--	10	1300		10	
Ethylbenzene	10		0.50		10		--	10	1300		10	
Isopropylbenzene	10		0.50		10		--	10	1300		10	
Methyl Acetate	10		0.50		10		--	10	1300		10	
Methylene Chloride	10	A C	0.50		10		--	10	1300		10	

Table 2-3

Analytical Reporting Limits[1]

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Parameter	Reporting Limit											
	Water						Soil					
	Water-NOS	ARARs or TBCs Not Met	Low Water	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met	Soil - NOS	Low Soil	Medium Soil	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met
Target Compound List Volatile Organic Compounds (TCL VOCs) (continued)												
	ug/L		ug/L		ug/L			ug/kg	ug/kg		ug/kg	
Methylcyclohexane	10		0.50		10		--	10	1300		10	
Methyl tert-Butyl Ether	10		0.50		10		--	10	1300		10	
Styrene	10		0.50		10		--	10	1300		10	
Tetrachloroethene	10	A C H	0.50	C	10		--	10	1300	J	10	J
Toluene	10		0.50		10		--	10	1300		10	
trans-1,2-Dichloroethene	10		0.50		10		--	10	1300		10	
trans-1,3-Dichloropropene	10	C	0.50	C	10		--	10	1300	N	10	N
Trichloroethene	10	A C	0.50	C	10		--	10	1300	J	10	J
Trichlorofluoromethane	10		0.50		10		--	10	1300		10	
Vinyl Chloride	10	A C	0.50	C	10		--	10	1300	J	10	J
Xylenes (total)	10		0.50		10		--	10	1300		10	
Target Compound List Semivolatile Organic Compounds (TCL SVOCs)												
	ug/L		ug/L		ug/L			ug/kg	ug/kg		ug/kg	
1,1'-Biphenyl	10		5.0		10		--	330	10000		330	
2-Chloronaphthalene	10		5.0		10		--	330	10000	J	330	J
2-Chlorophenol	10		5.0		10		--	330	10000	N	330	N
2-Methylnaphthalene	10		5.0		10		--	330	10000		330	
2-Methylphenol	10		5.0		10		--	330	10000	N	330	N
2-Nitroaniline	25	C H	20	C H	50	C H	--	830	25000		1600	
2-Nitrophenol	10		5.0		10		--	330	10000	N	330	N
2,2'-oxybis(1-chloropropane)	10		5.0		--		--	330	10000		--	
2,4-Dichlorophenol	10		5.0		10		--	330	10000	N	330	N
2,4-Dimethylphenol	10		5.0		10		--	330	10000	J N	330	J N
2,4-Dinitrophenol	25		20		10		--	830	25000	N	330	N
2,4-Dinitrotoluene	10		5.0		10		--	330	10000	N	330	N
2,4,5-Trichlorophenol	25		20		10		--	830	25000		330	
2,4,6-Trichlorophenol	10	C	5.0		10	C	--	330	10000	N	330	N
2,6-Dinitrotoluene	10		5.0		10		--	330	10000	J N	330	J N
3-Nitroaniline	25	C	20	C	50	C	--	830	25000		1600	J
3,3'-Dichlorobenzidine	10	C	5.0	C	20	C	--	330	10000	N	660	N
4-Bromophenyl-phenylether	10	B	5.0	B	10	B	--	330	10000		330	
4-Chloro-3-methylphenol	10	B	5.0	B	10	B	--	330	10000	N	330	N
4-Chloroaniline	10		5.0		10		--	330	10000	N	330	N

Table 2-3

Analytical Reporting Limits[1]

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Parameter	Reporting Limit											
	Water						Soil					
	Water-NOS	ARARs or TBCs Not Met	Low Water	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met	Soil - NOS	Low Soil	Medium Soil	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met
Target Compound List Semivolatile Organic Compounds (TCL SVOCs) (continued)												
	ug/L		ug/L		ug/L			ug/kg	ug/kg		ug/kg	
4-Chlorophenyl-phenyl ether	10		5.0		10		--	330	10000		330	
4-Methylphenol	10		5.0		10		--	330	10000		330	
4-Nitroaniline	25	B H	20	B H	50	B C H	--	830	25000		1600	
4-Nitrophenol	25		20		50		--	830	25000	N	1600	N
4,6-Dinitro-2-methylphenol	25	B C	20	C	50	B C	--	830	25000	J N	1600	J N
Acenaphthene	10		5.0		10		--	330	10000		330	
Acenaphthylene	10		5.0		10		--	330	10000	N	330	N
Acetophenone	10		5.0		--		--	330	10000	N	--	
Anthracene	10	B	5.0	B	10	B	--	330	10000	N	330	N
Atrazine	10	A C H	5.0	A C H	--		--	330	10000	J	--	
Benzaldehyde	10		5.0		--		--	330	10000		--	
Benzo(a)anthracene	10	C	5.0	C	10	C	--	330	10000	N	330	N
Benzo(a)pyrene	10	A B C	5.0	A B C	10	A B C	--	330	10000	L O	330	L O
Benzo(b)fluoranthene	10	B C	5.0	B C	10	B C	--	330	10000		330	
Benzo(g,h,i)perylene	10	B	5.0		10	B	--	330	10000	N	330	N
Benzo(k)fluoranthene	10	B C	5.0	B C	10	B C	--	330	10000	N	330	N
bis(2-Chloroethyl)ether	10	C	5.0	C	10	C	--	330	10000	N O	330	N O
bis(2-Chloroethoxy)methane	10		5.0		10		--	330	10000	J	330	J
bis(2-Ethylhexyl)phthalate	10	A B C	5.0	C	10	A B C	--	330	10000		330	
Butylbenzlphthalate	10		5.0		10		--	330	10000	J	330	J
Caprolactam	10		5.0		--		--	330	10000		--	
Carbazole	10	C H	5.0	C H	--		--	330	10000		--	
Chrysene	10	B C	5.0	B	10	B C	--	330	10000	N	330	N
Dibenzo(a,h)anthracene	10	B C	5.0	B C	10	B C	--	330	10000	L N O	330	L N O
Dibenzofuran	10		5.0		10		--	330	10000		330	
Diethylphthalate	10		5.0		10		--	330	10000		330	
Dimethylphthalate	10		5.0		10		--	330	10000	N	330	N
Di-n-butylphthalate	10		5.0		10		--	330	10000		330	
Di-n-octylphthalate	10		5.0		10		--	330	10000		330	
Fluoranthene	10	B	5.0		10	B	--	330	10000		330	
Fluorene	10		5.0		10		--	330	10000		330	
Hexachlorobenzene	10	A B C H I	5.0	A B C H I	10	A B C H I	--	330	10000	J N O	330	J N O
Hexachlorobutadiene	10	C	5.0	C	10	C	--	330	10000	J	330	J

Table 2-3

Analytical Reporting Limits[1]

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Parameter	Reporting Limit											
	Water						Soil					
	Water-NOS	ARARs or TBCs Not Met	Low Water	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met	Soil - NOS	Low Soil	Medium Soil	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met
Target Compound List Semivolatile Organic Compounds (TCL SVOCs) (continued)												
	ug/L		ug/L		ug/L			ug/kg	ug/kg		ug/kg	
Hexachlorocyclopentadiene	10	B	5.0	B	10	B	--	330	10000		330	
Hexachloroethane	10	C	5.0	C	10	C	--	330	10000		330	
Indeno(1,2,3-cd)pyrene	10	B C	5.0	B C	10	B C	--	330	10000	N	330	N
Isophorone	10		5.0		10		--	330	10000		330	
Naphthalene	10	C	5.0		10	C	--	330	10000		330	
Nitrobenzene	10	C	5.0	C	10	C	--	330	10000		330	
N-Nitroso-di-n-propylamine	10	C	5.0	C	10	C	--	330	10000	L O	330	L O
N-Nitrosodiphenylamine	10		5.0		10		--	330	10000	N	330	N
Pentachlorophenol	25	A B C	5.0	A B C	50	A B C	--	830	25000	N	1600	N
Phenanthrene	10		5.0		10		--	330	10000		330	
Phenol	10		5.0		10		--	330	10000	N	330	N
Pyrene	10	B	5.0		10	B	--	330	10000		330	
Target Compound List Pesticides (TCL-Pest)												
	ug/L		ug/L		ug/L		ug/kg				ug/kg	
alpha-BHC	0.050	C	--	--	--	--	1.7	--	--		--	--
beta-BHC	0.050	C	--	--	--	--	1.7	--	--		--	--
delta-BHC	0.050		--	--	--	--	1.7	--	--		--	--
gamma-BHC (Lindane)	0.050		--	--	--	--	1.7	--	--		--	--
Heptachlor	0.050	C G H I	--	--	--	--	1.7	--	--		--	--
Aldrin	0.050	C H I	--	--	--	--	1.7	--	--		--	--
Heptachlor epoxide	0.050	C	--	--	--	--	1.7	--	--		--	--
Endosulfan I	0.050	C	--	--	--	--	1.7	--	--		--	--
Dieldrin	0.10	C G H I	--	--	--	--	3.3	--	--		--	--
4,4'-DDE	0.10		--	--	--	--	3.3	--	--		--	--
Endrin	0.10	C G	--	--	--	--	3.3	--	--		--	--
Endosulfan II	0.10	C	--	--	--	--	3.3	--	--		--	--
4,4'-DDD	0.10		--	--	--	--	3.3	--	--		--	--
Endosulfan sulfate	0.10		--	--	--	--	3.3	--	--		--	--
4,4'-DDT	0.10	G H I	--	--	--	--	3.3	--	--		--	--
Methoxychlor	0.50	G	--	--	--	--	17	--	--		--	--
Endrin ketone	0.10		--	--	--	--	3.3	--	--		--	--
Endrin aldehyde	0.10		--	--	--	--	3.3	--	--		--	--
alpha-Chlordane	0.050	H I	--	--	--	--	1.7	--	--		--	--

Table 2-3

Analytical Reporting Limits[1]

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Parameter	Reporting Limit											
	Water						Soil					
	Water-NOS	ARARs or TBCs Not Met	Low Water	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met	Soil - NOS	Low Soil	Medium Soil	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met
Target Compound List Pesticides (TCL-Pest) (continued)												
gamma-Chlordane	0.050	H I	--	--	--	--	1.7	--	--		--	--
Toxaphene	5.0	A C F G	--	--	--	--	170	--	--		--	--
Target Compound List Polychlorinated Biphenyls (TCL-PCBs)												
	ug/L		ug/L		ug/L		ug/kg				ug/kg	
Aroclor-1016	1.0	A B C G H I	0.20	B G H I	1.0	A B C G H I	33	--	--	N	33	N
Aroclor-1221	2.0	A B C G H I	0.40	B C G H I	2.0	A B C G H I	67	--	--		67	
Aroclor-1232	1.0	A B C G H I	0.20	C G H I	1.0	A B C G H I	33	--	--	N	33	N
Aroclor-1242	1.0	A B C G H I	0.20	B C G H I	1.0	A B C G H I	33	--	--		33	
Aroclor-1248	1.0	A B C G H I	0.20	B C G H I	1.0	A B C G H I	33	--	--	N	33	N
Aroclor-1254	1.0	A B C G H I	0.20	B C G H I	1.0	A B C G H I	33	--	--	N	33	N
Aroclor-1260	1.0	A B C G H I	0.20	C G H I	1.0	A B C G H I	33	--	--	N	33	N
Total PCBs	2.0	A C G H I	0.40	B C G H I	2.0	A C G H I	67	--	--	N	67	N
General Chemistry (surface water and groundwater)												
	RL	Units										
pH	NA				NA		--	--	--	--	--	--
Chemical Oxygen Demand	5	mg/L			5		--	--	--	--	--	--
Specific Conductivity	10	uS			10		--	--	--	--	--	--
Alkalinity	10	mg/L as $CaCO_3$			10		--	--	--	--	--	--
Chloride	10	mg/L			10		--	--	--	--	--	--
Nitrate as nitrogen	0.05	mg/L			0.05		--	--	--	--	--	--
Sulfate	10	mg/L			10		--	--	--	--	--	--

* Critical parameters for the Tulsa Fuel and Manufacturing site.

1 Reporting limits are based on the Contract Required Quantitation Limits for the Contract Laboratory Program, Methods OLM04.3, OLC03.2, and ILM05.3. Each laboratory's limits may differ slightly from those listed. Significant differences are not anticipated.

2 Mercury is analyzed by cold vapor atomic absorption.

3 Cyanide is analyzed by colorimetry/spectrophotometry.

ARAR = Applicable or Relevant and Appropriate Requirement
ICP-AES = Inductively Coupled Plasma - Atomic Emission Spectroscopy
ICP-MS = Inductively Coupled Plasma - Mass Spectroscopy
mg/kg = millgrams per kilogram
ug/kg = micrograms per kilogram

Table 2-3

Analytical Reporting Limits[1]

Remedial Investigation/Feasibility Study

Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Parameter	Reporting Limit											
	Water						Soil					
	Water-NOS	ARARs or TBCs Not Met	Low Water	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met	Soil - NOS	Low Soil	Medium Soil	ARARs or TBCs Not Met	SEL	ARARs or TBCs Not Met

ug/L = micrograms per liter
NA = Not Applicable
NOS = Not Otherwise Specified
RL = Reporting Limit
SEL = Oklahoma State Environmental Lab
TBC = to-be-considered
XRF = X-Ray Fluorescence Spectroscopy

A = USEPA Maximum Contaminant Level (Table 3-1, Appendix A)
B = USEPA Region VI Ecological Screening Level, Freshwater Chronic (Table 3-1, Appendix A)
C = USEPA Region VI Screening Levels, Tap Water (Table 3-1 Appendix A)
F = Oklahoma Water Quality Criteria, Fish & Wildlife Propagation, Acute (Table 3-3, Appendix A)
G = Oklahoma Water Quality Criteria, Fish & Wildlife Propagation, Chronic (Table 3-3, Appendix A)
H = Oklahoma Water Quality Criteria, Human Health, Water and Fish Consumption (Table 3-3, Appendix A)
I = Oklahoma Water Quality Criteria, Human Health, Fish Consumption (Table 3-3, Appendix A)
J = USEPA Region VI Ecological Screening Levels for Soil (Table 3-4, Appendix A)
L = USEPA Region VI Screening Levels, Industrial Outdoor Worker (Table 3-4, Appendix A)
M = USEPA Region VI Screening Levels, Industrial Indoor Worker (Table 3-4, Appendix A)
N = USEPA Region VI Ecological Screening Levels for Sediment (Table 3-5, Appendix A)
O = USEPA Region VI Screening Levels, Residential Soil (Table 3-4, Appendix A)

Table 2-4
Decision Error Limits

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

True Concentration of the Parameter of Interest	Correct Decision	Tolerable Probability of Making an Incorrect Decision
0 to 80% of the Action Level	Does not exceed the Action Level	5%
80% to 100% of the Action Level to the Action Level	Does not exceed the Action Level	grey region - no probability specified
Greater than the Action Level	Exceeds the Action Level	5%

Action Level = The Action Level is dependent upon the use of the data. See text Section 2.4.5 for discussion of potentially applicable Action Levels for various data uses.

Table 3-1
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Oklahoma SEL Analyses **MS and MSD to be collected as separated samples, meaning triple volume is required at locations selected for the MS/MSD.**						
Metals As, Cd, Pb, & Zn by Lab XRF[3]	Soil	SW-846 6200	One 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
Metals As, Cd, Pb, & Zn by ICP for Confirmation[3] and Moisture Content	Soil	SW-846 6010B and ASTM D2216 or ILM05.3	One 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
TCLP Metals As, Cd, & Pb	Soil	SW-846 6010B	One 8-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
Metals As, Cd, Pb, & Zn by Lab XRF[3]	Sediment	SW-846 6200	One 8-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
Metals As, Cd, Pb, & Zn by ICP for Confirmation[3] and Moisture Content	Sediment	SW-846 6010B and ASTM D2216 or ILM05.3	One 8-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
TCLP Metals As, Cd, & Pb	Sediment	SW-846 6010B	One 8-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
Metals As, Cd, Pb, & Zn by ICP	Water	SW-846 6010B	One 500-mL High-Density Polyethylene Bottle	500 mL	HNO_3 to pH<2 Ice to 4°C	6 months - all metals
Alkalinity Chloride Sulfate	Water	Alkalinity - EPA 310.2 Chloride - EPA 325.2 Sulfate - EPA 375.4	One 500-mL High-Density Polyethylene Bottle	500 mL	Ice to 4°C	Alkanlinity - 14 days Chloride - 28 days Sulfate - 28 days
Nitrate as N COD TOC	Water	Nitrate as N - EPA 35.2 COD - EPA 410.2 TOC - EPA 415 Series	One 500-mL High-Density Polyethylene Bottle	500 mL	H_2SO_4 to pH<2 Ice to 4°C	Nitrate as N - 28 days COD - 28 days TOC - 28 days

Table 3-1
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Field Instrument Measurements						
pH[5]	Water	SW-846 9040B or EPA 150.1	One 100-mL High-Density Polyethylene Bottle	100 mL	--	ASAP (24 hours maximum)
Specific Conductivity[5]	Water	SW-846 9050A or EPA 120.1	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	28 days
Turbidity[5]	Water	EPA 180.1	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	48 hour
Temperature[5]	Water	EPA 170.1	NA - Field measurement using direct reading	--	None	Immediate
Metals by Labs other than the Oklahoma SEL						
Metals As, Cd, Pb, & Zn	Water	SW-846 6000 series or EPA 200 series or ILM05.3	One 1-L High-Density Polyethylene Bottle	1 L	HNO_3 to pH<2 Ice to 4°C	6 months - all metals
	Soil/Sediment[5]	SW-846 6000 series or EPA 200 series or ILM05.3	One 8-oz. or 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
	Vegetation	SW-846 6000 series or EPA 200 series or ILM05.3	1-Gallon Plastic Zipper Bag or 8-oz. Wide-Mouth Glass Jar	Fill to capacity	Ice to 4°C	6 months - all metals
Moisture Content[4]	Soil	ASTM D2216	4 oz. Glass Jar	Fill to capacity	None	28 days
TCLP Metals	Soil/Sediment	SW-846 6000 or 7000 series or EPA 200 series or ILM05.3	One 8-oz. or 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals

Table 3-1
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Air Quality by Labs other than the Oklahoma SEL						
PM_{10} and TSP	Air	IO-1 and IO-2 Series	Filter Cartridge	Determined by flow rate and sampling time.	Protective cover for filter	6 months
Metals As, Cd, Pb, & Zn	Air	IO-3 Series	Filter Cartridge	Determined by flow rate and sampling time.	Protective cover for filter	6 months - all metals
Water General Chemistry by Labs other than the Oklahoma SEL						
Alkalinity	Water	EPA 310 Series or SM 2320B	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	14 days
COD	Water	EPA 410 Series	One 250-mL High-Density Polyethylene Bottle	250 mL	H_2SO_4 to pH<2 Ice to 4°C	28 days
TOC	Water	EPA 415 Series	One 100-mL High-Density Polyethylene Bottle	100 mL	H_2SO_4 or HCl to pH<2 Ice to 4°C	28 days
Chloride	Water	SW-846 9000 Series or EPA 325 Series or EPA 300.0	One 100-mL High-Density Polyethylene Bottle	100 mL	--	28 days
Sulfate	Water	SW-846 9000 Series or EPA 375 Series or EPA 300.0	One 100-mL High-Density Polyethylene Bottle	100 mL	--	28 days
Nitrate as Nitrogen	Water	SW-846 9000 Series or EPA 353 Series or EPA 300.0	One 100-mL High-Density Polyethylene Bottle	100 mL	H_2SO_4 to pH<2 Ice to 4°C	28 days
pH[5]	Water	SW-846 9040B or EPA 150.1	One 100-mL High-Density Polyethylene Bottle	100 mL	--	ASAP (24 hours maximum)
Specific Conductivity[5]	Water	SW-846 9050A or EPA 120.1	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	28 days
Turbidity[5]	Water	EPA 180.1	One 100-mL High-Density Polyethylene Bottle	100 mL	Ice to 4°C	48 hour
Temperature[5]	Water	EPA 170.1	NA - Field measurement using direct reading	--	None	Immediate

Table 3-1
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Potential Soil and Water Analyses						
VOCs	Water	SW-846 5030B / 8260B or OLM04.3	(2 or 3), 40-mL VOC vial with PTFE-lined septa and open screw-caps	Fill to capacity	HCl to pH<2 Ice to 4°C or Ice to 4°C, no HCl	14 days 7 days
	Soil/Sediment[4, 6]	SW-846 5035A / 8260B or OLM04.3	Option 1: At least 3 40-mL VOC vials with PTFE-lined septa and open screw-caps, pre-weighed and containing magnetic stir bars AND One container of sample filled with no headspace for determination of moisture content	5 g 5 g	Frozen (-7°C to -15°C) Ice to 4°C	14 days 48 hours
			Option 2: At least 3 40-mL VOC vials with PTFE-lined septa and open screw-caps, pre-weighed and containing magnetic stir bars. Two of the containers will also contain 5-mL of water. AND One container of sample filled with no headspace for determination of moisture content	5 g 5 g	Frozen (-7°C to -15°C) Ice to 4°C	14 days 48 hours
			Option 3: At least 3 coring tools used as transport devices (e.g., Encore™ 5g Samplers) AND One container of sample filled with no headspace for determination of moisture content	5 g 5 g	Frozen (-7°C to -15°C) or Ice to 4°C Ice to 4°C	48 hours 48 hours
		SW-846 5030 / 8260B	(1 or 2), 4-oz. Glass Jar with PTFE-lined Lid	Fill to capacity	Ice to 4°C	14 days
SVOCs	Water	SW-846 8270C or OLM04.3	At least 2 1-L Amber Glass Bottles, fitted with screw-caps lined with PTFE	2 L	Ice to 4°C	7 days to extraction 40 days to analysis after extraction
	Soil/Sediment[4]	SW-846 8270C or OLM04.3	One 8-oz. Wide-Mouth Glass Jar or two 4-oz. Wide-Mouth Glass Jars	Fill to capacity	Ice to 4°C	14 days to extraction 40 days to analysis after extraction

Table 3-1
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time
Potential Soil and Water Analyses (continued)						
PCBs and Pesticides	Water	SW-846 8082 or OLM04.3	At least 2 1-L Amber Glass Bottles, fitted with screw-caps lined with PTFE	2 L	Ice to 4°C	7 days to extraction 40 days to analysis after extraction
	Soil/Sediment[4]	SW-846 8082 or OLM04.3	One 8-oz. Wide-Mouth Glass Jar or two 4-oz. Wide-Mouth Glass Jars	Fill to capacity	Ice to 4°C	14 days to extraction 40 days to analysis after extraction
TAL Metals	Water	SW-846 6000 or 7000 series or EPA 200 series or ILM05.3	One 1-L High-Density Polyethylene Bottle	1 L	HNO_3 to pH<2 Ice to 4°C	28 days - Mercury only 6 months - all other metals
	Soil/Sediment[4]	SW-846 6000 or 7000 series or EPA 200 series or ILM05.3	One 8-oz. or 4-oz. Wide-Mouth Glass Jar	Fill to capacity	None	6 months - all metals
Cyanide	Water	SW-846 9000 Series or EPA 335 Series or ILM05.3	One 1-L High-Density Polyethylene Bottle	1 L	NaOH to pH>12 Ice to 4°C	14 days
	Soil/Sediment[4]	SW-846 9000 Series or EPA 335 Series or ILM05.3	One 8-oz. or 4-oz. Wide-Mouth Glass Jar	Fill to capacity	Ice to 4°C	14 days

As = Arsenic
ASAP = as soon as possbile
ASTM = American Society for Testing and Materials
°C = Degrees Celsius
Cd = Cadmium
CLP = Contract Laboratory Program
COD = Chemical Oxygen Demand
EPA = Environmental Protection Agency
g = grams
HCl = Hydrochloric Acid
HNO_3 = Nitric Acid
H_2SO_4 = Sulfuric Acid
ICP = Inductively Coupled Plasma
L = liters
mL = milliliters
MS/MSD = Matrix Spike/Matrix Spike Duplicate

Table 3-1
Analytical Methods, Containers, Preservatives, and Holding Times Summary
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacutring, Collinsville, Oklahoma

Analysis	Matrix	Method(s)[1]	Container Type[2]	Volume/ Mass	Preservative	Holding Time

N = Nitrogen
NaOH = Sodium Hydroxide
oz = ounces
Pb = Lead
PM_{10} = Particulate Matter of 10 um or less
PCB = Polychlorinated Biphenyl
PTFE = polytetrafluoroethylene
PUF = Polyurethane Foam
RCRA = Resource Conservation and Recovery Act
SEL = Oklahoma State Environmental Lab
SVOC = Semivolatile Organic Compound
TAL = Target Analyte List
TCLP = Toxicity Characteristic Leaching Procedure
TOC = Total Organic Carbon
TSP = Total Suspended Particulates
VOC = Volatile Organic Compound
XRF = X-Ray Fluorescence Spectroscopy
Zn = Zinc

Notes:

1 Due to the use of multiple analytical laboratories, different methods may be used for sample analysis. In general, the methods indicated here should provide comparable results for a given analysis type.

2 Bottle requirements were based on those indicated by CLP requirements. Each laboratory will indicate appropriate sampling containers to meet their volume requirements, and this may differ from those indicated here. In particular, some of the general chemistry parameters can be combined into one sample bottle. Each laboratory will specify their preference. Quality control samples (field duplicates, MS, MSD, lab duplicates, and rinsates) require the same containers and volume as a typical field sample unless otherwise notified by the laboratory.

3 Metals of interest include As, Cd, Pb, and Zn. SEL will analyze 100% of the soil and sediment samples for these constituents using laboratory XRF techniques. In addition, SEL will analyze 10% of the soil and sediment samples for As, Cd, Pb, and Zn using ICP in order to confirm the laboratory XRF data.

4 Moisture content is listed since results for chemical analyses in soil are to be reported on a dry-weight basis. Unless otherwise noted, sufficient volume should be available to perform moisture content analyses using the volume collected for the primary chemical analysis.

5 Analyses are performed using direct-reading instruments while in the field. The manufacturer's instructions for the equipment provides guidance.

6 CLP methodology prefers the collection of soil/sediment samples for VOC analysis using SW-846 Method 5035. The Oklahoma SEL does not support this methodology. Soil/sediment samples for VOC analysis by the Oklahoma SEL will undergo collection and preparation using SW-846 Method 5030.

Table 3-2
Data Quality Indicator Goals
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Indicator	Criteria	Inorganics	Organics
PRECISION	LCS/LCSD (if analyzed)	Within laboratory established QC limits.[1] Typically RPD<20% for water and RPD<35% for soil	Within laboratory established QC limits.[1] Generally RPD<20% for water and RPD<35% for soil
	MS/MSD	Within method or laboratory established QC limits.[1] Typically RPD<20% for water and RPD<35% for soil	Within method or laboratory established QC limits.[1] Generally RPD<20% for water and RPD<35% for soil
	Lab Duplicate (if analyzed)	Within method or laboratory established QC limits.[1] Typically RPD<20% for water and RPD<35% for soil	NA
	Field Duplicate	RPD<20% for water and RPD<35% for soil	RPD<20% for water and RPD<35% for soil
ACCURACY	Method Blank	No Detections[2]	No Detections[2]
	Trip Blank	NA	No Detections[2]
	Field Blank	NA	No Detections[2]
	Surrogates	NA	Within method or laboratory established QC limits.[1] Generally 70%<REC<130%
	MS/MSD	Within method or laboratory established QC limits.[1] Generally 75%<REC<125%	Within method or laboratory established QC limits.[1] Generally 70%<REC<130%
	LCS	Within method or laboratory established QC limits.[1] Generally 80%<REC<120%	Within method or laboratory established QC limits.[1] Generally 70%<REC<130%
REPRESENTATIVENESS	Sample Collection/Preservation	Procedures in RI/FS FSP followed.	Procedures in RI/FS FSP followed.
	Unusable/Rejected Data	Unusable/Rejected data not used for decision-making.	Unusable/Rejected data not used for decision-making.
COMPLETENESS	Field Completeness	90% or more of planned samples collected.	90% or more of planned samples collected.
	Laboratory Completeness	95% or more of laboratory data usable.	95% or more of laboratory data usable.
COMPARABILITY	Units	Consistent units presented for parameters.	Consistent units presented for parameters.
	Anlaytical Methods	Similar methods used for parameter analysis.	Similar methods used for parameter analysis.

LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
MS = Matrix Spike
MSD = Matrix Spike Duplicate
RI/FS FSP = Remedial Investigation/Feasbility Study Field Sampling Plan
NA = Not Applicable
QC = Quality Control
REC = Percent Recovery
RPD = Relative Percent Difference

Notes:

1 CLP methodology has method-established RPD and REC limits. Other methodology allows the laboratory to statistically establish REC and RPD limits based upon historical data sets. General guidelines for REC and RPD are presented based upon generic method default limits and industry standards.

2 If the analyte of interest is detected about the reporting limit, corrective action should be taken. An exception is made for the common laboratory contaminants such as methylene chloride, acetone, 2-butanone, and phthalates.

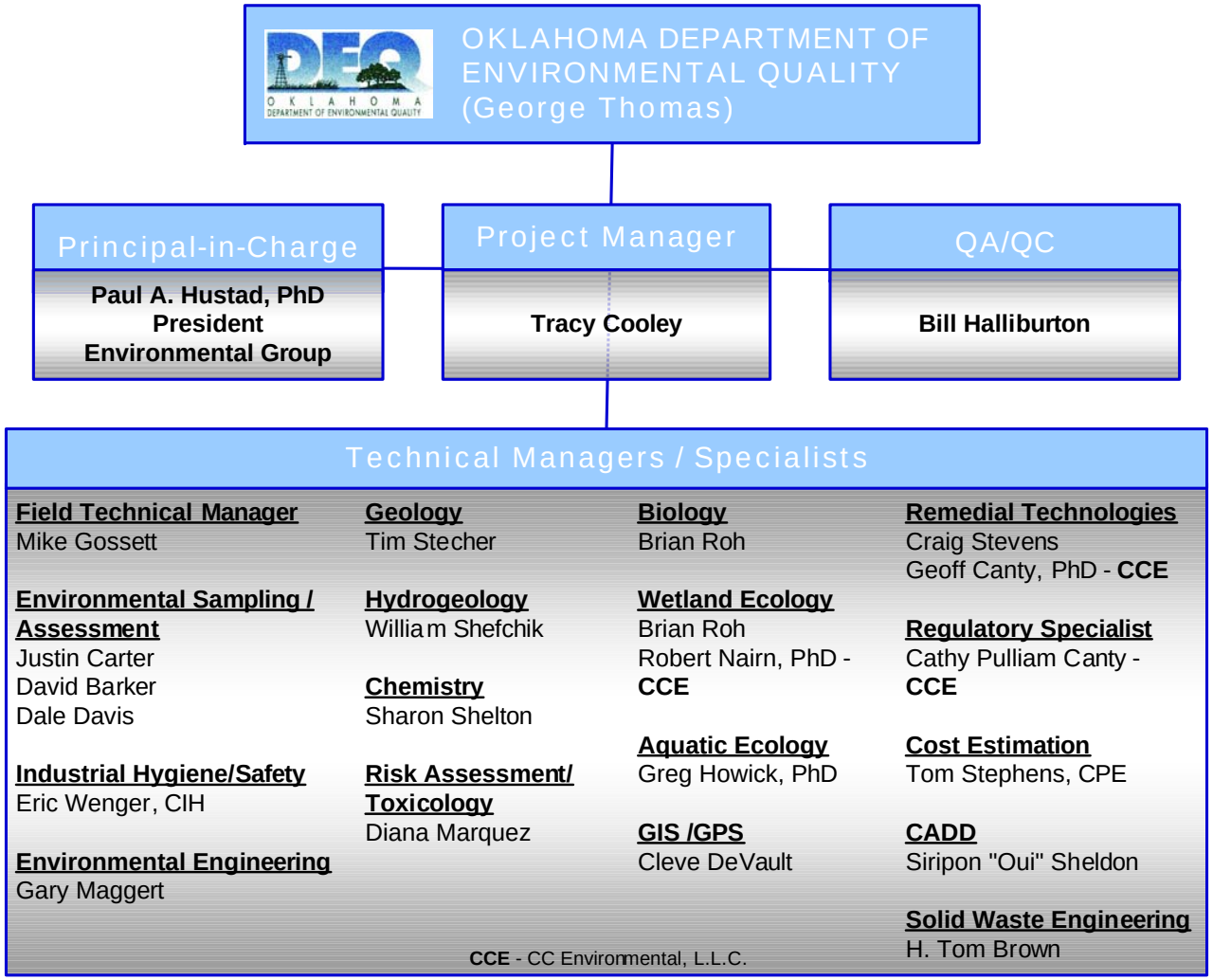
Table 3-3
Field Calibration Record

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

Equipment Item:		Mfr. Serial # B&M Equip. #		Project Abbr. Project No.		
Date Calibrated	Time	Known Standard	Instrument Reading	Adjustments Made	Calibrated By	Comments

Comments: _____

FIGURE



Burns & McDonnell
SINCE 1898

Figure 2-1
Organization Chart
Tulsa Fuel and Manufacturing Superfund Site
Collinsville, Oklahoma

APPENDIX A
POTENTIAL CHEMICAL-SPECIFIC ARARS OR TBCS
(Tables reprinted from RI/FS Work Plan)

TABLE 3-1
Potential Chemical-Specific TBCs for Groundwater
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	MCL[1] (ug/L)	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	USEPA Region VI Human Health Screening Levels Tap Water (ug/L)
Target Analyte List - Inorganics			
Aluminum[2]	50-200	87[a]	37,000
Antimony	6	692[b]	15
Arsenic	NA	190[c]	NA
Arsenic (noncancer endpoint)	10	NA	NA
Arsenic (cancer endpoint)	10	NA	0.045
Barium	2,000	4[d]	2,600
Beryllium	4	5.3[b]	73
Cadmium	5	0.25[c,e]	18
Calcium	NA	NA	NA
Chromium III	NA	10.6[c,e]	55,000
Chromium (total - III and VI)	100	NA	NA
Chromium VI	NA	100.8[c]	110
Cobalt	NA	1,500[b]	730
Copper[3]	1,300	9[d]	1,400
Iron[2]	300	1,000[f]	11,000
Lead[4]	15	2.5[c,e]	15
Lead (tetraethyl)	NA	NA	0.0037
Magnesium	NA	647[b]	NA
Manganese	50	120[d]	1,700
Mercury	2	1.3[c]	11
Nickel	NA	87.4[c,e]	730
Potassium	NA	NA	NA
Selenium	50	5[c]	180
Silver	100	0.11[e,f]	180
Sodium	NA	NA	NA
Thallium	2	40[b]	2.6[dd]
Vanadium	NA	19[d]	37
Zinc	5,000	58.1[c,e]	11,000
Cyanide[2]	200	5.2[c]	730
Target Compound List - Volatiles			
1,1,1-Trichloroethane	200	90.25[g]	840
1,1,2,2-Tetrachloroethane	NA	465[h]	0.055
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	413[h]	59,000
1,1,2-Trichloroethane	5	1,800[h]	0.2
1,1-Dichloroethane	NA	47[i]	810
1,1-Dichloroethene	7	25[i]	340
1,2,4-Trichlorobenzene	70	51[h]	8.2

TABLE 3-1
Potential Chemical-Specific TBCs for Groundwater
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	MCL[1] (ug/L)	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	USEPA Region VI Human Health Screening Levels Tap Water (ug/L)
Target Compound List - Volatiles (continued)			
1,2-Dibromo-3-chloropropane	0.2	11.2[j,k]	0.048
1,2-Dibromoethane	0.05	22.5[j,k]	0.0056
1,2-Dichlorobenzene	600	110[h]	49
1,2-Dichloroethane	5	910[i]	0.12
1,2-Dichloropropane	5	3,730[h]	0.16
1,3-Dichlorobenzene	NA	85[h]	16
1,4-Dichlorobenzene	75	110[h]	0.47
2-Butanone	NA	84,800[h]	7,100
2-Hexanone	NA	99[i]	NA
4-Methyl-2-pentanone	NA	170[i]	2,000
Acetone	NA	202,400	33,000
Benzene	5	130[i]	0.35
Bromodichloromethane	80	4,320[h]	0.18
Bromoform	80	320[i]	8.5
Bromomethane	NA	110[w]	8.7
Carbon disulfide	NA	0.92[i]	1,000
Carbon tetrachloride	5	9.8[i]	0.17
Chlorobenzene	NA	64[i]	110
Chloroethane	NA	NA	3.6[dd]
Chloroform	80	28[i]	75
Chloromethane	NA	55,000[h]	190[dd]
cis-1,2-Dichloroethene	70	NA	61
cis-1,3-Dichloropropene	NA	7.9[x,y]	0.4
Cyclohexane	NA	NA	13,000
Dibromochloromethane	80	257[l]	0.13
Dichlorodifluoromethane	NA	1,960[h]	390
Ethylbenzene	700	2,180[h]	1,300
Isopropylbenzene	NA	255[l]	660
Methyl acetate	NA	NA	6,100
Methyl tert-butyl ether	NA	11,070[l]	6.2
Methylcyclohexane	NA	NA	5,200
Methylene chloride	5	410[i]	4.3
Styrene	100	2,500[h]	1,600
Tetrachloroethene	5	NA	0.1
Toluene	1,000	9.8[i]	720
trans-1,2-dichloroethene	100	590[i]	120

TABLE 3-1
Potential Chemical-Specific TBCs for Groundwater
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	MCL[1] (ug/L)	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	USEPA Region VI Human Health Screening Levels Tap Water (ug/L)
Target Compound List - Volatiles (continued)			
trans-1,3-Dichloropropene	NA	0.055[l]	0.4
Trichloroethene	5	1,110[h]	0.028
Trichlorofluoromethane	NA	1,740[h]	1,300
Vinyl chloride	2	5,630[h]	0.043
Xylenes (total)	10,000	1.3[l]	200
Target Compound List - Semivolatiles			
1,1'-Biphenyl	NA	14[i]	300
2,2'-oxybis(1-Chloropropane)	NA	20[j,k]	NA
2,4,5-Trichlorophenol	NA	64[l]	3,700
2,4,6-Trichlorophenol	NA	13.5[h]	6.1
2,4-Dichlorophenol	NA	85[h]	110
2,4-Dimethylphenol	NA	210[h]	730
2,4-Dinitrophenol	NA	62[h]	73
2,4-Dinitrotoluene	NA	2,430[h]	73
2,6-Dinitrotoluene	NA	42[m]	37
2-Chloronaphthalene	NA	54[h]	490
2-Chlorophenol	NA	43.8[n]	30
2-Methylnaphthalene	NA	NA	120[dd]
2-Methylphenol	NA	1,120[h]	1,800
2-Nitroaniline	NA	NA	110
2-Nitrophenol	NA	1,920[l]	NA
3,3'-Dichlorobenzidine	NA	1,050[l]	0.15
3-Nitroaniline	NA	NA	3.3[dd]
4,6-Dinitro-2-methylphenol	NA	23[l]	3.7[dd]
4-Bromophenyl-phenyl ether	NA	1.5[i]	NA
4-Chloro-3-methylphenol	NA	0.3[i]	NA
4-Chloroaniline	NA	232[j,k]	150
4-Chlorophenol-phenyl ether	NA	NA	NA
4-Methylphenol	NA	543[l]	180
4-Nitroaniline	NA	NA	3.3[dd]
4-Nitrophenol	NA	300[i]	290
Acenaphthene	NA	23[p]	370
Acenaphthylene	NA	4,840[j,q]	NA
Acetophenone	NA	687[j,k]	3,700
Anthracene	NA	0.3[h]	1,800
Atrazine	3	NA	0.3

TABLE 3-1
Potential Chemical-Specific TBCs for Groundwater
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	MCL[1] (ug/L)	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	USEPA Region VI Human Health Screening Levels Tap Water (ug/L)
Target Compound List - Semivolatiles (continued)			
Benzaldehyde	NA	NA	3,700
Benzo(a)anthracene	NA	34.6[h]	0.092
Benzo(a)pyrene	0.2	0.014[i]	0.0092
Benzo(b)fluoranthene	NA	0.027[t]	0.092
Benzo(g,h,i)perylene	NA	7.64[j,q,dd]	NA
Benzo(k)fluoranthene	NA	0.027[t]	0.92
bis(2-Chloroethoxy)methane	NA	110,000[u,v]	NA
bis(2-Chloroethyl) ether	NA	1,140[j,k]	0.0098
bis(2-Ethylhexyl)phthalate	NA	7[h]	4.8
Butylbenzylphthalate	NA	19[i]	7,300
Caprolactam	NA	NA	18,000
Carbazole	NA	NA	3.4
Chrysene	NA	7[h]	9.2
Dibenzo(a,h)anthracene	NA	5[h]	0.0092
Dibenzofuran	NA	94[h]	12
Diethylphthalate	NA	2,090[h]	29,000
Dimethylphthalate	NA	330[z]	370,000
Di-n-butylphthalate	NA	7[h]	3,700
Di-n-octylphthalate	NA	22[h]	1,500
Fluoranthene	NA	6.16[o]	1,500
Fluorene	NA	11[h]	240
Hexachlorobenzene	1	3.68[u,v]	0.042
Hexachlorobutadiene	NA	9.3[u,v]	0.86
Hexachlorocyclopentadiene	50	5.2[u,v]	220
Hexachloroethane	NA	12[i]	4.8
Indeno(1,2,3-cd)pyrene	NA	0.027[t]	0.092
Isophorone	NA	12,000[h]	71
Naphthalene	NA	490[h]	6.2
Nitrobenzene	NA	27,000[u,v]	3.4
N-Nitroso-di-n-propylamine	NA	20[aa,bb]	0.0096
N-Nitrosodiphenylamine	NA	580[h]	14
Pentachlorophenol	1	2.1[aa,cc]	0.56
Phenanthrene	NA	30[aa]	NA
Phenol	NA	110[i]	11,000
Pyrene	NA	7[h]	180

TABLE 3-1
Potential Chemical-Specific TBCs for Groundwater
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	MCL[1] (ug/L)	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	USEPA Region VI Human Health Screening Levels Tap Water (ug/L)
Target Compound List Pesticides			
alpha-BHC	NA	NA	0.011[ee]
beta-BHC	NA	NA	0.037[ee]
delta-BHC	NA	NA	NA
gamma-BHC (Lindane)	0.2	NA	0.052[ee]
Heptachlor	0.4	NA	0.015
Aldrin	NA	NA	0.004
Heptachlor epoxide	0.2	NA	0.0074
Endosulfan I	NA	NA	220[ff]
Dieldrin	NA	NA	0.0042
4,4'-DDE	NA	NA	0.2
Endrin	2	NA	11
Endosulfan II	NA	NA	220[ff]
4,4'-DDD	NA	NA	0.28
Endosulfan sulfate	NA	NA	NA
4,4'-DDT	NA	NA	0.2
Methoxychlor	40	NA	180
Endrin ketone	NA	NA	NA
Endrin aldehyde	NA	NA	NA
alpha-Chlordane	2[gg]	NA	0.19[gg]
gamma-Chlordane	2[gg]	NA	0.19[gg]
Toxaphene	3	NA	0.061
Target Compound List Polychlorinated Biphenyls			
Total	0.5	0.0013[s]	0.034
Aroclor -1016	NA	0.014[i]	0.96
Aroclor -1221	NA	0.28[i]	0.034
Aroclor -1232	NA	0.58[i]	0.034
Aroclor -1242	NA	0.053[i]	0.034
Aroclor -1248	NA	0.081[i]	0.034
Aroclor -1254	NA	0.033[i]	0.034
Aroclor -1260	NA	94[i]	0.034

Notes:
*All hardness-dependent criteria are based on a 100 mg/L hardness value.
NA = not available
[1]MCLs listed for aluminum, iron, manganese, silver, and zinc are SMCLs.
[2]Represents benchmarks that are expressed as total concentrations in the aqueous phase. If the analyte does not have a [2], benchmark is expressed as a dissolved concentration.
[3]MCL listed for copper is an action level; the SMCL is 1,000 ug/L.

TABLE 3-1
Potential Chemical-Specific TBCs for Groundwater
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	MCL[1] (ug/L)	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	USEPA Region VI Human Health Screening Levels Tap Water (ug/L)

[4]MCL listed for lead is an action level.
[a]Benchmark for waters, pH = 6.5-9.0.
[b]Texas Commission on Environmental Quality (formerly TNRCC) Water Permits and Resource Management Division, 2001. In-house water quality chronic values derived for wastewater permits and requests from the Office of Waste based on LC50 values in accordance with methodology defined in the TSWQS.
[c]Texas Surface Water Quality Standards Chron+A200ic Criteria (30 TAC 307.6, Table 1, Effective 8/17/00.
[d]Value is from GLWQI, Tier II Values. Suter and Tsao, 1996.
[e]Criteria calculated using a hardness value of 50 mg/L based on formula: $Cd=0.909e^{(0.7852(\ln(hardness))-3.490)}$
[f]USEPA, 1999. National Recommended Water Quality Criteria.
[g]U.S. EPA Region 5. 1999. EDQL, MRL values for all media. Draft Document. Available at: http://www.epa.gov/reg5oopa/rcra/edql10-4-99.pdf. Value is based on equlibrium partitioning using surface water quality criterion presented in U.S. EPA Region 5 (1999).
[h]TNRCC Water Permits and Resource Management Division, 2001. In-house water quality chronic values derived for wastewater permits and requests from the Office of Waste based on LC50 values in accordance with methodology defined in the TSWQS.
[i]Suter, G.W. II, and Tsao, C.L. 1996. Toxicological Benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 Rebision. ES/ER/TM-96/R2. Available at http://www.esd.ornl.gov/programs/ecorisk/tm96r2.pdf.
[j]U.S. EPA Region 5. 1999. Ecological Screening Levels for RCRA Appendix IX Hazardous Constituents.
[k]Value is based on an interim criterion developed according to the procedures described in U.S. EPA Region 5 (1999w). Source data used in developing interim criteria were obtained through the Aquatic Toxicity Information Retrieval (ACQUIRE) database.
[l]TNRCC (Texas Natural Resource Conservation Commission), Toxicology and Risk Assessment Section.
[m]Ohio EPA, Division of Surface Water, 2002. Ohio Administrative Code (OAC) 3745-1-07: Water Use Designations and Statewide Criteria. Available at: www.epa.state.oh.us/dsw/rules/3745-1.html.
[n]U.S. EPA. 1980. Ambient Water Quality Criteria for 2-Chlorophenol. EPA 440/5-80-034, October 1980.
[o]These numbers are FCVs calculated by the EPA for use in the derivation of sediment quality criteria (U.S. EPA 1993).
[p]U.S. EPA. 1993. Sediment Quality Criteria for the protection of benthic organisms - acenapthene. EPA 822-R93-013.
[q]Value is based on a receptor specific value derived for mammals (mink), based on ingestion of aquatic life and using toxicity reference values (TRVs) obtained through toxicological information gathered from technical documents and computer databases, as described in U.S. EPA Region 5, 1999[j].
[r]U.S. EPA. 1999. National Recommended Water Quality Criteria - Correction. EPA 822-Z-99-001. Available at: http://www.epa.gov/ost/pc/revcom.pdf.
[s]Value is human health number from TSWQS. This value is lower than the chronic aquatic life number and incorporates bioaccumulation.

TABLE 3-1
Potential Chemical-Specific TBCs for Groundwater
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	MCL[1] (ug/L)	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	USEPA Region VI Human Health Screening Levels Tap Water (ug/L)

[t]U.S. EPA. 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Volume III: Appendix E. EPA 530-D-99-001C. Available at: http://www.epa.gov/epaoswer/hazwaste/combust/eco-risk/volume2/appx-a.pdf.
[u]U.S. EPA Region 3. 1995. BTAG Screening Levels. (Draft). August 9, 1995.
[v]IRIS (Integraded Risk Information System) Database. (Through May, 1995). Ambient Water Quality Criteria, Aquatic Organisms. Cincinnati, OH, Environmental Criteria and Assessment Office, US EPA. July 19, 1995.
[w]U.S. EPA 1980. Ambient Water Quality for Halomethanes. EPA 440/5-80-051, October 1980.
[x]Illinois PCB (Illinois Pollution Control Board). 1999. Administrative Code Title 35, Subtitle C, Chapter 1, Part 302, Subpart F, Sections 627 and 630: Procedures for Determining Water Quality Criteria. Available at: www.epa.gov/waterscience/standards/wqslibrary/il/il.html.
[y]Chronic Aquatic Toxicity Criterion developed using available toxcity data as described in Illinois PCB (1999[x]).
[z]U.S. EPA Region 4. 1999. Value derived from Region 4 Water Quality Management Division screening worksheet.
[aa]TNRCC (Texas Natural Resources Conservation Commission). 2000. Texas Surface Water Quality Standards. Texas Administrative Code (TAC), Title 30, Chapter 307. Effective August 17, 2000. Available at www.tnrcc.state.tx.us/oprd/rules/pdflib/307%60.pdf.
[bb]Values derived using LC50 approach in accordance with methodology defined in TNRCC 2000[aa].
[cc]Calculated for pH 6.0.
[dd]Region III Risk-Based Criteria
[ee]Technical BHC screening level is 0.037 ug/L.
[ff]For Endosulfan, not Endosulfan I or II.
[gg]For Chlordane, not specific isomers.

NA - Not Applicable
ug/L - micrograms per liter
MCL - Maximum Contaminant Level
TBC - To-Be-Considered
USEPA - United States Environmental Protection Agency

TABLE 3-2
Potential Chemical-Specific TBCs for Air
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Human Health Screening Levels (ug/m^3)	National Emissions Standards for Hazardous Air Pollutants (ug/m^3)
Target Analyte List - Inorganics		
Aluminum	5.2	NA
Antimony	1.5[a]	NA
Arsenic	0.00045	NA
Barium	260	NA
Beryllium	0.0008	NA
Cadmium	0.0011	NA
Calcium	NA	NA
Chromium	0.00016	NA
Cobalt	0.00069	NA
Copper	150[a]	NA
Iron	1,100[a]	NA
Lead	NA	1.5
Magnesium	NA	NA
Manganese	0.051	NA
Mercury	0.31	NA
Nickel	73[a]	NA
Potassium	NA	NA
Selenium	18[a]	NA
Silver	18[a]	NA
Sodium	NA	NA
Thallium	0.26[a]	NA
Vanadium	1.1[a]	NA
Zinc	1,100[a]	NA
Cyanide	NA	NA
Target Compound List - Volatiles		
1,1,1-Trichloroethane	2,300	NA
1,1,2,2-Tetrachloroethane	0.033	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	31,000	NA
1,1,2-Trichloroethane	0.12	NA
1,1-Dichloroethane	520	NA
1,1-Dichloroethene	210	NA
1,2,4-Trichlorobenzene	4.2	NA
1,2-Dibromo-3-chloropropane	0.21	NA
1,2-Dibromoethane	0.0034	NA
1,2-Dichlorobenzene	25	NA
1,2-Dichloroethane	0.074	NA
1,2-Dichloropropane	0.099	NA
1,3-Dichlorobenzene	8.3	NA
1,4-Dichlorobenzene	0.28	NA
2-Butanone	5,200	NA

TABLE 3-2
Potential Chemical-Specific TBCs for Air
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Human Health Screening Levels (ug/m^3)	National Emissions Standards for Hazardous Air Pollutants (ug/m^3)
Target Compound List - Volatiles (continued)		
2-Hexanone	NA	NA
4-Methyl-2-pentanone	3,100	NA
Acetone	3,300[a]	NA
Benzene	0.25	NA
Bromodichloromethane	0.11	NA
Bromoform	1.7	NA
Bromomethane	5.2	NA
Carbon disulfide	730	NA
Carbon Tetrachloride	0.13	NA
Chlorobenzene	63	NA
Chloroethane	2.2[a]	NA
Chloroform	0.084	NA
Chloromethane	1.1	NA
cis-1,2-Dichloroethene	37	NA
cis-1,3-Dichloropropene	0.48	NA
Cyclohexane	6,300	NA
Dibromochloromethane	0.08	NA
Dichlorodifluoromethane	210	NA
Ethylbenzene	1,100	NA
Isopropylbenzene	400[a]	NA
Methyl acetate	3,700	NA
Methyl tert-butyl ether	3.7	NA
Methylcyclohexane	3,100	NA
Methylene chloride	4.1	NA
Styrene	1,100	NA
Tetrachloroethene	0.33	NA
Toluene	400	NA
trans-1,2-dichloroethene	73	NA
trans-1,3-Dichloropropene	0.48	NA
Trichloroethene	0.017	NA
Trichlorofluoromethane	730	NA
Vinyl chloride	0.22	NA
Xylenes (total)[+A138]	100	NA
Target Compound List - Semivolatiles		
1,1'-Biphenyl	180	NA
2,2'-oxybis(1-Chloropropane)	NA	NA
2,4,5-Trichlorophenol	370	NA
2,4,6-Trichlorophenol	0.62	NA
2,4-Dichlorophenol	11	NA
2,4-Dimethylphenol	73	NA

TABLE 3-2
Potential Chemical-Specific TBCs for Air
Numerical Criteria for Indicator Chemicals
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Human Health Screening Levels (ug/m^3)	National Emissions Standards for Hazardous Air Pollutants (ug/m^3)
Target Compound List - Semivolatiles (continued)		
2,4-Dinitrophenol	7.3	NA
2,4-Dinitrotoluene	7.3	NA
2,6-Dinitrotoluene	3.7	NA
2-Chloronaphthalene	290	NA
2-Chlorophenol	18	NA
2-Methylnaphthalene	73[a]	NA
2-Nitroaniline	0.1	NA
2-Nitrophenol	29	NA
3,3'-Dichlorobenzidine	0.015	NA
3-Nitroaniline	0.31[a]	NA
4,6-Dinitro-2-methylphenol	0.37[a]	NA
4-Bromophenyl-phenyl ether	NA	NA
4-Chloro-3-methylphenol	NA	NA
4-Chloroaniline	15	NA
4-Chlorophenol-phenyl ether	NA	NA
4-Methylphenol	18	NA
4-Nitroaniline	0.31[a]	NA
4-Nitrophenol	29	NA
Acenaphthene	220	NA
Acenaphthylene	NA	NA
Acetophenone	370[a]	NA
Anthracene	1,100	NA
Atrazine	0.031	NA
Naphthalene	3.1	NA
Benzaldehyde	370	NA
Benzo(a)anthracene	0.022	NA
Benzo(a)pyrene	0.0022	NA
Benzo(b)fluoranthene	0.022	NA
Benzo(g,h,i)perylene	NA	NA
Benzo(k)fluoranthene	0.22	NA
bis(2-Chloroethoxy)methane	NA	NA
bis(2-Chloroethyl) ether	0.0058	NA
bis(2-Ethylhexyl)phthalate	0.48	NA
Butylbenzylphthalate	730	NA
Caprolactam	1,800	NA
Carbazole	0.34	NA
Chrysene	2.2	NA
Dibenzo(a,h)anthracene	0.0022	NA
Dibenzofuran	7.3	NA
Diethylphthalate	2,900	NA

TABLE 3-2
Potential Chemical-Specific TBCs for Air
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Human Health Screening Levels (ug/m^3)	National Emissions Standards for Hazardous Air Pollutants (ug/m^3)
Target Compound List - Semivolatiles (continued)		
Dimethylphthalate	37,000	NA
Di-n-butylphthalate	370	NA
Di-n-octylphthalate	150	NA
Fluoranthene	150	NA
Fluorene	150	NA
Hexachlorobenzene	0.0042	NA
Hexachlorobutadiene	0.087	NA
Hexachlorocyclopentadiene	0.21	NA
Hexachloroethane	0.48	NA
Indeno(1,2,3-cd)pyrene	0.022	NA
Naphthalene	3.1	NA
Isophorone	7.1	NA
Nitrobenzene	2.1	NA
N-Nitroso-di-n-propylamine	0.00096	NA
N-Nitrosodiphenylamine	1.4	NA
Pentachlorophenol	0.056	NA
Phenanthrene	NA	NA
Phenol	1,100[a]	NA
Pyrene	110	NA
Target Compound List Pesticides		
alpha-BHC	0.0011[b]	NA
beta-BHC	0.0037[b]	NA
delta-BHC	NA	NA
gamma-BHC (Lindane)	0.0052[b]	NA
Heptachlor	0.0015	NA
Aldrin	0.00039	NA
Heptachlor epoxide	0.00074	NA
Endosulfan I	2[c]	NA
Dieldrin	0.00042	NA
4,4'-DDE	0.02	NA
Endrin	1.1	NA
Endosulfan II	22[c]	NA
4,4'-DDD	0.028	NA
Endosulfan sulfate	NA	NA
4,4'-DDT	0.02	NA
Methoxychlor	18	NA
Endrin ketone	NA	NA
Endrin aldehyde	NA	NA
alpha-Chlordane	0.019[d]	NA

TABLE 3-2
Potential Chemical-Specific TBCs for Air
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Human Health Screening Levels (ug/m^3)	National Emissions Standards for Hazardous Air Pollutants (ug/m^3)
Target Compound List Pesticides (continued)		
gamma-Chlordane	0.019[d]	NA
Toxaphene	0.006	NA
Target Compound List Polychlorinated Biphenyls		
Total	0.0034	NA
Aroclor -1016	0.096	NA
Aroclor -1221	0.0034	NA
Aroclor -1232	0.0034	NA
Aroclor -1242	0.0034	NA
Aroclor -1248	0.0034	NA
Aroclor -1254	0.0034	NA
Aroclor -1260	0.0034	NA

Notes:
[1]The Oklahoma screening level is 100 for m-xylene and 730 for o-xylene.
[a]Region III Risk-Based Criteria for Ambient Air
[b]Technical BHC screening level is 0.0038 ug/m^3.
[c]For Endosulfan not Endosulfan I or II.
[d]For Chlordane not specific isomers.
ARAR - applicable or relevant and appropriate requirements
NA - not available
TBC - to be considered criteria
ug/m^3 - micrograms per cubic meter
USEPA - United States Environmental Protection Agency

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)
Target Analyte List - Inorganics					
Aluminum	87[a]	NA	NA	NA	NA
Antimony	692[b]	NA	NA	NA	NA
Arsenic	190[c]	360	190	NA	205.0
Barium	4[d]	NA	NA	NA	NA
Beryllium	5.3[b]	NA	NA	NA	NA
Cadmium	0.25[c,e]	e(1.128[ln(hardness)]-1.6774	e(0.7852[ln(hardness)]-3.490)	14.49	84.13
Calcium	NA	NA	NA	NA	NA
Chromium III	10.6[c,e]	NA	NA	NA	NA
Chromium (total - III and VI)	NA	NA	50	166.3	3365.0
Chromium VI	100.8[c]	NA	NA	NA	NA
Cobalt	1,500[b]	NA	NA	NA	NA
Copper	9[d]	e(0.9422[ln(hardness)]-1.3844)	e(0.8545[ln(hardness)]-1.386)	NA	NA
Iron	1,000[f]	NA	NA	NA	NA
Lead	2.5[c,e]	e(1.273[ln(hardness)]-1.460	e(1.273[ln(hardness)]-4.705)	5.0	25.0
Lead (tetraethyl)	NA	NA	NA	0.0037^{+E53}	NA
Magnesium	647[b]	NA	NA	NA	NA
Manganese	120[d]	NA	NA	NA	NA
Mercury	1.3[c]	2.4	1.302	0.050	0.051
Nickel	87.4[c,e]	e(0.8460[ln(hardness)]+3.3612)	e(0.846[ln(hardness)]+1.1645)	607.2	4,583.0
Potassium	NA	NA	NA	NA	NA
Selenium	5[c]	20.0	5	NA	NA
Silver	0.11[e,f]	e(1.72[ln(hardness)]-6.52)	NA	104.8	64,620.0

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)
Target Analyte List - Inorganics (continued)					
Sodium	NA	NA	NA	NA	NA
Thallium	40[b]	1,400.0	0	1.7	6.0
Vanadium	19[d]	NA	NA	37[dd]	NA
Zinc	58.1[c,e]	e(0.8473[ln(hardness)]+0.8604	e(0.8473[ln(hardness)]+0.7614)	NA	NA
Cyanide	5.2[c]	45.93	10.72	NA	NA
Target Compound List - Volatiles					
1,1,1-Trichloroethane	90.25[g]	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	465[h]	NA	NA	NA	NA
1,1,2-Trichloro-1,2,2-trifluoroetha	413[h]	NA	NA	NA	NA
1,1,2-Trichloroethane	1,800[h]	NA	NA	NA	NA
1,1-Dichloroethane	47[i]	NA	NA	NA	NA
1,1-Dichloroethene	25[i]	NA	NA	NA	NA
1,2,4-Trichlorobenzene	51[h]	NA	NA	NA	NA
1,2-Dibromo-3-chloropropane	11.2[j,k]	NA	NA	NA	NA
1,2-Dibromoethane	22.5[j,k]	NA	NA	NA	NA
1,2-Dichlorobenzene	110[h]	NA	NA	NA	NA
1,2-Dichloroethane	910[i]	NA	NA	NA	NA
1,2-Dichloropropane	3,730[h]	NA	NA	NA	NA
1,3-Dichlorobenzene	85[h]	NA	NA	NA	NA
1,4-Dichlorobenzene	110[h]	NA	NA	NA	NA
2-Butanone	84,800[h]	NA	NA	NA	NA
2-Hexanone	99[l]	NA	NA	NA	NA

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)
Target Compound List - Volatiles (continued)					
4-Methyl-2-pentanone	170[i]	NA	NA	NA	NA
Acetone	202,400	NA	NA	NA	NA
Benzene	130[i]	NA	2,200.0	11.87	714.1
Bromodichloromethane	4,320[h]	NA	NA	1.9	157.0
Bromoform	320[i]	NA	NA	NA	NA
Bromomethane	110[w]	NA	NA	NA	NA
Carbon disulfide	0.92[i]	NA	NA	NA	NA
Carbon Tetrachloride	9.8[i]	NA	NA	2.538	44.18
Chlorobenzene	64[i]	NA	NA	NA	NA
Chloroethane	NA	NA	NA	3.6[ee]	NA
Chloroform	28[i]	NA	NA	56.69	4,708.0
Chloromethane	55,000[h]	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	61[dd]	NA
cis-1,3-Dichloropropene	7.9[x,y]	NA	NA	NA	NA
Cyclohexane	NA	NA	NA	12,000[ee]	NA
Dibromochloromethane	257[l]	NA	NA	NA	NA
Dichlorodifluoromethane	1,960[h]	NA	NA	NA	NA
Ethylbenzene	2,180[h]	NA	NA	3,120.0	2+F1058720
Isopropylbenzene	255[l]	NA	NA	NA	NA
Methyl acetate	NA	NA	NA	6,100[dd]	NA
Methyl tert-butyl ether	11,070[l]	NA	NA	NA	NA
Methylcyclohexane	NA	NA	NA	5,200[dd]	NA

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)
Target Compound List - Volatiles (continued)					
Methylene chloride	410[i]	NA	NA	NA	NA
Styrene	2,500[h]	NA	NA	NA	NA
Tetrachloroethene	NA	5,280.0	NA	8.0	88.5
Toluene	9.8[i]	NA	875.0	10,150.0	301,900.0
trans-1,2-dichloroethene	590[i]	NA	NA	NA	NA
trans-1,3-Dichloropropene	0.055[i]	NA	NA	NA	NA
Trichloroethene	1,110[h]	NA	NA	3,094.0	173,100.0
Trichlorofluoromethane	1,740[h]	NA	NA	NA	NA
Vinyl chloride	5,630[h]	NA	NA	NA	NA
Xylenes (total)	1.3[l]	NA	NA	NA	NA
Target Compound List - Semivolatiles					
1,1'-Biphenyl	14[i]	NA	NA	NA	NA
2,2'-oxybis(1-Chloropropane)	20[i,k]	NA	NA	NA	NA
2,4,5-Trichlorophenol	64[l]	NA	NA	NA	NA
2,4,6-Trichlorophenol	13.5[h]	NA	NA	NA	NA
2,4-Dichlorophenol	85[h]	NA	NA	NA	NA
2,4-Dimethylphenol	210[h]	NA	NA	NA	NA
2,4-Dinitrophenol	62[h]	NA	NA	NA	NA
2,4-Dinitrotoluene	2,430[h]	NA	NA	NA	NA
2,6-Dinitrotoluene	42[m]	NA	NA	NA	NA
2-Chloronaphthalene	54[h]	NA	NA	NA	NA
2-Chlorophenol	43.8[n]	NA	NA	NA	NA

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)
Target Compound List - Semivolatiles (continued)					
2-Methylnaphthalene	NA	NA	NA	120[ee]	NA
2-Methylphenol	1,120[h]	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	1.1[dd]	NA
2-Nitrophenol	1,920[l]	NA	NA	NA	NA
3,3'-Dichlorobenzidine	1,050[l]	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	23[l]	NA	NA	NA	NA
4-Bromophenyl-phenyl ether	1.5[i]	NA	NA	NA	NA
4-Chloro-3-methylphenol	0.3[i]	NA	NA	NA	NA
4-Chloroaniline	232[j,k]	NA	NA	NA	NA
4-Chlorophenol-phenyl ether	NA	NA	NA	NA	NA
4-Methylphenol	543[l]	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	3.3[ee]	NA
4-Nitrophenol	300[i]	NA	NA	NA	NA
Acenaphthene	23[p]	NA	NA	NA	NA
Acenaphthylene	4,840[j,q]	NA	NA	NA	NA
Acetophenone	687[j,k]	NA	NA	NA	NA
Anthracene	0.3[h]	NA	NA	NA	NA
Atrazine	NA	NA	NA	0.3[dd]	NA
Benzaldehyde	NA	NA	NA	3,700[dd]	NA
Benzo(a)anthracene	34.6[h]	NA	NA	NA	NA
Benzo(a)pyrene	0.014[l]	NA	NA	NA	NA

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)
Target Compound List - Semivolatiles (continued)					
Benzo(b)fluoranthene	0.027[t]	NA	NA	NA	NA
Benzo(g,h,i)perylene	7.64[j,q,dd]	NA	NA	NA	NA
Benzo(k)fluoranthene	0.027[t]	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	110,000[u,v]	NA	NA	NA	NA
bis(2-Chloroethyl) ether	1,140[j,k]	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	7[h]	NA	NA	NA	NA
Butylbenzylphthalate	19[i]	NA	NA	NA	NA
Caprolactam	NA	NA	NA	18,000[dd]	NA
Carbazole	NA	NA	NA	3.4[dd]	NA
Chrysene	7[h]	NA	NA	NA	NA
Dibenzo(a,h)anthracene	5[h]	NA	NA	NA	NA
Dibenzofuran	94[h]	NA	NA	NA	NA
Diethylphthalate	2,090[h]	NA	NA	NA	NA
Dimethylphthalate	330[z]	NA	NA	NA	NA
Di-n-butylphthalate	7[h]	NA	NA	NA	NA
Di-n-octylphthalate	22[h]	NA	NA	NA	NA
Fluoranthene	6.16[o]	NA	NA	NA	NA
Fluorene	11[h]	NA	NA	NA	NA
Hexachlorobenzene	3.68[u,v]	NA	NA	0.009026	0.009346
Hexachlorobutadiene	9.3[u,v]	NA	NA	NA	NA
Hexachlorocyclopentadiene	5.2[u,v]	NA	NA	NA	NA
Hexachloroethane	12[l]	NA	NA	NA	NA

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)
Target Compound List - Semivolatiles (continued)					
Isophorone	0.027[t]	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	12,000[h]	NA	NA	NA	NA
Naphthalene	490[h]	NA	NA	NA	NA
Nitrobenzene	27,000[u,v]	NA	NA	NA	NA
N-Nitroso-di-n-propylamine	20[aa,bb]	NA	NA	NA	NA
N-Nitrosodiphenylamine	580[h]	NA	NA	NA	NA
Pentachlorophenol	2.1[aa,cc]	e[1.005(pH)-4.830]	e[1.005(pH)-5.290]	1,014.0	29,370.0
Phenanthrene	30[aa]	NA	NA	NA	NA
Phenol	110[i]	NA	NA	20,900.0	4,615,000.0
Pyrene	7[h]	NA	NA	NA	NA
Target Compound List Pesticides					
alpha-BHC	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA
delta-BHC	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	2	0.08	0.1458	0.4908
Heptachlor	NA	0.52	0.0038	0.00208	0.00214
Aldrin	NA	3	NA	0.001273	0.001356
Heptachlor epoxide	NA	NA	NA	NA	NA
Endosulfan I	NA	0.22[ff]	0.056[ff]	NA	NA
Dieldrin	NA	2.5	0.0019	0.001352	0.00144
4,4'-DDE	NA	NA	NA	NA	NA
Endrin	NA	0.18	0.0023	0.7553	0.814
Endosulfan II	NA	0.22[ii]	0.056[ii]	NA	NA

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)
Target Compound List Pesticides (continued)					
4,4'-DDD	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA
4,4'-DDT	NA	1.1	0.001	0.005876	0.0059
Methoxychlor	NA	NA	0.03	NA	NA
Endrin ketone	NA	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA	NA
alpha-Chlordane	NA	2.4[gg]	0.17[gg]	0.00575[gg]	0.00587[gg]
gamma-Chlordane	NA	NA	NA	NA	NA
Toxaphene	NA	0.78	0.0002	NA	NA
Target Compound List Polychlorinated Biphenyls					
Total	0.0013[s]	NA	0.044	0.00079	0.00079
Aroclor -1016	0.014[i]	NA	NA	NA	NA
Aroclor -1221	0.28[i]	NA	NA	NA	NA
Aroclor -1232	0.58[i]	NA	NA	NA	NA
Aroclor -1242	0.053[i]	NA	NA	NA	NA
Aroclor -1248	0.081[i]	NA	NA	NA	NA
Aroclor -1254	0.033[i]	NA	NA	NA	NA
Aroclor -1260	94[i]	NA	NA	NA	NA

Notes:
*All hardness-dependent criteria are based on a 100 mg/L hardness value.
[a]Benchmark for waters, pH = 6.5-9.0.

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)

[b]Texas Commission on Environmental Quality (formerly TNRCC) Water Permits and Resource Management Division, 2001. In-house water quality chronic values derived for wastewater permits and requests from the Office of Waste based on LC50 values in accordance with methodology defined in the TSWQS.

[c]Texas Surface Water Quality Standards Chronic Criteria (30 TAC 307.6, Table 1, Effective 8/17/00.

[d]Value is from GLWQI, Tier II Values. Suter and Tsao, 1996.

[e]Criteria calculated using a hardness value of 50 mg/L based on formula: $Cd=0.909e^{(0.7852(\ln(hardness))-3.490)}$

[f]USEPA, 1999. National Recommended Water Quality Criteria.

[g]U.S. EPA Region 5. 1999. EDQL, MRL values for all media. Draft Document. Available at: http://www.epa.gov/reg5oopa/rcra/edql10-4-99.pdf. Value is based on equlibrium partitioning using surface water quality criterion presented in U.S. EPA Region 5 (1999).

[h]TNRCC Water Permits and Resource Management Division, 2001. In-house water quality chronic values derived for wastewater permits and requests from the Office of Waste based on LC50 values in accordance with methodology defined in the TSWQS.

[i]Suter, G.W. II, and Tsao, C.L. 1996. Toxicological Benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 Rebision. ES/ER/TM-96/R2. Available at http://www.esd.ornl.gov/programs/ecorisk/tm96r2.pdf.

[j]U.S. EPA Region 5. 1999. Ecological Screening Levels for RCRA Appendix IX Hazardous Constituents.

[k]Value is based on an interim criterion developed according to the procedures described in U.S. EPA Region 5 (1999w). Source data used in developing interim criteria were obtained through the Aquatic Toxicity Information Retrieval (ACQUIRE) database.

[l]TNRCC (Texas Natural Resource Conservation Commission), Toxicology and Risk Assessment Section. December 2001. Guidance for Conducting Ecological Risk Assessments at Remediation sites in Texas. Available at: http://www.tnrcc.state.tx.us/admin/topdoc/rg/263.pdf.

[m]Ohio EPA, Division of Surface Water, 2002. Ohio Administrative Code (OAC) 3745-1-07: Water Use Designations and Statewide Criteria. Available at:

[n]U.S. EPA. 1980. Ambient Water Quality Criteria for 2-Chlorophenol. EPA 440/5-80-034, October 1980.

[o]These numbers are FCVs calculated by the EPA for use in the derivation of sediment quality criteria (U.S. EPA 1993).

[p]U.S. EPA. 1993. Sediment Quality Criteria for the protection of benthic organisms - acenapthene. EPA 822-R93-013.

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)

[q]Value is based on a receptor specific value derived for mammals (mink), based on ingestion of aquatic life and using toxicity reference values (TRVs) obtained through toxicological information gathered from technical documents and computer databases, as described in U.S. EPA Region 5, 1999j.
[r]U.S. EPA. 1999. National Recommended Water Quality Criteria - Correction. EPA 822-Z-99-001. Available at: http://www.epa.gov/ost/pc/revcom.pdf.
[s]Value is human health number from TSWQS. This value is lower than the chronic aquatic life number and incorporates bioaccumulation.
[t]U.S. EPA. 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Volume III: Appendix E. EPA 530-D-99-001C. Available at: http://www.epa.gov/epaoswer/hazwaste/combust/eco-risk/volume2/appx-a.pdf.
[u]U.S. EPA Region 3. 1995. BTAG Screening Levels. (Draft). August 9, 1995.
[v]IRIS (Integrated Risk Information System) Database. (Through May, 1995). Ambient Water Quality Criteria, Aquatic Organisms. Cincinnati, OH, Environmental Criteria and Assessment Office, US EPA. July 19, 1995.
[w]U.S. EPA 1980. Ambient Water Quality for Halomethanes. EPA 440/5-80-051, October 1980.
[x]Illinois PCB (Illinois Pollution Control Board). 1999. Administrative Code Title 35, Subtitle C, Chapter 1, Part 302, Subpart F, Sections 627 and 630: Procedures for Determining Water Quality Criteria. Available at: www.epa.gov/waterscience/standarsds/wqslibrary/il/il.html.
[y]Chronic Aquatic Toxicity Criterion developed using available toxicity data as described in Illinois PCB (1999[x]).
[z]U.S. EPA Region 4. 1999. Value derived from Region 4 Water Quality Management Division screening worksheet.
[aa]TNRCC (Texas Natural Resources Conservation Commission). 2000. Texas Surface Water Quality Standards. Texas Administrative Code (TAC), Title 30, Chapter 307. Effective August 17, 2000. Available at www.tnrcc.state.tx.us/oprd/rules/pdflib/307%60.pdf.
[bb]Values derived using LC50 approach in accordance with methodology defined in TNRCC 2000[aa].
[cc]Calculated for pH 6.0.
[dd]Region VI Human Health Screening Levels - Tap Water
[ee]Region III Risk-Based Criteria for Tap Water
[ff]For Endosulfan, not Endosulfan I or II.
[gg]For Chlordane, not specific isomers.
ARAR - applicable or relevant and appropriate requirements

TABLE 3-3
Potential Chemical-Specific TBCs for Surface Water
Numerical Criteria for Indicator Chemicals
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels Freshwater Chronic* (ug/L)	Oklahoma Water Quality Criteria			
		Fish & Wildlife Propagation		Human Health	
		Acute (ug/L)	Chronic (ug/L)	Water and Fish Consumption (ug/L)	Fish Consumption (ug/L)

NA - not available
TBC - to be considered criteria
ug/L - micrograms per liter
USEPA - United States Environmental Protection Agency

.

TABLE 3-4
Potential Chemical-Specific TBCs for Soil
Numerical Criteria for Indicator Chemicals
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Indoor Worker (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Analyte List Inorganics				
Aluminum	See below[a]	100,000	100,000	76,000
Antimony	0.3[b]	820	450	31
Arsenic	31[b]	NA	NA	NA
Arsenic (noncancer endpoint)	NA	610	280	22
Arsenic (cancer endpoint)	NA	3.8	1.8	0.39
Barium	330[b]	100,000	79,000	5,500
Beryllium	30[b]	2,200	2,200	150
Cadmium	0.4[b]	1,000	560	39
Calcium	NA	NA	NA	NA
Chromium III	7.9[b]	100,000	100,000	10,000
Chromium (total - III and VI)	NA	450	500	210
Chromium VI	94[b]	64	71	30
Cobalt	32[b]	1,900	2,100	900
Copper	54[b]	76,000	42,000	2,900
Iron	See below[c]	100,000	100,000	23,000
Lead	15[b]	800	800	400
Lead (tetraethyl)	NA	0.2	0.068	0.0061
Magnesium	NA	NA	NA	NA
Manganese	152[b]	47,000	35,000	3,200
Mercury	0.1[d]	610	340	23
Nickel	48[b]	41,000	23,000	1,600
Potassium	NA	NA	NA	NA
Selenium	1[b]	10,000	5,700	390
Silver	2[e]	10,000	5,700	390
Sodium	NA	NA	NA	NA
Thallium	1[e]	72[s]	72[s]	5.5[s]
Vanadium	2[e]	2,000	1,100	78
Zinc	120[b]	100,000	100,000	23,000
Cyanide	5[f]	41,000	14,000	1,200
Target Compound List - Volatiles				
1,1,1-Trichloroethane	0.1[g]	1,400	1,400	1,400
1,1,2,2-Tetrachloroethane	0.1[g]	0.9	0.97	0.38
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	5,600	5,600	5,600
1,1,2-Trichloroethane	0.1[g]	1.9	2.1	0.84
1,1-Dichloroethane	20.1[j,k]	2,100	2,300	590
1,1-Dichloroethene	0.0024[l]	430	470	280
1,2,4-Trichlorobenzene	20[m]	240	260	68
1,2-Dibromo-3-chloropropane	0.03518[j,k]	4	2.2	0.45
1,2-Dibromoethane	1.23[j,k]	0.065	0.070	0.028
1,2-Dichlorobenzene	2.96[j,k]	370	370	280
1,2-Dichloroethane	0.1[g]	0.77	0.84	590
1,2-Dichloropropane	700[m]	0.77	0.85	0.35
1,3-Dichlorobenzene	37.7[j,k]	140	150	93
1,4-Dichlorobenzene	20[m]	7.5	8.1	3.2

TABLE 3-4
Potential Chemical-Specific TBCs for Soil
Numerical Criteria for Indicator Chemicals
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Indoor Worker (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Compound List - Volatiles (continued)				
2-Butanone	89.6[q,k]	34,000	34,000	32,000
2-Hexanone	12.6[j,k]	NA	NA	NA
4-Methyl-2-pentanone	443[j,k]	17,000	17,000	5,800
Acetone	2.5[q,k]	100,000	100,000	7,000
Benzene	0.5[r]	1.5	1.6	0.66
Bromodichloromethane	0.53978[j,o,k]	2.4	2.6	1.0
Bromoform	15.9[o,k]	720	240	62
Bromomethane	0.23516[q,o,k]	13	15	3.9
Carbon disulfide	0.09412[j,k]	720	720	720
Carbon Tetrachloride	1,000[e]	0.53	0.58	0.24
Chlorobenzene	40	550	600	320
Chloroethane	NA	990[s]	990[s]	220[s]
Chloroform	0.001[r]	0.52	0.58	0.25
Chloromethane	10.4[q]	2.7	3.0	1.3
cis-1,2-Dichloroethene	NA	150	160	43
cis-1,3-Dichloropropene	0.39786[j,o,k]	1.6	1.7	0.70
Cyclohexane	0.1[r]	140	140	140
Dibromochloromethane	2.05[j,o,k]	2.4	2.6	1.0
Dichlorodifluoromethane	39.5[j,k]	310	340	94
Ethylbenzene	5[r]	230	230	230
Isopropylbenzene	NA	520	580	370
Methyl acetate	NA	96,000	100,000	22,000
Methyl tert-butyl ether	NA	37	41	17
Methylcyclohexane	NA	140	140	140
Methylene chloride	2[r]	21	22	8.9
Styrene	300	1,700	1,700	1,700
Tetrachloroethene	0.01[r]	1.8	1.7	0.55
Toluene	200	520	520	520
trans-1,2-Dichloroethene	0.78373[j,o,k]	210	240	63
trans-1,3-Dichloropropene	0.39786[j,o,k]	1.6	1.7	0.70
Trichloroethene	0.001[r]	0.092	0.1	0.043
Trichlorofluoromethane	16.4[j,k]	1,300	1,400	390
Vinyl chloride	0.01[r]	0.43	0.43	0.15
Xylenes (total)	5[r]	210	210	210
Target Compound List - Semivolatiles				
1,1'-Biphenyl	60[i]	30,000	26,000	3,000
2,2'-oxybis(1-Chloropropane)	19.9[j,k]	NA	NA	NA
2,4,5-Trichlorophenol	4[e]	100,000	68,000	6,100
2,4,6-Trichlorophenol	10[m]	520	170	44
2,4-Dichlorophenol	20[e]	6,100	2,100	180
2,4-Dimethylphenol	0.01[o,k,p]	41,000	14,000	1,200
2,4-Dinitrophenol	20[e]	4,100	1,400	120
2,6-Dinitrotoluene	0.03283[j,k]	2,000	680	61
2-Chloronaphthalene	0.01218[j,o,k]	27,000	26,000	3,900

TABLE 3-4
Potential Chemical-Specific TBCs for Soil
Numerical Criteria for Indicator Chemicals
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Indoor Worker (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Compound List - Semivolatiles (continued)				
2-Chlorophenol	20[n]	240	260	64
2-Methylnaphthalene	NA	20,000[s]	20,000[s]	310[s]
2-Methylphenol	40.4[j,o,k]	100,000	34,000	3,100
2-Nitroaniline	74.1[j,o,k]	5,900	2,000	180
2-Nitrophenol	1.6[j,o,k]	NA	NA	NA
3,3'-Dichlorobenzidine	0.64636[j,o,k]	13	4.3	1.1
3-Nitroaniline	3.16[j,o,k]	140[s]	140[s]	23[s]
4,6-Dinitro-2-methylphenol	0.14408[j,o,k]	120[s]	120[s]	7.8[s]
4-Bromophenyl-phenyl ether	NA	NA	NA	NA
4-Chloro-3-methylphenol	7.95[j,k]	NA	NA	NA
4-Chloroaniline	1.1[j,o,k]	8,200	2,700	240
4-Chlorophenol-phenyl ether	NA	NA	NA	NA
4-Methylphenol	163[j,o,k]	10,000	3,400	310
4-Nitroaniline	21.9[j,o,k]	140[s]	140[s]	32[s]
4-Nitrophenol	7[m]	16,000	5,500	490
Hexachlorobutadiene	0.03976[j,o,k]	73	25	6.2
Acenaphthene	20	38,000	33,000	3,700
Acenaphthylene	682[j,o,k]	NA	NA	NA
Acetophenone	300[j,o,k]	1,700	1,700	1,700
Anthracene	10[r,m]	100,000	100,000	22,000
Atrazine	0.00005[r]	26	8.6	2.2
Benzaldehyde	NA	100,000	68,000	6,100
Benzo(a)anthracene	5.21[j,k]	7.8	2.3	0.62
Benzo(a)pyrene	1[r]	0.78	0.23	0.062
Benzo(b)fluoranthene	59.8[j,k]	7.8	2.3	0.62
Benzo(g,h,i)perylene	119[j,k]	NA	NA	NA
Benzo(k)fluoranthene	148[j,k]	78	23	6.2
bis(2-Chloroethoxy)methane	0.30209[q,o,k]	NA	NA	NA
bis(2-Chloroethyl) ether	23.7[qok]	0.62	0.62	0.21
bis(2-Ethylhexyl)phthalate	0.92594[j,k]	410	140	35
Butylbenzylphthalate	0.23889[j,k]	240	240	240
Caprolactam	NA	100,000	100,000	31,000
Carbazole	NA	290	96	24
Chrysene	4.73[j,k]	780	230	62
Dibenzo(a,h)anthracene	18.4[j,k]	0.78	0.23	0.062
Dibenzofuran	NA	2,500	1,700	150
Diethylphthalate	100	100,000	100,000	49,000
Dimethylphthalate	200	100,000	100,000	100,000
Di-n-butylphthalate	200	100,000	68,000	3,100
Di-n-octylphthalate	709[j,k]	82,000	27,000	2,400
Fluoranthene	10[r]	82,000	24,000	2,300
Fluorene	30	33,000	26,000	2,600
Hexachlorobutadiene	0.03976[j,o,k]	73	25	6.2
Hexachlorobenzene	0.0025[r]	3.6	1.2	0.30

TABLE 3-4
Potential Chemical-Specific TBCs for Soil
Numerical Criteria for Indicator Chemicals
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Indoor Worker (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Compound List - Semivolatiles (continued)				
Hexachlorocyclopentadiene	10[r]	12,000	4,100	370
Hexachloroethane	0.59634[j,o,k]	410	140	35
Indeno(1,2,3-cd)pyrene	109[j,k]	7.8	2.3	0.62
Isophorone	139[j,k]	6,000	2,000	510
Naphthalene	5[r]	190	210	120
Nitrobenzene	40[r]	110	110	20
N-Nitroso-di-n-propylamine	0.54368[j]	0.82	0.27	0.069
N-Nitrosodiphenylamine	20	1,200	390	99
Pentachlorophenol	3[n]	48	10	3.0
Phenanthrene	5[r]	NA	NA	NA
Phenol	30	100,000	100,000	18,000
Pyrene	10[r]	54,000	32,000	2,300
Target Compound List Pesticides				
alpha-BHC	NA	0.91 (1)	0.4 (1)	0.09 (1)
beta-BHC	NA	3.2	1.4	0.32
delta-BHC	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	4.4	1.9	0.44
Heptachlor	NA	1.3	0.43	0.11
Aldrin	NA	0.34	0.11	0.029
Heptachlor epoxide	NA	0.63	0.21	0.053
Endosulfan I	NA	12,000 (2)	4,100 (2)	370 (2)
Dieldrin	NA	0.36	0.12	0.03
4,4'-DDE	NA	17	7.8	1.7
Endrin	NA	610	210	18
Endosulfan II	NA	12,000 (2)	4,100 (2)	370 (2)
4,4'-DDD	NA	24	11	2.4
Endosulfan sulfate	NA	NA	NA	NA
4,4'-DDT	NA	17	7.8	1.7
Methoxychlor	NA	10,000	3,400	310
Endrin ketone	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA
alpha-Chlordane	NA	16 (3)	7.2 (3)	1.6 (3)
gamma-Chlordane	NA	16 (3)	7.2 (3)	1.6 (3)
Toxaphene	NA	5.2	1.7	0.44
Target Compound List Polychlorinated Biphenyls				
Total	40[e]	2.9	0.83	0.22
Aroclor -1016	10[h,n]	82	24	3.9
Aroclor -1221	10[h,n]	2.9	0.83	0.22
Aroclor -1232	10[h,n]	2.9	0.83	0.22
Aroclor -1242	10[h,n]	2.9	0.83	0.22
Aroclor -1248	10[h,n]	2.9	0.83	0.22
Aroclor -1254	10[h,n]	2.9	0.83	0.22
Aroclor -1260	10[h,n]	2.9	0.83	0.22

Notes:

TABLE 3-4
Potential Chemical-Specific TBCs for Soil
Numerical Criteria for Indicator Chemicals
Remedial Investigation/Feasibility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Indoor Worker (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)

[a]Aluminum should only be included as COPC if soil pH<5.5. (Based on Ecological Soil Screening Level for Aluminum (Eco-SSL), USEPA, 2003.)
[b]Ecological Soil Screening Levels (Eco-SSL). U.S. EPA 2003. http://www.epa.gov/ecotox/ecossl/
[c]In well-aerated soils of pH 5-8, iron is not expected to be toxic. (Based on Ecological Soil Screening Level for Aluminum (Eco-SSL), USEPA, 2003.)
[d]Efroymson, R.A., M.E. Will, and G.W. Suter. 1997. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Lockheed Martin Energy Systems, Inc. ES/ER/TM-126/R2.
[e]Efroymson, R.A., M.E. Will, G.W. Suter, and A.C. Wooten. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Lockheed Martin Energy Systems, Inc. ES/ER/TM-85/R3.
[f]Friday, G.P. 1998. Ecological Screening Values for Surface Water, Sediment, and Soil. Report # WSRC-TR-98-00110, Westinghouse Savannah River Company, November 1998.
[g]CCME (Canadian Council of Ministers of the Environment). 2002. Canadian Environmental Quality Guidelines: Summary Table 2002. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba.
[h]These values represent Region 8 Aroclor specific SLC.
[i]Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary remediation goals for ecological endpoints. ES/ER/TM-162/R2. Oak Ridge National Laboratory, Oak Ridge, TN.
[j]Value is based on an adjusted TRV developed using the masked shrew as the receptor species, exposed to chemicals through ingestion of soil and earthworms, based on the exposure parameters described in U.S. EPA. Region 5. 1999 [k].
[k]U.S. EPA Region 5. 1999. Ecological Screening Levels for RCRA Appendix IX Hazardous Constituents.
[l]Ontario Ministry of the Environment and Energy. 1998. Guidance for Ecological Risk Assessment: Level II Screening Benchmark Values. Oregon Dept. Env. Qual., Portland. Available at: http://www.deq.state.or.us/wmc/documents/eco-2slv.pdf.
[m]Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997. Toxicological benchmarks for contaminants of potential concern for effects on soil and litter invertebrates and heterotrophic processes. ES/ER/TM-126/R2.
[n]U.S. EPA OSWER. 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. August. EPA 530-D-99-011A.
[o]U.S. EPA Region 5. 1999. EDQL, MRL values for all media. Draft Document. Available at: http://www.epa.gov/reg5oopa/rcra/edql10-4-99.pdf. Value is based on equlibrium partitioning using surface water quality criterion presented in U.S. EPA Region 5 (1999).
[p]Value was developed based on a review of existing toxicological information for plant receptors as described in U.S. EPA Region 5[o,k].
[q]Value is based on an adjusted TRV developed using the meadow vole as the receptor species, exposed to chemicals through ingestion of soil and contaminated vegetation, based on the exposure parameters described in U.S. EPA. Region 5. 1999 [k].
[r]Friday, G.P. 1998. Ecological Screening Values for Surface Water, Sediment, and Soil. Report WSRC-TR-98-00110, Westinghouse Savannah River Company, November 1998.
[s]Region III Risk-Based Criteria for Industrial Soil
[t]Region IX Preliminary Remedial Goals for Industrial Soil
[u]Technical BHC screening levels for industrical indoor workers, industrial outdoor workers, and residential are 3.2, 1.4, and 0.32 mg/kg, respectively.
[v]For Endosulfan, not Endosulfan I or II.
[w]For Chlordane, not specific isomers.
ARAR - applicable or relevant and appropriate requirements
mg/kg - milligrams per kilogram
NA - not available
TBC - to be considered criteria
USEPA - United States Environmental Protection Agency

TABLE 3-5
Potential Chemical-Specific TBCs for Sediment
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasbility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Analyte List Inorganics			
Aluminum	25,500	100,000	76,000
Antimony	2[a]	450	31
Arsenic	5.9[b]	NA	NA
Barium	NA	79,000	5,500
Beryllium	NA	2,200	150
Cadmium	0.596[b]	560	39
Calcium	NA	NA	NA
Chromium III	37.3[b]	100,000	10,000
Chromium VI	NA	71	30
Cobalt	50[c]	2,100	900
Copper	35.7[b]	42,000	2,900
Iron	20,000[d]	100,000	23,000
Lead	35[b]	800	400
Magnesium	NA	NA	NA
Manganese	460[d]	35,000	3,200
Mercury	0.174[b]	340	23
Nickel	18[b]	23,000	1,600
Potassium	NA	NA	NA
Selenium	2[e]	5,700	390
Silver	1[a]	5,700	390
Sodium	NA	NA	NA
Thallium	NA	72[y]	5.5[y]
Vanadium	NA	1,100	78
Zinc	123[b]	100,000	23,000
Cyanide	0.0001[d]	14,000	1,200
Target Compound List - Volatiles			
1,1,1-Trichloroethane	0.17[g]	1,400	1,400
1,1,2,2-Tetrachloroethane	0.94[g]	0.97	0.38
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	5,600	5,600
1,1,2-Trichloroethane	1.2[h,i]	2.1	0.84
1,1-Dichloroethane	0.25[h,i]	2,300	590
1,1-Dichloroethene	0.4[h,i]	470	280
1,2,4-Trichlorobenzene	9.2[g]	260	68
1,2-Dibromo-3-chloropropane	0.01998[j,k,l]	2.2	0.45
1,2-Dibromoethane	0.01237[j,k,l]	0.070	0.028
1,2-Dichlorobenzene	0.34[g]	370	280
1,2-Dichloroethane	0.25[h,i]	0.84	590
1,2-Dichloropropane	NA	0.85	0.35
1,3-Dichlorobenzene	1.7[g]	150	93
1,4-Dichlorobenzene	0.35[g]	8.1	3.2
2-Butanone	0.27[r]	34,000	32,000
2-Hexanone	0.022[h,i]	NA	NA

TABLE 3-5
Potential Chemical-Specific TBCs for Sediment
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasbility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Compound List - Volatiles (continued)			
4-Methyl-2-pentanone	0.033[h,i]	17,000	5,800
Acetone	0.0087[i]	100,000	7,000
Benzene	0.057[g]	1.6	0.66
Bromodichloromethane	NA	2.6	1.0
Bromoform	0.65[g]	240	62
Bromomethane	NA	15	3.9
Carbon disulfide	0.0085[r]	720	720
Carbon Tetrachloride	1.2[g]	0.58	0.24
Chlorobenzene	0.82[g]	600	320
Chloroethane	NA	990[y]	220[y]
Chloroform	0.022[h,i]	0.58	0.25
Chloromethane	NA	3.0	1.3
cis-1,2-Dichloroethene	NA	160	43
cis-1,3-Dichloropropene	0.00296[j,p,n]	1.7	0.70
Cyclohexane	NA	140	140
Dibromochloromethane	NA	2.6	1.0
Dichlorodifluoromethane	NA	340	94
Ethylbenzene	3.6[g]	230	230
Isopropylbenzene	NA	580	370
Methyl acetate	NA	100,000	22,000
Methyl tert-butyl ether	NA	41	17
Methylcyclohexane	NA	140	140
Methylene chloride	0.37[h,i]	22	8.9
Styrene	NA	1,700	1,700
Tetrachloroethene	0.53[g]	1.7	0.55
Toluene	0.67[g]	520	520
trans-1,2-dichloroethene	0.031[h,i]	240	63
trans-1,3-Dichloropropene	0.000051[h,i]	1.7	0.70
Trichloroethene	1.6[g]	0.1	0.043
Trichlorofluoromethane	NA	1,400	390
Vinyl chloride	NA	0.43	0.15
Xylenes (total)	0.16[h,i]	210	210
Target Compound List - Semivolatiles			
1,1'-Biphenyl	1.1[g]	26,000	3,000
2,2'-oxybis(1-Chloropropane)	0.6878[j,k,l]	NA	NA
2,4,5-Trichlorophenol	NA	68,000	6,100
2,4,6-Trichlorophenol	0.08484[j,m,n]	170	44
2,4-Dichlorophenol	0.13363[j,n,o]	2,100	180
2,4-Dimethylphenol	0.029[h]	14,000	1,200
2,4-Dinitrophenol	0.0013[j,p,n]	1,400	120
2,4-Dinitrotoluene	0.07513[j,n,q]	1,400	120
2,6-Dinitrotoluene	0.02062[j,n,o]	680	61

TABLE 3-5
Potential Chemical-Specific TBCs for Sediment
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasbility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Compound List - Semivolatiles (continued)			
2-Chloronaphthalene	0.41723[j,k,s]	26,000	3,900
2-Chlorophenol	0.0117[j,n,o]	260	64
2-Methylphenol	0.012[h,i]	34,000	3,100
2-Nitroaniline	NA	2,000	180
2-Nitrophenol	0.00777[j,k,l]	NA	NA
3,3'-Dichlorobenzidine	0.2822[j,k,s]	4.3	1.1
3-Nitroaniline	NA	140[y]	23[y]
4,6-Dinitro-2-methylphenol	0.01038[j,p,n]	120[y]	7.8[y]
4-Bromophenyl-phenyl ether	1.3[g]	NA	NA
4-Chloro-3-methylphenol	0.38818[j,k,l]	NA	NA
4-Chloroaniline	0.14608[j,k,l]	2,700	240
4-Chlorophenol-phenyl ether	NA	NA	NA
4-Methylphenol	0.67[h,t]	3,400	310
4-Nitroaniline	NA	140[y]	32[y]
4-Nitrophenol	0.00778[j,m,n]	5,500	490
Acenaphthene	0.62[g]	33,000	3,700
Acenaphthylene	0.044[u,v,w]	NA	NA
Acetophenone	0.246[j,k,l]	1,700	1,700
Anthracene	0.0572[x]	100,000	22,000
Isophorone	0.4223[j,m,n]	2,000	510
Atrazine	NA	8.6	2.2
Benzaldehyde	NA	68,000	6,100
Benzo(a)anthracene	0.0017[h,i]	2.3	0.62
Benzo(a)pyrene	0.43[g]	0.23	0.062
Benzo(b)fluoranthene	10.4[j,k,s]	2.3	0.62
Benzo(g,h,i)perylene	0.17[r]	NA	NA
Benzo(k)fluoranthene	0.24[r]	23	6.2
bis(2-Chloroethoxy)methane	NA	NA	NA
bis(2-Chloroethyl) ether	0.21196[j,k,l]	0.62	0.21
bis(2-Ethylhexyl)phthalate	890[h,i]	140	35
Butylbenzylphthalate	11[g]	240	240
Caprolactam	NA	100,000	31,000
Carbazole	NA	96	24
Chrysene	0.34[r]	230	62
Dibenzo(a,h)anthracene	0.06[r]	0.23	0.062
Dibenzofuran	2[g]	1,700	150
Diethylphthalate	0.63[g]	100,000	49,000
Dimethylphthalate	0.02495[j,m,n]	100,000	100,000
Di-n-butylphthalate	11[g]	68,000	3,100
Di-n-octylphthalate	40.6[j,n,o]	27,000	2,400
Fluoranthene	2.9[g]	24,000	2,300

TABLE 3-5
Potential Chemical-Specific TBCs for Sediment
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasbility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Compound List - Semivolatiles (continued)			
Fluorene	0.54[g]	26,000	2,600
Hexachlorobenzene	0.02[r]	1.2	0.30
Hexachlorobutadiene	1.38[j,k,y]	25	6.2
Hexachlorocyclopentadiene	0.90074[j,k,s]	4,100	370
Hexachloroethane	1[g]	140	35
Isophorone	0.4223[j,m,n]	2,000	510
Indeno(1,2,3-cd)pyrene	0.2[r]	2.3	0.62
Naphthalene	0.48[g]	210	120
Nitrobenzene	0.4876[j,m,n]	110	20
N-Nitroso-di-n-propylamine	NA	0.27	0.069
N-Nitrosodiphenylamine	0.15524[j,m,n]	390	99
Pentachlorophenol	0.36[h,i]	10	3.0
Phenanthrene	0.85[g]	NA	NA
Phenol	0.031[h,i]	100,000	18,000
Pyrene	0.66[g]	32,000	2,300
Target Compound List Pesticides			
alpha-BHC	NA	0.4[z]	0.09[z]
beta-BHC	NA	1.4	0.32
delta-BHC	NA	NA	NA
gamma-BHC (Lindane)	NA	1.9	0.44
Heptachlor	NA	0.43	0.11
Aldrin	NA	0.11	0.029
Heptachlor epoxide	NA	0.21	0.053
Endosulfan I	NA	4,100[aa]	370[aa]
Dieldrin	NA	0.12	0.03
4,4'-DDE	NA	7.8	1.7
Endrin	NA	210	18
Endosulfan II	NA	4,100[aa]	370[aa]
4,4'-DDD	NA	11	2.4
Endosulfan sulfate	NA	NA	NA
4,4'-DDT	NA	7.8	1.7
Methoxychlor	NA	3,400	310
Endrin ketone	NA	NA	NA
Endrin aldehyde	NA	NA	NA
alpha-Chlordane	NA	7.2[bb]	1.6[bb]
gamma-Chlordane	NA	7.2[bb]	1.6[bb]
Toxaphene	NA	1.7	0.44
Target Compound List Polychlorinated Biphenyls			
Total	0.023[g,u,w]	0.83	0.22
Aroclor -1016	0.007[r]	24	3.9
Aroclor -1221	0.12[h,i]	0.83	0.22
Aroclor -1232	0.06[h,i]	0.83	0.22

TABLE 3-5
Potential Chemical-Specific TBCs for Sediment
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasbility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)
Target Compound List Polychlorinated Biphenyls (continued)			
Aroclor -1242	0.17[h,i]	0.83	0.22
Aroclor -1248	0.030[r]	0.83	0.22
Aroclor -1254	0.060[r]	0.83	0.22
Aroclor -1260	0.005[r]	0.83	0.22

Notes:
[a]Effects Range Low (ERL) from: Long, E.R. and L.G. Morgan. 1990. The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, March 1990.
[b]Threshold Effects Level (TEL) from: Smith, S.L., D.D. MacDonald, K.A. Keenleyside, C.G. Ingersoll, and L.J. Field. 1996a. A Preliminary Evaluation of Sediment Quality Assessment Values for Freshwater Ecosystems. J. Great Lakes REs. 22(3): 624-638.
[c]LEL from: Persaud et al. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment, Queen's Printer for Ontario.
[d]Lowest Effects Level (LEL) from : Persaud, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment in Ontario. Water Resources Branch. Ontario Ministry of the Environment and Energy. August.
[e]Department of the Interior. 1998. Guidelines for interpretation of biological effects of selected constituents in biota, water, and sediment. National Irrigation Water Quality Information Report #3. Bureau of Reclamation, Denver, CO. 198 pp.
[f]EqP value derived using surface water quality criterion presented in U.S. EPA Region 5 (1999n). Surface water criterion was calculated using a receptor specific value derived for mammals (mink), based on ingestion of aquatic life and using toxicity reference values (TRVs) obtained through toxicological information gathered from technical documents and computer databases, as described in U.S. EPA Region 5 (1999w).
[g]U.S. EPA. 1996. Eco Update: Ecotox Thresholds. Office of Solid Waste and Emergency Response, Washington, D.C. EPA 540/F-95/038.
[h]Jones, D.S., Suter, G.W. II, and Hull, R.N. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 revision. ES/ER/TM-95/R4. Oak Ridge National Laboratory, Oak Ridge, TN. Available at: http://www.esd.ornl.gov/programs/ecorisk/tm95r4/pdf.

[i]EqP value calculated using Tier II Secondary Chronic Value from Suter and Tsao (1996o). Units are in mg/kg dry weight assuming an organic carbon content of 1% (Jones et al. 1997pp).
[j]U.S. EPA Region 5. 1999. EDQL, MRL values for all media. Draft Document. Available at: http://www.epa.gov/reg5oopa/rcra/edql10-4-99.pdf. Value is based on equlibrium partitioning using surface water quality criterion presented in U.S. EPA Region 5 (1999).
[k]U.S. EPA Region 5. 1999. Ecological Screening Levels for RCRA Appendix IX Hazardous Constituents.
[l]Value is based on equilibrium partitioning using surface water quality criterion presented in U.S. EPA Region 5 (1999w). Surface water criterion is an interim criterion developed according to the procedures described in the USEPA Region 5 1999n. Source data used to derive interim criteria were obtained through the Aquatic Toxicity Information Retrieval (ACQUIRE) database.
[m]Ohio EPA, Division of Surface Water, 2002. Ohio Administrative Code (OAC) 3745-1-07: Water Use Designations and Statewide Criteria. Available at: www.epa.state.oh.us/dsw/rules/3745-1.html.

TABLE 3-5
Potential Chemical-Specific TBCs for Sediment
Numerical Criteria for Indicator Chemicals

Remedial Investigation/Feasbility Study
Tulsa Fuel and Manufacturing, Collinsville, Oklahoma

	USEPA Region VI Ecological Screening Levels (mg/kg)	USEPA Region VI Screening Levels Industrial Outdoor Worker (mg/kg)	USEPA Region VI Screening Levels Residential Soil (mg/kg)

[n]EqP value derived using surface water quality criterion presented in U.S. EPA Region 5 (1999n). Surface Water Quality critierion was taken from either federal water quality criteria, water quality criteria from states within U.S. EPA Region 5, or Great Lakes Water Quality Initiative Tier II Values (1996o).

[o]Minnesota PCA (Pollution Control Agency). 2000. Specific Standards of Quality and Purity for Class 2 Waters of the State; Aquatic Life and Recreation. Available at: www.revisor.leg.state.mn.us/arule/7050/0222.html.

[p]Illinois PCB (Illinois Pollution Control Board). 1999. Administrative Code Title 35, Subtitle C, Chapter 1, Part 302, Subpart F, Sections 627 and 630: Procedures for Determining Water Quality Criteria. Available at: www.epa.gov/waterscience/standarsds/wqslibrary/il/il.html.

[q]U.S. EPA. 1980. Ambient Water Quality Criteria for Dinitrotoluene. EPA 400/5-80-045, October 1980.

[r]Jones, D.S., Suter, G.W. II, and Hull, R.N. 1997. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1997 Revision. ES/ER/TM-96/R4. Oak Ridge National Laboratory, Oak Ridge, TN. Available at: http://www.esd.ornl.gov/programs/ecorisk/tm95r4.pdf.

[s]Value is based on a receptor specific value derived for mammals (mink), based on ingestion of aquatic life and using toxicity reference values (TRVs) obtained through toxicological information gathered from technical documents and computer databases, as described in U.S. EPA Region 5, 1999[k].

[t]Apparent Effects Threshold (AET) from Washington state Sediment Quality Standards (Ginn and Pastorak 1992), as cited by Jones et al. (1997pp).

[u]Long E.R., MacDonald, D.D., Smith, S.L., and Calder, F.D. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environ. Manage. 19(1):81-97.

[v]Long, E.R. and Morgan, L.G. 1990. The Potential for Biological Effects of Sediment Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52.

[w]Effect Range Lows (ERL's), (Long et al. 1995ww; Long and Morgan 1990xx). Equivalent to the lower 10th percentile of the analyzed data (Long and Morgan 1990xx). When criteria used to develop ERLs were listed units of organic carbon, they were converted to units of dry weight, assuming an organic carbon content of 1% (Long eta al. 1995ww), or the organic carbon content indicated in the source documents (Long and Morgan 1990xx).

[x]Threshold Effects Concentration (TEC) from: MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contamin. Toxicol. 39:20-31.

[y]Region III Risk-Based Criteria for Industrial Soil

[z]Technical BHC screening level is 0.0038 ug/m^3.

[aa]For Endosulfan not Endosulfan I or II.

[bb]For Chlordane not specific isomers.

ARAR - applicable or relevant and appropriate requirements
mg/kg - milligrams per kilogram
NA - not available
TBC - to be considered criteria
USEPA - United States Environmental Protection Agency

APPENDIX B
STANDARD OPERATING PROCEDURE TFM-124
X-Ray Fluorescence Procedures for Field Analysis
(Reprinted from RI/FS Field Sampling Plan)

TULSA FUEL AND MANUFACTURING
COLLINSVILLE, OKLAHOMA
STANDARD OPERATING PROCEDURE

Title: X-Ray Fluorescence Procedures

Document Number: SOP TFM-124

Revision Number: 0

Date: April 27, 2005 **Replaces: New**

Objective: To establish a method for screening soils using x-ray fluorescence (XRF).

Scope: When using XRF methods, this procedure covers:
- Administrative controls,
- XRF sampling equipment, and
- XRF procedure.

Procedure:

1.0 Administrative Control

1.1 The requirements for collecting direct-push soil samples for chemical analysis are detailed in the Remedial Investigation/ Feasibility Study (RI/FS) Field Sampling Plan (FSP) (BMcD, 2005b). Any deviations from or additions to this procedure will be noted in the field logbook.

2.0 XRF sampling equipment may include:

- Sample cups with Mylar film
- Sample labels
- Stainless steel trowel
- Mallet
- Field logbook
- Traffic Report (TR)/Chain of Custody (COC) form
- Indelible marking pen
- Decontamination equipment
- Paper towels

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- Utility knife
- Stainless steel knife, spoon, and composting bowl
- Photographic equipment
- Laths, stakes, and/or flags for marking probehole locations
- Gloves

3.0 XRF Procedure

3.1 Follow specific manufacturer's instructions.

3.2 Allow XRF instrument to warm up for 15 to 30 minutes before analyzing samples to alleviate drift or energy calibration problems.

3.3 XRF instruments can be operated in two modes – in situ and intrusive. The two modes of analysis are discussed below.

3.3.1 The in situ mode involves the analysis of an undisturbed soil sample.

3.3.1.1 Select an area for sampling that is not saturated with water, as XRF does not work well for saturated soils.

3.3.1.2 Remove any large or nonrepresentative debris from the soil surface before analysis.

3.3.1.3 Smooth the surface of the soil with a stainless steel trowel so the probe window will have good contact with the soil surface.

3.3.1.4 Tamp the surface of the area to be sampled with a mallet to increase soil density and compactness for better repeatability and representativeness.

3.3.1.5 Place probe window firmly against compacted soil for 30 to 120 seconds, as per the specific manufacturer's instructions, as source count times vary among instruments.

3.3.2 The intrusive analysis involves the collection and preparation of a soil sample before analysis.

3.3.2.1 Remove any large or nonrepresentative debris from the soil surface before analysis.

3.3.2.2 Collect a composite soil sample and place in a stainless steel bowl.

3.3.2.3 Thoroughly homogenize the soil by mixing the sample in the bowl with a spoon, by hand (wearing clean disposable gloves), or by mechanical means (e.g., mixer or blender).

3.3.2.4 Place a sample of the homogenized soil into a 31.0-millimeter polyethylene cup (or equivalent) for analysis. The cup should be at least one-half to three-quarters full. Cover the sample cup with t 2.5-micrometer (um) Mylar (or equivalent) film for analysis.

3.3.2.5 Analyze as per the specific manufacturer's instructions, as source count times vary among instruments.

3.4 Decontaminate all equipment that comes in contact with the sample.

3.5 Although most XRF instruments have software capable of storing all analytical results and spectra, results should be recorded in the field logbook.

APPENDIX C
OKLAHOMA SEL PROCEDURE #405
Sample Preparation and Handling for Analysis by XRF

Sample Preparation and Handling for Analysis by XRF

1.0 IDENTIFICATION AND DESCRIPTION OF TEST METHOD

Reference: EPA 6200
Soil and Sediment (Dried at 104°C)
Aquarius Parameter Codes: 1052 (Pb), 1003 (As), 1028 (Cd), 1093 (Zn)

2.0 SCOPE AND APPLICATION

This method is applicable to soil and sediment samples.

3.0 METHOD DETECTION LIMIT

Internal Reporting Limits : Pb = 20mg/kg , As = 10mg/kg , Cd = 10mg/kg , Zn = 50mg/kg ,
Mn = 70mg/kg
Applicable Ranges : Pb = 20 - 1000mg/kg
As = 10 – 1000mg/kg
Cd = 10 – 1000mg/kg
Zn = 50 – 1000mg/kg
Mn = 70 – 1000mg/kg

4.0 SUMMARY OF METHOD

A thoroughly homogenized sample is dried at 104°C and then ground to pass through a 200 mesh wire sieve, so they can be analyzed on the ThermoNoran QuanX EDXRF. A radioisotope source is used to excite the sample, which in turn will cause electrons to be rearranged between shells. This rearrangement can then be measured to yield a concentration value.

5.0 INTERFERENCES

- Samples not completely dried will not grind properly and will not pass through the sieve.
- Samples that are of a coarse nature such as chat or gravel will not be ground. The result will be a large variation in particle size. This in turn could lead to large discrepancies in the analysis of the samples, which will abnormally affect laboratory precision measurements.
- In order to draw significance between XRF and ICP(6010) analysis it is critical that the pretreatment of the samples must be exactly the same for both methods.

6.0 SAFETY

Careful attention must be used when removing samples from the oven. Heat resistant gloves should be worn. A lab coat and safety glasses should be worn during sample grinding. When handling samples where potentially hazardous dust will be generated an approved dust mask should be worn. All samples should be ground inside a fume hood to prevent contamination of the instrument area, and to minimize the potential health hazards of inhaling dust from the samples. Care should be taken when handling the Nitric acid, Hydrochloric Acid, Methanol and Isopropyl Alcohol wash solutions. This includes but is not limited to a lab coat, safety glass, face shield and proper chemically resistant gloves. A reference file of material safety data sheets (MSDS's) is available on the desktop of each computer. A hard copy is also available in a central location on the 9th floor. The laboratory Safety officer is available to assist in locating any particular MSDS, or answering any other related questions or problems that may arise. See also CSD SEL Chemical Hygiene Plan and Laboratory Safety Manual.

7.0 EQUIPMENT AND SUPPLIES

Balance
Insulated Gloves
Dessicator (s)
200 mesh wire sieve (s)
Sieve cover (s)
Sieve pan (s)
Numbered Crucible (s)
Heat Resistant Pan (s)
Drying Oven (104°C)
Ceramic Mortar and Pestle
Kontes Duall Tissue Grinder Size 24
Glas-Col Homogenizer and Control Unit

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Sieve brush (s)
Tongs
Analytical Balance capable of reading to the nearest 0.0001g
Large Plastic Weigh boats
ThermoNoran QuanX EDXRF

8.0 REAGENTS AND STANDARDS

Class I Water (MilliQ)
35% Nitric Acid (HNO_3)
19% Hydrochloric Acid (HCl)
Isopropyl Alcohol
Methanol
Sand
NIST Certified Standard Reference Materials numbers 2709, 2710, 2711, 8704
Certified Powder form of

9.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

PRESERVATIVE	SAMPLE HOLDING TIME	SUGGESTED SAMPLE SIZE	TYPE OF CONTAINER
Room Temperature	6 months	4 oz container	Plastic or glass

10.0 QUALITY CONTROL

REQUIRMENT	MINIMUM FREQUENCY	CALCULATION	EVALUATION CRITERIA (DQRs)
Method Blank	1 per run	Direct Read	< MDL's
Instrument Blank	1 per run	Direct Read	< MDL's
Calibration Verification Check	Initial, 1/10, Final	%Recovery	90-110%
Matrix Duplicate	1 per run	RPD	+/- 10%

11.0 DAILY PROCEDURE

11.1 Initial

- Fill in the XRF Sample Drying Worksheet with the appropriate information. Great care must be taken to ensure that the sample and corresponding crucible numbers match. Once the samples are put in the crucibles there will be no way of determining which samples are which if the information is not recorded correctly.
- The numbered crucibles should be placed into the heat resistant pan in a orderly fashion
- If possible the entire sample should be processed. If this is not possible then a homogenized representative aliquot should be taken from the sample container and processed.
- The representative sample is placed into a crucible and any large chunks or clods are to be broken up, as much as possible, to facilitate complete drying of the sample.
- The pan with the samples is then covered with a sheet of aluminum foil to help prevent the scattering of the samples as they dry. The pan of samples is then placed in the 104°C oven to dry overnight.

11.2 Next Day

- After drying overnight the samples are to be removed from the oven using the insulated gloves for protection.
- Using a pair of tongs the crucibles are placed into a dessicator to cool. This will take approximately 3-4 hours. Once the samples have cooled to room temperature the grinding process can begin.
- Remove the samples from the dessicator one at a time to prevent the possible absorption of water from the atmosphere. Because of the afore mentioned reason the samples should be ground and sieved as quickly as possible.
- Before grinding the samples should be passed through a 10 mesh sieve to separate out any large rocks or other materials that could interfere with the sample processing.

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- Assemble the grinding apparatus inside of a fume hood by attaching the appropriate size pestle onto the high-speed side of the Glas-Col Homogenizer.
- Add approximately 1-2g of sample to the mortar of the Kontes Duall grinder.
- Lower the pestle into the mortar until it touches the sample. Slowly increase the dial setting on the Homogenizer control box to start the pestle spinning.
- As the speed increases raise the mortar until a chirping noise is heard. This indicates that the pestle has reached the bottom of the mortar. Maintain the height necessary so that the pestle rides just above the bottom of the mortar.
- Gradually increase the speed to a dial setting of 40-50 and continue grinding until the sample appears to be completely ground. This will take approximately 1-3 minutes depending on the type of sample being ground.
- When the grinding is complete slowly decrease the dial setting simultaneously lowering the mortar. Once the pestle has cleared the sample and is in the upper part of the mortar, then turn the dial to zero and remove the mortar.
- The ground sample can now be dumped into a sieve with the pan attached. Place a sieve cover on top of sieve-sieve pan assembly and set aside for later.
- Continue grinding until the all of the representative sample has been ground.
- When grinding has been completed use a shaking motion to make the sample pass through the sieve into the pan.
- Not all of the sample will pass through the sieve. The left over sample should be collected into a large weigh boat and reground until the entire aliquot passes the 200 mesh sieve.
- Empty the contents of the pan into a large weigh boat. The ground aliquot can now me transferred to a properly labeled and sealed storage container. Until it is time for analysis.
- Repeat the procedure until all samples have been processed.
- Once all samples have been processed wash the mortar and pestles in hot soapy water. All surfaces should be scrubbed thoroughly.
- Rinse with hot tap water, then with D.I. water.
- Allow the mortar, pestles and crucibles to soak overnight in a 35% Nitric Acid bath.
- Remove the mortar, pestles and crucibles from the Nitric Acid bath and rinse with D.I. water.
- Next soak the mortar, pestles and crucibles in a 19% Hydrochloric bath for 30 minutes.
- Remove the mortar, pestles, crucibles from the acid bath and rinse 3 times with D.I. water.
- These can now be placed in a heat resistant tray and dried in the 104°C oven.
- The sieves, covers and pans can be cleaned with a light brushing using the sieve brush.
- Then they should be rinsed with Isopropyl Alcohol or Methanol.
- Then the sieves, covers and pans are patted dry with a clean paper towel.
- Repeat rinse/pat dry cycle until the towel shows no discoloration.

12.0 CALIBRATION

ELEMENT	FREQUENCY	CALCULATION	DQR
Pb	Initial setup, when there are any changes in method	R	0.995
As	Initial setup, when there are any changes in method	R	0.995
Cd	Initial setup, when there are any changes in method	R	0.995
Zn	Initial setup, when there are any changes in method	R	0.995
Mn	Initial setup, when	R	0.995

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	there are any changes in method		

All calibrators will be made using Certified Powders of the element being analyzed.

ELEMENT	WORKING STANDARDS	1000 mg/kg	750 mg/kg	250 mg/kg	20 mg/kg
Pb	Mass of Stock	1.0g of 5000ppm	0.75g of 5000ppm	0.25g of 5000ppm	0.02g of 5000ppm

ELEMENT	WORKING STANDARDS	1000 mg/kg	750 mg/kg	250 mg/kg	20 mg/kg
As	Mass of Stock	1.0g of 5000ppm	0.75g of 5000ppm	0.25g of 5000ppm	0.02g of 5000ppm

ELEMENT	WORKING STANDARDS	1000 mg/kg	750 mg/kg	250 mg/kg	10 mg/kg
Cd	Mass of Stock	1.0g of 5000ppm	0.75g of 5000ppm	0.25g of 5000ppm	0.01g of 5000ppm

ELEMENT	WORKING STANDARDS	1000 mg/kg	750 mg/kg	250 mg/kg	50 mg/kg
Zn	Mass of Stock	1.0g of 5000ppm	0.75g of 5000ppm	0.25g of 5000ppm	0.05g of 5000ppm

ELEMENT	WORKING STANDARDS	1000 mg/kg	750 mg/kg	250 mg/kg	70 mg/kg
Mn	Mass of Stock	1.0g of 5000ppm	0.75g of 5000ppm	0.25g of 5000ppm	0.07g of 5000ppm

All calibrators made to a total mass of 5.0g.

13.0 DATA REPORTING

- All data should be reported to 3 significant figures
- Samples results will not be corrected for %solid, i.e. moisture.
- With advance notice and Laboratory Management approval incoming samples will be "screened" qualitatively to give a basic analysis of what elements are present in a sample.

14.0 POLLUTION PREVENTION AND WASTE MANAGEMENT

The acid baths must be changed once per month. Care must be taken to ensure that all acid wash solutions, before being disposed of, are properly neutralized down to a pH of 6-7 using Sodium Bicarbonate. The Isopropyl Alcohol and Methanol solutions must be placed in the appropriate waste container, and should also be changed on at least a monthly basis.

15.0 REFERENCES

EPA Method 6200, Revision 0, January 1998.

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