Final
Sampling and Analysis Plan
Volume I – Field Sampling Plan

OU 1 Remedial Investigation Addendum/ Feasibility Study

Former Schilling Air Force Base
Salina, Kansas

January 12, 2007

Prepared for

U.S. Army Corps of Engineers
Kansas City District

Prepared by

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SINCE 1898

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LIST OF ACRONYMS AND ABBREVIATIONS

AML	Analytical Management Laboratories, Inc.
APP	*Accident Prevention Plan, OU 1 Remedial Investigation Addendum/Feasibility Study, Former Schilling Air Force Base, Salina, Kansas*
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BLRA	Baseline Risk Assessment
BMcD	Burns & McDonnell Engineering Company, Inc.
BOW	Bureau of Water
BWM	Bureau of Waste Management
^{o}C	degrees Celsius
CCQA	contractor chemical quality assurance
CENWK	United States Army Corps of Engineers– Kansas City District
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
cm/s	centimeters per second
COC	chain-of-custody record
COPC	chemical of potential concern
CQC	contractor quality control
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DOT	U.S. Department of Transportation
DQCR	Daily Quality Control Report
DQO	data quality objectives
EC	electrical conductivity
ECD	electron capture detector
EPA 600 Methods	*Methods for Chemical Analysis of Water and Wastes*
EPS	Environmental Priority Service, Inc.
ERB	equipment rinsate blank
ESI	Expanded Site Investigation
°F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
FSM	Field Site Manager
FSP	Field Sampling Plan
GC	gas chromatograph
GIS	geographical information system
gpm	gallons per minute

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

GPS	global positioning system
H	head
HAZWOPER	hazardous waste operations
HSA	hollow-stem auger
ICBM	intercontinental ballistic missile
ICP	inductively coupled plasma
ID	inside diameter
IDW	investigative-derived waste
KAR	Kansas Administrative Regulations
KDHE	Kansas Department of Health and Environment
LDPE	low-density polyethylene
LIMS	laboratory information management system
LOX	liquid oxygen
MCL	Maximum Contaminant Level
MEE	methane, ethane, ethene
mg/L	milligrams per Liter
min	minute
mL	milliliter
mm	millimeter
MP	Malcolm Pirnie, Inc.
MPS	multiprobe system
mS/m	milli-Siemens per meter
MSDS	Material Safety Data Sheet
MS	matrix spike
MSD	matrix spike duplicate
msl	mean sea level
mV	millivolt
MWIP	Monitoring Well Installation Plan
NA	natural attenuation
NAPL	non-aqueous phase liquid
NAVD 88	North American Vertical Datum 88
NCP	National Contingency Plan
NTU	Nephelometric turbidity unit
OA	organic analysis
OD	outside diameter
ORP	oxidation-reduction potential
OU	Operable Unit
PCE	tetrachloroethene
PDB	passive diffusion bag
pH	potential for hydrogen

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PID	photoionization detector
POC	point of contact
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
Q	discharge
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
redox	reduction-oxidation
RI	Remedial Investigation
RLS	registered land surveyor
SAA	Salina Airport Authority
SAFB	Schilling Air Force Base
SAP	Sampling and Analysis Plan
SI	Site Investigation
SMA	Salina Municipal Airport
SOP	standard operating procedure
SSHS	Site Safety and Health Supervisor
SVOC	semi-volatile organic compound
SW-846	*Test Methods for Evaluating Solid Waste, Physical and Chemical Methods*
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal
UN	United Nations
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOA	volatile organic analytes
VOC	volatile organic compound
µg/L	micrograms per Liter
µmhos/cm	micro-mhos per centimeter
Work Plan	*Work Plan, OU 1 Remedial Investigation Addendum/Feasibility Study, Former Schilling Air Force Base, Salina, Kansas*

LIST OF IMPORTANT TELEPHONE NUMBERS

EMERGENCY NUMBERS

Ambulance:	911
Fire:	911
Police Department:	911
Poison Control Center:	(913) 239-7777
Regional Health Center:	(913) 239-7777

UTILITY CLEARANCE NUMBERS

Kansas One-Call:	1-800-344-7233

PROJECT CONTACT NUMBERS

USACE – Robyn Kiefer	(816) 389-3615
USEPA – Ken Rapplean	(913) 551-7769
KDHE – Jorge Jacobs	(785) 296-8801
Malcolm Pirnie – John Logigian	(914) 641-2690
Burns & McDonnell – Tracy Cooley – Program Manager	(816) 822-3369
Burns & McDonnell – Eric Wenger – Safety & Health Officer	(816) 822-3894
Burns & McDonnell – Sharon Shelton – Quality Control Coordinator	(816) 822-3168
AML – Dr. Viswanathan	(913) 829-0101
Chemical Quality Assurance Branch Laboratory Sample Custodian	(601) 634-3652
Environmental Priority Services, Inc.	(785) 823-6205
GeoCore Services, Inc.	(785) 826-1616
Carlson-Baughman	(785) 628-3219

* * * * *

1.0 PROJECT BACKGROUND

1.1 SITE HISTORY AND CONTAMINANTS

1.1.1 Introduction

The United States Army Corps of Engineers (USACE) – Kansas City District (CENWK) will conduct a Remedial Investigation (RI) Addendum/Feasibility Study (FS) at Operable Unit 1 (OU 1) at the former Schilling Air Force Base (SAFB) in Salina, Kansas (Figure 1-1). Malcolm Pirnie, Inc. (MP) has a contract with the USACE through which environmental investigations are being performed. MP has subcontracted Burns & McDonnell Engineering Company, Inc. (BMcD) to prepare this Sampling and Analysis Plan (SAP) for the field activities to be conducted at SAFB. This Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) have been prepared by BMcD as the SAP. This SAP details work to be conducted that supplements the RI work outlined in the *Remedial Investigation for Operable Unit One at the Former Schilling Air Force Base, Salina, Kansas* (USACE, 2005). The SAP is presented in the following volumes:

- Volume I, FSP
- Volume II, QAPP

This FSP presents the requirements and procedures for conducting field operations and investigations at OU 1. The organization of this FSP is as follows:

Section 2.0 Project Organization and Responsibilities

Section 3.0 Project Scope and Objectives

Section 4.0 Nonmeasurement Data Acquisition

Section 5.0 Field Activities by Area

Section 6.0 Field Operations and Sampling Procedures

Section 7.0 Field Operations Documentation

Section 8.0 Sample Packaging and Shipping Requirements

Section 9.0 Investigative-Derived Wastes

Section 10.0 Field Assessment/Three Phase Inspection Procedures

Section 11.0 Nonconformance/Corrective Actions

Section 12.0 - References

1.1.2 Summary of SAFB History

The Smoky Hill Army Air Base was built in 1942. The name of the base was changed to the Smoky Hill Air Force Base in 1946 and to the SAFB in 1957. In 1942, the base encompassed 2,600 acres and housed 5,000 military personnel. By 1967, SAFB had expanded to 4,000 acres.

In 1942, the base served as headquarters for the newly created Army Air Corps Unit, 20th Bomber Command, and became the first operational training base for B-29 bombers. The base remained a bomber base for five years after World War II ended and was deactivated in 1949.

In 1951, the base was reopened for the Korean War. Upon reactivation, several improvements to the facility were made, including a 25-mile long jet fuel pipeline that terminated at a bulk fuel tank farm on the base. Additional improvements were made after the Strategic Air Command took over operational control of the base. These included construction of a training building, a boiler facility, a gas distribution system, and a bulk oil storage system. The base was designated a permanent Air Force installation in July 1953. B-47 bombers were operated from the facility.

In 1960, the bombardment wing was transferred to Forbes Air Force Base at Topeka. A squadron of Atlas F intercontinental ballistic missiles (ICBMs) and Nike surface-to-air missiles was deployed to twelve sites around SAFB and attached to SAFB for support. New facilities were constructed for storage and repair of both conventional and nuclear munitions and nuclear warhead maintenance. The SAFB was also upgraded to receive B-52 bombers and KC-135 tankers.

The closure of SAFB was announced in 1964 and in 1966 the property was transferred to the Salina Airport Authority (SAA). SAA has since used much of the property in operating the airfield, renamed the Salina Municipal Airport (SMA). The remainder of the former SAFB is currently used primarily for light-to-heavy industrial, aviation, and educational purposes. Many of these entities either lease property from SAA or have purchased their properties outright. Major landowners at the SAFB include the Kansas Board of Regents, the Salina Area Vocational Technical School, Kansas National Guard, and the Occupational Center of Central Kansas. Local industries include Tony’s Pizza, Schwan’s Sales Enterprises, Raytheon Aircraft Co. (known prior as Beechcraft), Flower Aviation, and Moore’s Midway Aviation.

More detailed information on the history of the former SAFB site can be found in the *Final Remedial Investigation for Operable Unit One at the Former Schilling Air Force Base, Salina, Kansas* (USACE, 2005). The primary contaminants at the former SAFB site are trichloroethene (TCE) and its associated degradation products. Contaminants detected at the site are discussed in Section 1.2.

1.1.3 Summary of SAFB Environmental Setting

1.1.3.1 Physical Setting

Physiographically, the former SAFB site is located near the western boundary of the Osage Plains section of the Central Lowland Province. This boundary is gradational with the Plains Border section of the Great Plains Province to the west and the site exhibits many of the same characteristics of that province. The combination of westward dipping bedrock and an eastward-sloping erosional plain results in the exposure of successively older strata from west to east. The Osage Plains Province is characterized by east-facing escarpments of Permian limestone that trend roughly north-south. Between the escarpments lie gently rolling plains underlain by soft Permian shale. To the west, the easternmost section of the Plains border section, known as the Smoky Hill Upland, is characterized by less regularly spaced eastward-facing escarpments composed of Cretaceous sandstone. The Smoky Hill Buttes, which lie on the west side of the Smoky Hill Valley in south-central Saline County, are examples of these escarpments.

Saline County is located within the Salina Basin, a synclinal feature bordered on the east by the Nemaha Anticline, on the west by the Cambridge Arch and Central Kansas Uplift, and on the south by an indistinct structural saddle. The basin is a post-Mississippian syncline that trends northwest-southeast and plunges to the northwest into the deeper part of the basin in north-central Kansas (Merriam, 1957). Bedrock strata in the central Kansas region dip gently to the west. Major streams, such as the Smoky Hill River, have cut below the erosional bedrock surface and are now flowing in wide, flat-bottomed alluvial valleys (Latta, 1949).

Maximum topographic relief occurs in the western part of the County where ground surface elevations reach over 1,600 feet above mean sea level (msl). The lowest elevations are along the Smoky Hill River, at approximately 1,150 feet above msl.

Surface elevations in OU 1 range from just below 1,230 feet above msl where Dry Creek exits OU 1 to just under 1,260 feet above msl in the southwest portion of OU 1. The land surface slopes gently from south to north in OU 1 at a grade generally less than 1 percent.

1.1.3.2 Geology

1.1.3.2.1 Regional Geology

The regional geology of Saline County consists of westward-dipping strata which have been leveled by an erosional plain that slopes gently to the east. The Smoky Hill River and its tributaries have cut below this plain and are flowing in wide, nearly flat-bottomed valleys underlain by alluvial deposits. The uplands bordering the valley of the Smoky Hill River, to the east and west, are underlain by Permian and Cretaceous bedrock formations.

In Saline County, approximately 4,000 feet of sedimentary rock and sediment overlies Precambrian basement rock. Sedimentary rock consists of units from the Cambrian through the Cretaceous periods. The majority of the sedimentary rock is composed of alternating limestone, shale, sandstone, and dolomite that were deposited from the Cambrian to the Permian. Above these older Paleozoic rocks lies the Wellington Formation of Permian Age. The Wellington Formation constitutes uppermost bedrock in much of eastern Saline County. In some areas, the Kiowa Formation of Cretaceous age unconformably overlies the Wellington Formation. Unconsolidated Quaternary deposits lay unconformably on Permian and Cretaceous bedrock. These deposits include slope deposits, terrace deposits, dune sand, and alluvium.

The Permian Wellington Formation forms the bluffs and upland surface on both sides of the Smoky Hill Valley in Saline County, and is the first bedrock unit encountered at the SAFB. The Wellington Formation has a total thickness of approximately 700 feet and is divided into three distinct members (Latta, 1949). The lower Wellington Member consists of gray shale and some dolomite alternating with numerous thin anhydrite and gypsum beds. In Saline County, this member averages about 200 feet thick. The middle unit of the Wellington Formation is the Hutchinson Salt Member. This member averages as much as 300 feet thick and consists of salt interbedded with minor amounts of shale, gypsum, and anhydrite. The upper Wellington Member consists primarily of gray shale with minor amounts of gypsum, anhydrite, dolomite, and siltstone. This upper member averages 250 feet thick.

Within the Wellington Formation, there are two zones of dissolution: the “salt-dissolution” zone and the “gypsum-dissolution” zone. The salt-dissolution zone occurs within the Hutchinson Salt Member and has caused water-quality issues due to the dissolution of the salt along its up-dip limit from Salina to nearly the Oklahoma border. The circulation of freshwater from the overlying alluvial aquifer has dissolved and removed the halite, gypsum, and anhydrite from the surrounding rocks. This continuing dissolution process has been accompanied by the formation of cavities and the associated subsidence, slumping, collapse, and fracturing of overlying shale. The dissolution process had created a permeable zone along

the eastern margin of the Hutchinson Salt Member for lateral and vertical movement of groundwater. The salt-dissolution zone has been named the Wellington Aquifer, but cannot be used for drinking water due to the high salinity. The zone is used for oil-field brine disposal. The Wellington Aquifer probably does not occur under the upland areas adjacent to the river valleys. The gypsum-dissolution zone extends from northeast of Salina to Solomon and averages 10 feet in thickness. The gypsum-dissolution zone formed in much the same way as the salt-dissolution zone (United States Geological Survey [USGS], 1986).

The Cretaceous Kiowa Shale overlies the Wellington Formation in the uplands bordering part of the Smoky Hill and Saline River Valleys in Saline County, but is not found at the SAFB. The Kiowa Shale has a maximum thickness of approximately 200 feet and consists of light gray to black, illitic shale with lenses of dark brown, iron-rich sandstones. Sandstone beds of the unit cap the high hills bordering the Smoky Hill and Saline River Valleys. Selenite is common in the shale and locally there are thin beds of limestone composed largely of fossil oyster shells (Latta, 1949 and Zeller, 1968).

Alluvium of the Pleistocene and Recent age occurs in the Smoky Hill River Valley and its tributary valleys. The alluvium is the most important source of water in the Smoky Hill River Valley area and furnishes water to stock, domestic, irrigation, industrial, and public-supply wells. The alluvium consists of stream-laid deposits of clay silt, sand, and gravel, with the shallow interval being generally finer grained than the deeper materials. The thickness of alluvium in the Smoky Hill River Valley ranges from less than 30 feet to more than 90 feet. The alluvium south of Salina consists mostly of fine material deposited by Dry Creek. The alluvium in this area may be composed entirely of clay, silt, and sand (Latta, 1949).

1.1.3.2.2 SAFB Geology

In the vicinity of the former SAFB site, unconsolidated Quaternary deposits overlies bedrock consisting of the upper Wellington Member of the Wellington Formation. Depth to bedrock is variable, but generally increases from west to east. The result is two principal geologic regimes at the former SAFB site: the bedrock uplands, and the alluvial valley floor and terraces of the Smoky Hill River. The uplands are primarily located in the southern and western portions of the SAFB including some of the western inter-runway areas. Typically these areas are topographically higher with shallow bedrock present at 1 to 15 feet below ground surface (bgs). Shallow bedrock in the east central section of the SAFB indicates this area may also have been uplands prior to rework during base construction. The alluvial valley floor and terraces are primarily located in the northern and eastern portions of the former SAFB. These areas are topographically lower and have little relief with bedrock usually present at depths greater than 20 feet. In the northeast portion of the SAFB, the depth to bedrock increases to approximately 50 feet bgs. The

boundary between the two regimes is gradational and can not be discerned from surface features. Bedrock at OU 1 ranges from more that 1,250 feet above msl in the southwest portion of OU 1 to less that 1,160 feet above msl in the northeast portion of OU 1. Top of bedrock, in general, slopes to the northeast but is locally variable in slope and relief.

1.1.3.3 SAFB Soil

At least eight different soil types exist on the former SAFB. These soil types can be divided into two main categories based on the parent material. Along the eastern and northern areas of the site are soils derived from alluvial parent material that belong to the Detroit-Hord-Sutphen association. These soils are deep and nearly level, moderately well- to well-drained with a silty or clayey subsoil. They form on stream terraces or floodplains. Soils within the remainder of the SAFB, to the west and south, belong to the Crete-Longford Association and are generally derived from upland parent material. These soils are deep, nearly level to moderately sloping, moderately well- to well-drained with a silty or clayey subsoil. Since the natural topography and drainage of the former SAFB site was substantially altered during construction of the facility, soils in many areas of the site may not exhibit the natural characteristics of these associations.

The soils for OU 1 are shown on Figure 2-3 (in the *Work Plan, OU1 Remedial Investigation Addendum/Feasibility Study, Former Schilling Air Force Base, Salina, Kansas* [Work Plan] [USACE, 2007b]). The descriptions of the soil associations are summarized in the following paragraphs (Palmer, 1992). These descriptions are for the soil column from ground surface to five feet bgs.

- The **Crete series silt loam soils** are deep, nearly level, moderately well-drained soils that developed in the uplands on the side slopes and flat areas. Permeability is slow in the subsoil and moderate or moderately slow in the substratum with a range of 4.2×10^{-5} to 1.4×10^{-3} centimeters per second (cm/s). The surface runoff for these soils is medium. The shrink-swell potential is high. Soil potential of hydrogen (pH) ranges from 5.6 to 8.4.

- The **Orthents clayey soils** are mapped in areas where material has been excavated and used as fill. They are on uplands and bottom land. These soils are often flooded during part of the growing season. Soil permeability ranges from 4.2×10^{-4} to 1.4×10^{-4} cm/s. Soil pH ranges from 5.6 to 7.8, and the soil shrink-swell potential is high.

- The **Longford series silt loam soils** are deep, gently to moderately sloping, well-drained soils that formed on broad slopes and ridges in the uplands. Permeability is slow, ranging from 4.2 x

10^{-5} to 1.4 x 10^{-4} cm/s, with medium surface runoff. Soil pH ranges from 5.6 to 8.4 and the shrink-swell potential for the soils is high.

- The **New Cambrian silty clay** is a deep, nearly level, moderately well-drained soil found on stream terraces. Permeability and runoff are slow. Soil permeability ranges from 4.2 x 10^{-5} to 1.4 x 10^{-4} cm/s. The soil is sticky when wet and very hard when dry. The shrink-swell potential is high and the soil pH ranges from 6.6 to 8.4.

- The **Bavaria-Detroit silt loam** is a silty clay loam comprised of moderately well-drained soils that formed on stream terraces. Permeability and surface runoff are slow, with the permeability ranging from 4.2 x 10^{-5} to 1.4 x 10^{-3} cm/s. The shrink-swell potential of the topsoil is high and the pH ranges from 6.1 to 9.0.

- The **Roxbury silt loam** is a calcareous silt loam comprised of deep, nearly level, well-drained soils that formed on terraces along larger streams. Permeability is moderate and surface runoff is slow with permeability ranging from 4.2 x 10^{-3} to 1.4 x 10^{-2} cm/s. The shrink-swell potential is low in the topsoil and moderate in the subsoil. Soil pH ranges from 7.4 to 8.4.

- The **Hord silt loam** is a silt loam comprised of deep, nearly level, well-drained soils that formed on stream terraces. Permeability is moderate and surface runoff is slow with permeability ranging from 4.2 x 10^{-3} to 1.4 x 10^{-2} cm/s. The shrink-swell potential of is low, and pH ranges from 5.6 to 8.4 and increases with depth.

- The **McCook silt loam** is a calcareous silt loam comprised of deep, nearly level, well-drained soils that formed on stream terraces. Permeability is moderate and surface runoff is slow with permeability ranging from 4.2 x 10^{-3} to 1.4 x 10^{-2} cm/s. The shrink-swell potential of is low and pH ranges from 7.4 to 8.4.

- The **Sutphen silty clay** is a dark grey silty clay overlying a calcareous silty clay and is comprised of deep, nearly level, moderately well-drained soil, generally found in slight depressions on the higher parts of flood plains. Permeability is very slow and surface runoff is very slow with permeability ranging from 1.4 x 10^{-4} to less than 4.2 x 10^{-5} cm/s. The shrink-swell potential of is high and pH ranges from 6.1 to 8.4.

- The **Cozad silt loam** is a silt loam over a calcareous sandy loam and is comprised of deep, nearly level, well drained soil that is found on terraces. Permeability is very slow and surface runoff is

very slow with permeability ranging from 4.2 x 10^{-5} to 1.4 x 10^{-4} cm/s. The shrink-swell potential of is low and pH ranges from 6.1 to 8.4.

Surface soils at OU 1 have been extensively modified by construction and drainage activities. The surface soil in some areas has been stripped of the original topsoil and up to five feet of subsoil, while in other areas the original soil has been buried by up to five feet of fill. The majority of the fill is believed to be soil material removed from other areas within SAFB, but some imported fill may be present. Since upper horizons of both residual and alluvial soils are comprised predominantly of silt and clay-sized particles, it is difficult to distinguish one from the other. The presence of coarse-grained material at the surface is almost certainly indicative of imported fill.

Subsurface soils at OU 1 consist primarily of residual soils, weathered bedrock, and alluvial soils. Residual soils are typically thin and rarely exceed 16 feet in thickness at OU 1. These materials are silt-clay mixtures, and found only in the southern portion of OU 1. There is typically little variation in the soil column from the base of the surface soil to the top of bedrock.

Alluvium is located in the eastern and northern areas of the SAFB and thickens toward the Smoky Hill River. Alluvium consists of variable thicknesses of clay, silt, sand, and gravel. Alluvium thickness in OU 1 ranges from zero in the southwest portion to more than 70 feet in the north and northeast portions. An anomalous area of thick alluvium near Building 837/former Building 847 area is either a paleo-channel or a collapse feature due to salt dissolution in the Hutchison Member of the Wellington Formation.

1.1.3.4 Hydrogeology

1.1.3.4.1 Regional Hydrogeology

Regionally, three of the previously described stratigraphic units are capable of serving as aquifers. These include the more permeable strata of the Wellington and Kiowa Formations, and the unconsolidated Quaternary deposits.

Fracturing, slumping, and collapsing of the upper Wellington Member coincident with dissolution of gypsum and anhydrite in the middle and lower Wellington Formation has resulted in a unit that is capable of transmitting groundwater. This permeable unit has been named the Wellington Aquifer. The Wellington Aquifer extends both south of Salina along the Smoky Hill River Valley and north of Salina along the Saline River Valley. The well-developed dissolution of gypsum and anhydrite in the Smoky Hill River Valley has resulted in an identifiable “salt-dissolution zone” and a “gypsum-dissolution zone.” Depths below land surface to the salt-dissolution are on the order of 200 feet bgs in the Salina area.

Depths to the gypsum-dissolution zone in the Smoky Hill River Valley range between 60 and 200 feet bgs.

Groundwater flow is primarily northward through the salt dissolution zone with discharge through the gypsum-dissolution zone into the Smoky Hill River alluvium. This discharge results in saltwater intrusion within the alluvium and Smoky Hill River system. The occurrence of groundwater in the Wellington Aquifer is the result of leakage from the overlying unconsolidated deposits through the Upper Wellington Member. This leakage is likely through fractures and slumping created by dissolution of salt and collapse of overlying units. There is discharge of some saline water derived from dissolution of the Hutchinson Salt Member into the overlying alluvium. Major dissolved cations in these waters are calcium, magnesium, and sodium. Major anions are chloride, sulfate, and bicarbonate.

Portions of the overlying Kiowa Formation are capable of providing water in sufficient quantity to be considered an aquifer. Sandstone lenses have been tapped for livestock and domestic wells. The city of Gypsum, to the southeast of Salina, was served by wells penetrating the Kiowa Formation at one time (Latta, 1949).

The uppermost aquifer in the area consists of unconsolidated alluvial deposits found in the Smoky Hill River Valley. Groundwater occurs within the alluvial deposits at depths ranging from a few feet to approximately 40 feet bgs, with an average of approximately 25 feet bgs. Well yields vary widely and are dependent on the local transmissivity of the alluvium. Reported yields range from 50 to 1,700 gallons per minute (gpm). If coarser-grained, relatively porous alluvial materials are not present, the unconsolidated materials exhibit a very low permeability. Little groundwater is discharged from the fine-grained materials. Groundwater within the alluvium is interconnected with, and flows toward, the Smoky Hill and Saline Rivers and their major tributaries under unconfined conditions.

During an investigation conducted by the City of Salina to determine the best locations for new water wells in 1957, it was determined that the thicker areas of alluvium tended to be coarser grained at depth and were capable of yielding the largest amounts of water. The area studied by the City of Salina was mainly to the east of Dry Creek and north of Front Street. The Permian deposits in the Salina vicinity are relatively impervious what minor amounts of water they contain is of poor quality (Wilson & Company, 1957).

1.1.3.4.2 SAFB Hydrogeology

The uppermost aquifer at the former SAFB site consists of the unconsolidated alluvial/residual deposits overlying shale of the Wellington Formation. The thickness of the unconsolidated aquifer varies from not

present along the southern and western portion of the site to greater than 40 feet in the north and northeast portion of OU 1.

Groundwater flow beneath the eastern and northeastern portions of the site, where the alluvial deposits are located, is generally to the northeast. However, local flow directions can vary significantly due to both natural and artificial influences. Water level elevation maps from previous investigations indicate groundwater flow diverging around bedrock highs. In some areas, bedrock highs rise above the level of the water table. Also, the operation of a sump pump within the Salina Area Technical School administration building (Building 658) at the site has locally altered the direction of groundwater flow. Groundwater flow in the western portion of the former SAFB site is locally to the north-northwest. Groundwater gradients also appear to be steeper in the upland areas than in the alluvial deposits.

Figure 2-5 in the Work Plan (USACE, 2007b) presents the piezometric surface for the groundwater levels collected on July 25, 26, and 27, 2006. As shown on the figure, the groundwater gradient within OU 1 is to the northeast with a small area in the southwest portion of OU 1 to the northwest. Groundwater elevations ranged from a high of 1247 feet above msl just south of OU 1 to 1215 feet above msl in the east central portion of OU 1. Groundwater gradient across OU 1 averaged 0.004 feet per foot. Depth to groundwater at OU 1 ranged from 6.5 to 19 ft bgs.

In-situ hydraulic conductivity varies significantly within short distances due primarily to the presence or absence of clayey sand lenses. Hydraulic conductivities generally tend to be higher in the northeastern and eastern portions of the SAFB where alluvial deposits are present. Bedrock highs, resulting in areas where the aquifer is absent, were found in the southern, southwestern, western, and east central portions of the SAFB during previous investigations.

1.1.3.5 Surface Water Hydrology

1.1.3.5.1 Regional Surface Water Drainage

Surface water drainage within most of Saline County is dominated by the Smoky Hill River and its tributaries, which flow north and east across the county. The northern part of the county is drained by the Saline and Solomon Rivers. Spring Creek, Mulberry Creek, and Gypsum Creek are the major tributaries in the area. Mulberry Creek heads west of Salina and joins the Saline River north of Salina. Spring Creek enters Mulberry Creek approximately four miles west of Salina. Dry Creek is an ephemeral stream which flows through Salina, and parallels the Smoky River. Dry Creek joins Mulberry Creek just north of Salina. The USGS maintains stream-flow measurement stations on the Smoky Hill River both above and below Salina (at Mentor and New Cambria).

1.1.3.5.2 SAFB Surface Water Drainage

The majority of the former SAFB property lies on or adjacent to the alluvial valley floodplain of the Smoky Hill River. This area was subject to seasonal flooding before the implementation of flood-control measures. With development of SAFB, many of the natural drainage features were modified or removed, and major surface drainage was diverted into constructed ditches. Local flooding is now controlled by natural drainage features coupled with a system of storm sewers and interconnecting drainage ditches in and around the former SAFB. Surface water runoff from the site is diverted east into either Dry Creek or north/northeast into Spring Creek. Small portions of the SAFB are located within the 500-year flood zones.

1.1.3.5.3 OU 1 Surface Water Drainage

In the OU 1 area, runoff is generally channeled to the ditches by swales that parallel the roadways. Several surface drainage ditches were constructed to direct surface water generally eastward into a primary north-south drainage ditch known as Centennial Ditch, which flows into Dry Creek. Surface water features in OU 1 include:

- **Tony's Road Ditch** is located parallel to Tony' Road and flows from west to east. It drains the northern portion of OU 1. Tony's Road Ditch is a perennial drainage that receives discharge from groundwater.

- **Scanlan Ditch** begins near the south end of Hein Avenue and extends past Magnolia Road with flow from southwest to northeast. Scanlan Ditch is a major contributor to Centennial Ditch and , drains much of the southern portion of OU 1. Scanlan Ditch typically holds water, but flow reduces to a trickle or even ceases during periods of drought. It is possible that during times of high water levels, Scanlan Ditch may intersect groundwater.

- **Derussy Ditch** is located along the south side of Derussy Road and flows eastward into Centennial Ditch. In the western portion of Derussy Ditch, flow is present only after precipitation events; however, water is present more often in the eastern portion of the ditch. Groundwater from the sump at the Salina Area Technical School administration building (Building 658) originally drained to Derussy Ditch; however, in 1998 an air stripper was installed and the treated groundwater is now directed to the sanitary sewer.

- **Centennial Ditch** enters the OU 1 area from the south and flows north between the east edge of the former SAFB and the Burlington Northern railroad tracks. Centennial Ditch empties into Dry

Creek near the northeast corner of the former SAFB, approximately 300 feet upstream of the point where Tony's Road Ditch empties into Dry Creek. Centennial Ditch is an ephemeral drainage with little or no flow during periods of drought.

- **Dry Creek** has undergone extensive channelization and construction of levees as flood control measures. Close to half of its watershed was diverted into Smoky Hill River several miles south of Salina to alleviate chronic flooding problems. Dry Creek is now undersized with respect to its channel, with relatively little flow except during precipitation events. Dry Creek flows northward into Mulberry Creek which flows northeastward approximately three miles to the Saline River.

1.1.3.6 Climatology

Saline County has typical mid-continent climate conditions, characterized by warm to hot summers, cold winters, moderate but constant winds, maximum precipitation in the warm season, and frequent changes in the weather. The average yearly precipitation for the area is 32.19 inches. Precipitation in the 1990s was typically above average and precipitation since 2000 has been below average. The average winter temperature is 33 degrees Fahrenheit (°F). The average summer temperature is 79 °F. The prevailing winds are southerly and the average humidity is 62 to 67 percent (City of Salina, Kansas, 2006).

1.1.3.7 Demography

Salina is the county seat of Saline County and has a population of over 45,000 (United States Census Bureau, 2006). Approximately 25 percent of the population is under the age of 18 (United States Census Bureau, 2006). Salina covers more than 13,000 acres (City of Salina, Kansas, 2006). When SAFB was developed in the 1940s, the city's population (24,000) and boundaries were significantly smaller, and the facility was not physically connected to Salina.

1.1.3.8 Zoning

There are five principal zoned land uses within the boundaries of OU 1 on the former SAFB property: Industrial I-1 and I-2; University, U; and Agriculture, A-1 , as shown on Figure 2-6 in the Work Plan. A small commercial area (PC-5) is located at the southeast corner of Centennial and Magnolia Roads.

The Industrial Park District (I-1) is designed to permit a broad range of industrial activities within certain limitations. All uses are required to be in an enclosed structure and have approved landscape plans. Permitted uses in the I-1 district include over 100 types of light manufacturing. Conditional uses include: automobile washes; automobile repair; boat sales and service; building material yard; contractor's office and storage yard; mini-warehouse; pest control; plumbing shops; and recreation vehicle rental, sales, and service. The I-2 district is designed to permit industrial activities of a limited nature. Permitted uses

include retail or commercial use and over 160 types of light industry. There are no conditional uses applied to the I-2 district.

The U district is designed to be used separately, as a district zone, or in combination with any one or more of the residential districts. The principal functions of the district are to provide flexibility to the university-oriented functions and permit the establishment of land uses ordinarily associated with a university. Permitted uses include: art galleries, libraries, and museums; colleges, universities, and theological schools; fraternal and service clubs; lodging and boardinghouses; offices, meeting rooms, and laboratories; parking lots; and elementary, intermediate, and secondary schools. Conditional uses include private or public parking lots.

The R-2 and R-3 district is designed to provide for multiple-family development while the R-1 district is designed to provide for single- family development. Although none of the R-1, R-2, or R-3 zoned areas are located within OU 1 on the former SAFB property, these zones are located along the northeast boundary of OU 1.

Agricultural district land use is designed to reflect the pattern of land uses in rural areas, primarily agriculture. Permitted uses within the A-1 district include: cemeteries; dog kennels; animal hospitals; single-family dwellings; family-care facilities; oil or gas wells; public service and utilities; recreational and social facilities; religious institutions; riding stables; and well head stations. Conditional uses within the A-1 district include: airports; campgrounds; sewage treatment plans; sand or gravel mining; greenhouses; group-care facilities including day-care centers; hospitals; libraries; power plants; recreational facilities; and sanitary landfills. Land at the former SAFB that is zoned Agricultural District includes areas in the eastern portion of OU 1. Although day-care centers and hospitals are permitted land uses, their construction within the airport perimeter is unlikely.

A building restriction, limiting building height to 37.5 feet, is present in areas surrounding the airport runways and taxiways. In addition runway protection zones are located at the ends of each runway. Large portions of the airport within the runway protection zones require a Saline County conditional use permit for construction or development.

1.1.3.9 Future Land Use and Plans

Land use is not projected to change significantly in the future. The city of Salina's Comprehensive Plan (Trkla et al., undated) projects that "most of any new development activity in the city will be located in and near the Airport Industrial Park" and has designated the area for continued and new industrial

business park projects. The city has encouraged this development due to I-135 access and proximity of air cargo facilities.

The Salina Municipal Airport Master Plan Update (Bucher, Willis & Ratliff, 1997) provides a land use plan that indicates future aviation-related industry at the airport within the perimeter fencing. The airport services nearly all of Saline County, a portion of Dickinson County, and the northern part of McPherson County, Kansas. Historic trends indicate continued growth of operations at the airport. Therefore, future use of the airport and surrounding commercial/industrial properties is expected to remain the same.

1.1.3.10 Water Use

The City of Salina obtains its drinking water from the Smoky Hill River and 16 alluvial wells located in and around the city. The City of Salina's goal is to use 50% river water and 50% groundwater. However, actual use from each source varies depending upon the river stage, temperature, and other factors. The surface water intake is located approximately three miles northeast of the SAFB. Surface water from the SAFB flows from Dry Creek to Mulberry Creek to the Saline River and into the Smoky Hill River. The confluence of the Saline River with the Smoky Hill River is approximately seven miles downstream from the Salina surface water intake. Alluvial wells range in depth from 55 to 89 feet bgs and are located to the east and north of the SAFB. The closest of the wells is approximately two miles from the northeast corner of the SAFB.

SAFB was originally supplied by five wells located approximately two and one-half miles east of the SAFB. The wells are currently owned by the city of Salina and listed as "not in use" or "stand by." The SMA and surrounding areas are supplied by the Salina water distribution system. Approximately 30 privately-owned wells are located within a one-mile radius of the former SAFB. The predominant use of the wells, as classified by the State of Kansas, is domestic. Water use in the future is not expected to change significantly. The city currently supplies potable water to the industrialized areas at SAFB. The need for the installation of private potable water wells within the OU 1 boundary is not expected.

1.1.3.11 Ecology

The former SAFB and the surrounding area lie within the transitional zone between the tall-grass prairies of eastern Kansas and the mixed prairies of central Kansas. Prior to European settlement, the area consisted of open prairies. Due to the extensive modification of the land to accommodate base activities and later industrial activities, there are no natural mixed prairie communities remaining within the former SAFB. Currently, the majority of the former SAFB is industrial with some minor agricultural and residential areas. Prairie wildlife species capable of adapting to developed conditions and human activity,

such as coyote, raccoon, and a variety of reptiles, amphibians, and songbirds are known to exist throughout the former SAFB.

1.2 PREVIOUS INVESTIGATIONS

The USACE - CENWK, the United States Environmental Protection Agency (USEPA) Region VII, and the Kansas Department of Health and Environment (KDHE) have conducted several environmental investigations at the former SAFB. In 1993, CENWK tasked RUST Environmental and Infrastructure to conduct a Site Investigation (SI) in order to locate potential contamination in areas of suspected contamination (USACE, 1996). CENWK personnel conducted an SI in 1996 to investigate newly identified areas of concern and to obtain additional information on selected areas identified by the RUST SI (USACE, 1998). If areas identified by the CENWK SI required additional investigation, they were included in the RI performed by BMcD (USACE, 1999). The RI performed by BMcD included a Baseline Risk Assessment (BLRA) (USACE, 1999). In 2000, the USEPA conducted an Expanded Site Investigation (ESI) that focused on groundwater and potential sources of contamination (USEPA, 2001). Three phases of a Supplemental RI were conducted by CENWK and URS Group in 1999, 2003, and 2004 (USACE, 2005). The Supplemental RI was conducted to acquire data to address issues remaining from previous investigations. Minor Phase I and Phase II investigations have also been conducted within the OU 1 area.

Indoor air and subslab samples at the Kansas State University and the Salina School of Technology have been collected for both landowners/operators by KDHE. KDHE has performed this sampling over several rounds. The USEPA has also sampled the indoor air at KSU. USEPA and KDHE conducted this sampling in order to determine if contaminants in the subsurface were migrating into the buildings by way of vapor intrusion.

1.3 SITE-SPECIFIC DEFINITION OF PROBLEMS

Intrusive sample locations may need to be adjusted in the field due to the presence of underground utilities. Activities at SAFB have resulted in extensive installation of underground utilities, repeated demolition, and moving of structures over time. Utility locations may be unclear or even unknown. At the Sewage Treatment Plant and Landfill, care will be taken not to sample into the Landfill area. If a core appears to contain landfill waste, the boring will be discontinued, the borehole backfilled, and the sample point relocated further outside of the suspected Landfill area. In addition, other areas planned for sampling may have been the subject of potential landfilling in the past. The nature of potential materials landfilled on the SAFB site may be the cause of refusal in certain places well above the water table.

BMcD will attempt to offset sample locations, where necessary, such that the rationale for the sample location remains valid.

* * * * *

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Planning, field investigation, and reporting will be conducted by BMcD and coordinated with the USACE and MP. 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. Names, addresses, and telephone numbers for all primary contacts can be found in the front of this document, as well as in the *Draft Accident Prevention Plan, OU 1 Remedial Investigation Addendum/Feasibility Study, Former Schilling Air Force Base, Salina, Kansas* (APP) (MP-BMcD, 2007a).

2.1 UNITED STATES ARMY CORPS OF ENGINEERS

The USACE is responsible for coordinating and providing oversight for the RI Addendum/FS. The USACE's Chemical and Materials Quality Assurance Branch Laboratory (Chemical QA Branch Lab) is charged with analyzing split samples that are collected to aid the USACE in evaluation of project data. Ms. Robyn Kiefer is the USACE Project Manager for this project and will serve as the primary point of contact (POC) for all questions of a technical nature. Ms. Kiefer can be contacted at 816-389-3615.

2.2 KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

KDHE will provide regulatory oversight for the RI Addendum/FS at the former SAFB. Mr. Jorge Jacobs is the KDHE Project Manager for this project and can be contacted at 785-296-8801.

2.3 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

USEPA will also provide regulatory oversight for the RI Addendum/FS at the former SAFB. Mr. Ken Rapplean is the USEPA Project Manager for this project and can be contacted at 913-551-7769.

2.4 MALCOLM PIRNIE

MP has a contract with USACE through which environmental investigations are being performed. For this effort, BMcD will report directly to the USACE, but will inform MP of significant project activities at the former SAFB. MP has overall responsibility for the project to the USACE and will act as the program administrator and provide independent quality control (QC) of all submittals. Mr. John Logigian is MP's Program Manager. Mr. Logigian can be reached at 914-641-2690. However, the BMcD field team will coordinate all field activities with the BMcD Project Manager.

2.5 BURNS & MCDONNELL

MP has subcontracted BMcD to support MP's contract with the USACE for work at SAFB. BMcD will report directly to the USACE, but will inform MP of significant project activities.

Mr. Tracy Cooley will serve as the BMcD Project Manager for the OU 1 RI Addendum/FS. Mr. Cooley will be responsible for complete coordination of the work, including adequate internal controls and review procedures to eliminate conflicts, errors, and to verify technical accuracy. In addition, Mr. Cooley is responsible for overseeing activities involving sampling and performance of audits. Mr. Cooley can be contacted at 816-822-3369.

A BMcD Field Site Manager (FSM) and the Site Safety and Health Supervisor (SSHS) will be designated for each sampling event. The FSM/SSHS will supervise the field activities relevant to this project and will have direct responsibility for site-specific activities and decisions regarding the immediate safety of investigation personnel. The FSM/SSHS will report to the BMcD Project Manager and the BMcD Safety and Health Officer.

Mr. Eric Wenger, Certified Industrial Hygienist (CIH), will serve as the BMcD Safety and Health Officer for this project and will have ultimate responsibility for the health and safety of field personnel. Mr. Wenger can be contacted at 816-822-3894.

The Quality Control Coordinator, Ms. Sharon Shelton, will oversee activities involving sampling, laboratory analyses, and audits of performance necessary to meet the data quality objectives (DQOs) for each field effort. Ms. Shelton can be contacted at 816-822-3168.

The project chemist will oversee the activities involving the field procedures for chemical samples, laboratory analyses, chemical sample documentation procedures, and tracking of chemical samples.

Sampling personnel will be responsible for completing daily quality control reports (DQCRs) and coordinating with the FSM. All sampling personnel will report directly to the FSM and are required to have 40-hour Hazardous Waste Operations (HAZWOPER) training as discussed in the APP.

2.6 CONTRACT ANALYTICAL LABORATORY

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* (SW-846) (USEPA, 1997) and Methods for Chemical Analysis of Water and Wastes (EPA 600 Methods) (USEPA, 1983), where applicable. Additional potential analytical methods are presented in the QAPP.

Analytical Management Laboratories, Inc. (AML) is the contract laboratory for the analysis of soil, sediment, surface water, and groundwater samples from the site. AML is under contract to BMcD. The AML address is listed below.

Analytical Management Laboratories, Inc.
15130 South Keeler
Olathe, KS 66062
(913) 829-0101
POC: Dr. Viswanathan

2.7 CHEMICAL QA BRANCH LAB

The Chemical QA Branch Lab is the designated chemical quality assurance (QA) laboratory for samples collected from the former SAFB site. The Chemical QA Branch Lab's address is listed below:

US Army Corps of Engineers
Attn: Dr. Tony Bednar
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
(601) 634-3652

2.8 DRILLING CONTRACTORS

Direct-push borings will be conducted by Environmental Priority Services, Inc. (EPS). Monitoring well installations and aquifer testing will be conducted by Geocore Services, Inc. Contact information for these subcontractors is provided below:

Environmental Priority Services, Inc.
7193 Benfield Road
Salina, Kansas 67401
(785) 823-6205

GeoCore Services, Inc.
P.O. Box 386
Salina, KS 67402
(785) 826-1616

2.9 SURVEYOR

A Kansas State Registered Land Surveyor (RLS) will perform all surveys and provide survey data necessary for completion of investigative activities. Carlson-Baughman will conduct the necessary surveys for the field activities for this RI Addendum/FS. Their contact information is below:

Carlson-Baughman
1506 Vine Street
Hays, KS 67601
(785) 628-3219

* * * * *

3.0 PROJECT SCOPE AND OBJECTIVES

3.1 OBJECTIVES

The overall DQO for this FSP is to obtain data of sufficient quality and quantity to satisfy investigation needs associated with OU 1 at the former SAFB.

This RI Addendum is being conducted to further investigate areas not fully defined in the 2005 RI and to investigate two areas not previously investigated under the 2005 RI. Objectives of the RI Addendum, for these areas are to:

- Quantify the nature and extent of contamination on the former SAFB;
- Determine the nature and extent of any contamination off the former SAFB;
- Characterize the physical and chemical nature of the former SAFB site, including fate and transport mechanisms; and
- Obtain information necessary to evaluate remedial alternatives in the FS.

Objectives of the BLRA are to:

- Determine potential ecological and human health risk.

Objectives of the FS are to:

- Develop and evaluate remediation alternatives.

BMcD will use the DQO process to justify the scope of work at each area being investigated, as detailed in the Work Plan (BMcD, 2007b). The USACE is conducting investigations to determine if past SAFB activities have impacted the environment in such a way as to present a threat or potential threat to human health or the environment on and around the facility.

3.2 TASK DESCRIPTION

Planned investigative activities at the former SAFB include a geophysical investigation; sampling of surface soil, surface water, sediment, subsurface soil, and groundwater; stream gauging activities; and hydrogeologic and geologic investigation activities.

Geophysical activities will be conducted to aid in the determination of the top of bedrock. This information may be used to place monitoring wells and plan remediation activities.

Boreholes may be advanced for collection of subsurface soil samples, groundwater chemical screening, and geological and hydrogeological information. Proposed monitoring well locations will be submitted to

the USACE Project Manager for approval. Borehole locations will be logged in the field by BMcD personnel. Physical samples may be collected from selected intervals for analysis of soil characteristics and physical properties.

Field screening and on-site analyses will be conducted on groundwater samples from selected boreholes. Groundwater samples will be collected from the boreholes for every 10 or 15 feet of saturated thickness of the aquifer and analyzed on the former SAFB site for selected volatile organic compounds (VOCs) (tetrachloroethene [PCE], TCE, cis-1,2-dichloroethene (DCE), and 1,1-DCE [and carbon tetrachloride at one area]) using a portable or on-site gas chromatograph (GC). Chemical data generated using this approach will be used for screening purposes only. Ten percent of the samples will be submitted to the off-site laboratory (AML) for confirmation. Additional boreholes and monitoring well locations may be proposed based upon the screening data. The guidelines for analysis notebook documentation for screening samples are presented in the QAPP.

Monitoring well locations/clusters will be chosen based upon hydrogeological and groundwater screening data. Monitoring wells/clusters will be placed to assist in the determination of groundwater contamination, the nature and extent of any such contamination, the risk that the contamination might pose, and possible future methods of remediation. Monitoring well locations/clusters will be proposed to USACE for approval prior to installation. The monitoring wells will be designed based upon physical samples collected from the corresponding borehole and/or hydrogeologic information determined from nearby wells or piezometers.

Field activities are presented below on an area basis, with the exception of the activities associated with groundwater, which are detailed under the Groundwater heading. The areas are presented on Figure 3-1.

Jet Engine Repair Hangar and Aircraft Wash Area No. 2

At the Jet Engine Repair Hangar and Aircraft Wash Area No. 2, ten feet of bedrock core will be collected from five feet into the top of competent bedrock to fifteen feet below the top of competent bedrock. A monitoring well will be installed within the bedrock. A groundwater sample will be collected using passive diffusion bag (PDB) samplers and analyzed at the off-site laboratory for VOCs.

Sewage Treatment Plant and Landfill

At the Sewage Treatment Plant and Landfill, a direct-push investigation is planned, consisting of subsurface soil and groundwater sample collection. Surface soil samples will also be collected near the direct-push boring locations. In addition, sediment and surface water sampling is planned along the drainage areas. Groundwater samples will be analyzed on the former SAFB site for VOCs, with 10

percent of the samples to be analyzed at the off site laboratory for VOCs for confirmation. Surface soil (0 to 0.5 feet bgs) will be analyzed at the off-site laboratory for semi-volatile organic compounds (SVOCs) and Resource Conservation and Recovery Act (RCRA) metals. Subsurface soil samples from 0.5 feet to 2 feet bgs and from 10 feet bgs to the top of groundwater will be analyzed at the off-site laboratory for VOCs. Sediment, surface water, and subsurface soil samples from 2 feet to 10 feet will be analyzed at the off-site laboratory for VOCs, SVOCs, and RCRA metals. The results of the direct-push investigation will be used to determine locations for the installation of additional monitoring wells/clusters. During drilling of selected new monitoring wells, geotechnical samples will be collected from the vadose zone at two locations and will be analyzed for hydraulic conductivity (which includes reporting of dry bulk density and moisture content), and total organic carbon (TOC). Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for natural attenuation (NA) indicator parameters (nitrate; nitrite; sulfate; sulfide; total iron; TOC; methane, ethane, and ethene [MEE]; chloride, dissolved oxygen [DO], oxidation reduction potential [ORP], alkalinity, and ferrous iron).

Liquid Oxygen (LOX) Plant

At the LOX Plant, a direct-push investigation is planned, consisting of subsurface soil and groundwater sample collection. In addition, sediment and surface water sampling is planned along the drainage areas. Groundwater samples will be analyzed on the former SAFB site for VOCs, with 10 percent of the samples to be analyzed at the off-site laboratory for VOCs for confirmation. Surface soil (0 to 0.5 feet bgs) will be analyzed at the off-site laboratory for SVOCs. Subsurface soil samples from 0.5 feet to 2 feet and from 10 feet bgs to the top of groundwater will be analyzed at the off-site laboratory for VOCs. Sediment, surface water, and subsurface soil samples from 2 feet to 10 feet bgs will be analyzed at the off-site laboratory for VOCs and SVOCs. The results of the direct-push investigation will be used to determine locations for the installation of additional monitoring wells/clusters. In addition, based upon the results of the direct push investigation, ten feet of bedrock core may be collected from five feet into the top of competent bedrock to fifteen feet below the top of competent bedrock. If the core is collected, a monitoring well will be installed within the bedrock. During drilling of selected new monitoring wells, geotechnical samples will be collected from the vadose zone at two locations and will be analyzed for hydraulic conductivity (which includes reporting of dry bulk density and moisture content), and TOC. Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for NA indicator parameters.

Building 837 and Former Building 847

At the Building 837 and Former Building 847 area, a direct-push investigation is planned, consisting of groundwater sample collection. In addition, a conductivity survey is planned to determine the top of bedrock. Two of the conductivity borings will be logged to bedrock, and soil will be collected and field tested using Sudan IV dye field test kits. Groundwater samples will be analyzed using an on-site GC for VOCs, with 10 percent of the samples to be analyzed at the off-site laboratory for VOCs for confirmation. Two new monitoring wells, one shallow and one deep, will be installed in a cluster with Monitoring Well 99M24. The results of the direct-push investigation will be used to select locations for the installation of additional monitoring wells/clusters. A bedrock core sample will be collected based upon the conductivity survey and the direct push investigation to determine the nature of the bedrock low at the area and to determine if contamination is present within the bedrock. The bedrock core location will be, if possible, also be located downgradient, but not within, any DNAPL. The bedrock core will be collected from five feet into the top of competent bedrock to fifteen feet below the top of competent bedrock and a monitoring well will be installed within the bedrock. During drilling of selected new monitoring wells, geotechnical samples will be collected from the vadose zone at two locations and will be analyzed for hydraulic conductivity (which includes reporting of dry bulk density and moisture content), and TOC. Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for NA indicator parameters.

Additionally, soil samples will be collected from the area surrounding the Tullis Building. KSU is planning to place a day care facility within this building. The results from the soil samples will be used in the risk assessment for this area. Surface soil (0 to 0.5 feet bgs) will be analyzed at the off-site laboratory for SVOCs and RCRA metals. Subsurface soil samples from 0.5 feet to 2 feet will be analyzed at the off-site laboratory for VOCs.

Groundwater Plume Areas

VOC-contaminated groundwater is present beneath much of OU 1. Multiple sources for the groundwater contamination are known, with other sources potentially present. For this RI FSP, groundwater contamination at OU 1 has been divided into areas based upon plume configuration. For the Groundwater Plume Areas, a direct-push investigation is planned, consisting of groundwater sample collection. Groundwater samples will be analyzed on the former SAFB site for VOCs, with 10 percent of the samples to be analyzed at the off-site laboratory for VOCs for confirmation. The results of the direct-push investigation will be used to determine locations for the installation of additional monitoring

wells/clusters. During drilling of selected new monitoring wells, geotechnical soil samples will be collected from the vadose zone at 10 locations to better define the hydrogeologic properties of the aquifer to aid in potential future remediation and groundwater modeling. The geotechnical sample sets will be analyzed for grain size distribution, hydraulic conductivity, specific gravity, and TOC. Locations from which sample sets will be collected will be determined after monitoring well locations are determined. Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for NA indicator parameters.

Additionally, hydraulic parameters will be determined through slug tests and pumping tests. Four slug tests will be conducted in the shallow, less-permeable aquifer. Slug test locations will be chosen after installation of the monitoring wells. Two pumping tests will be conducted in the alluvial aquifer. One will be placed south of Plume Area D near I-135 in the finer-grained alluvium, and the other will be placed downgradient of Plume D in the coarser-grained alluvium.

3.3 SAMPLE ANALYSES SUMMARY

Groundwater samples may be collected from direct-push boreholes for VOCs and from monitoring wells for one or more of the following: VOCs, NA indicator parameters (nitrate; nitrite; sulfate; sulfide; total iron; TOC; MEE; and chloride, DO, ORP, alkalinity, and ferrous iron).

Subsurface soil, surface soil, sediment, and surface water may be collected to determine the nature and extent (horizontal and vertical) of contamination, the risk the contamination may pose to human health and the environment, and geotechnical properties that would facilitate site evaluation and remedial design.

Laboratory analytical data will be validated as it is received. The chemical results will be compared to background data, applicable or relevant and appropriate requirements (ARARs), and appropriately conservative risk screening concentrations to aid in the identification of chemicals of potential concern (COPCs) at the former SAFB. The results will also be used to evaluate if the former SAFB has been fully characterized with regard to such COPCs. Based upon this evaluation, a recommendation will be presented to the USACE Project Manager and other decision makers (e.g., KDHE, USEPA) concerning the need for any additional characterization of the former SAFB.

QA/QC samples will be collected and analyzed on a percentage basis. QA/QC samples will generally consist of field (blind) duplicates; QA samples for the Chemical QA Branch Lab; matrix spike (MS) and

matrix spike duplicates (MSD) (Spike Samples); equipment rinsate blank (ERB) samples; trip blanks; and temperature blanks as detailed in Section 6.10.

3.4 APPLICABLE REGULATIONS/STANDARDS

The RI Addendum/FS will be performed in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP), and will follow *USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (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.

3.5 PROJECT SCHEDULE

Investigation activities for SAFB are being conducted in accordance with the schedule provided as Figure 3-2.

* * * * *

4.0 NONMEASUREMENT DATA ACQUISITION

Electronic base map and historical data files will be obtained from the USACE. USACE will also provide copies of necessary reference documents which will be used to obtain historical, geological, hyrdrogeological, and meteorological data. The United States Fish and Wildlife Service will be contacted to obtain the latest information concerning endangered species and significant habitats. The National Register of Historical Places will be contacted to determine if the Site is on the registry. The City of Salina will provide topological information, and the Federal Emergency Management Agency (FEMA) will provide Flood Zone maps. The local planning authority will provide zoning and planned future land use information.

Prior to any field work involving intrusive subsurface activities, utility clearance will be required by contacting Kansas One Call and individual land owners as discussed in Section 6.11.

* * * * *

5.0 FIELD ACTIVITIES BY AREA

This section of the FSP presents the RI Addendum/FS field activities planned for each area. Field activities are presented on an area basis, with the exception of the activities associated with groundwater. This FSP (or WP) is a dynamic document and activities described in subsequent sections could be modified as field activities progress and field screening results become available. This could result in the addition or deletion of sampling locations or lines. Deviations from this FSP will be discussed with and approved by the USACE Project Manager prior to implementation.

All field activities associated with the groundwater plume investigation are presented in Section 5.5. All field procedures that will be used to conduct these field activities are presented in Section 6.0. Preparation and analytical methods are presented in Table 5-1.

5.1 JET ENGINE REPAIR HANGAR AND AIRCRAFT WASH AREA NO. 2

At the Jet Engine Repair Hangar and Aircraft Wash Area No. 2, bedrock will be characterized by obtaining bedrock core. Following the placement of a surface casing five feet into competent bedrock, ten feet of bedrock core will be collected from five feet into the top of competent bedrock to fifteen feet below the top of competent bedrock. The bedrock will be continuously cored, and samples will be collected to determine the characteristics of the bedrock including type, weathering, strength, bedding, and fractures. The borehole will then be reamed to 6 inches and completed as a bedrock monitoring well. The monitoring well will have five feet of screen set within the bedrock interval. Following completion of all new monitoring wells within OU 1, the bedrock monitoring well will be sampled for VOCs. The proposed location of the bedrock monitoring well is shown on Figure 5-1. The proposed samples to be collected are presented in Table 5-2.

5.1.1 BEDROCK DATA COLLECTION

5.1.1.1 Rationale/Design

Information is required on the nature of the bedrock present below the Jet Engine Repair Hangar and Aircraft Wash Area No. 2 in order to determine if significant groundwater is present in bedrock and whether contaminants are present.

A boring will be advanced through approximately 15 feet of unconsolidated overburden to five feet within competent bedrock. A six-inch surface casing will be set and cemented in place. The boring will then be advanced 10 feet into competent bedrock. The bedrock interval will be continuously cored. This core will be logged in detail by the site geologist, and the core will be boxed and retained. The borehole

will then be reamed to 6 inches and a two-inch monitoring well with five feet of screen will be installed within the borehole. Appendix A (Monitoring Well Installation Plan [MWIP]) presents detailed information on procedures to be used for drilling, setting the surface casing, bedrock coring, and monitoring well installation.

5.1.2 GROUNDWATER

5.1.2.1 Rationale/Design

Groundwater, if present in the bedrock monitoring well, will be collected and analyzed to determine if activities at the Jet Engine Repair Hangar and Aircraft Wash Area No. 2 have impacted the bedrock groundwater medium. Groundwater sample results will be evaluated to determine the nature and possible extent of bedrock groundwater contamination. Groundwater samples will also aid in determination of the risk that the contamination may pose to human health and the environment, and the most appropriate method of remediation. The groundwater in the overburden has been adequately characterized in this area.

5.1.2.2 Monitoring Well Installation and Sampling

Procedures presented in Appendix A (MWIP) will be followed to ensure proper construction of the bedrock monitoring well. Following construction, the monitoring well will be developed using procedures discussed in Section 4.0 of the MWIP.

Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for NA indicator parameters using low-flow techniques. Procedures for groundwater sampling are presented in Section 6.2 of this FSP. Preparation and analytical methods are presented in Table 5-1.

5.2 SEWAGE TREATMENT PLANT AND LANDFILL

At the Sewage Treatment Plant and Landfill (Figure 5-2), a direct-push investigation is planned, consisting of subsurface soil and groundwater sample collection. Surface soil samples will also be collected near the direct-push boring locations. In addition, sediment and surface water sampling is planned along the drainage areas. Groundwater samples will be analyzed on the former SAFB site for selected VOCs, with 10 percent of the samples to be analyzed at the off-site laboratory for VOCs for confirmation. Surface soil (0 to 0.5 feet) will be analyzed at the off-site laboratory for SVOCs and RCRA metals. Subsurface soil samples from 0.5 feet to 2 feet bgs and from 10 feet bgs to the top of groundwater will be analyzed at the off-site laboratory for VOCs. Sediment samples, surface water samples, and

subsurface soil samples from 2 feet to 10 feet bgs will be analyzed at the off-site laboratory for VOCs, SVOCs, and RCRA metals.

The results of the direct-push groundwater investigation will be used to determine locations for the installation of monitoring wells/clusters. During drilling of selected new monitoring wells, geotechnical samples will be collected from the vadose zone at two locations and will be analyzed for hydraulic conductivity (which includes reporting of dry bulk density and moisture content) and TOC. Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for NA indicator parameters using low-flow techniques. The samples to be collected are presented in Table 5-3.

5.2.1 GROUNDWATER

5.2.1.1 Rationale/Design

Groundwater will be collected and analyzed to determine if the Sewage Treatment Plant and Landfill have impacted groundwater. Groundwater sample results will be evaluated to determine the nature and possible vertical and horizontal extent of contamination. Groundwater samples will also aid in determination of the risk that the contamination may pose to human health and the environment, and the most appropriate method of remediation. The results of the groundwater samples will be used to determine if Groundwater Plume Areas A and E are connected or if they appear to be individual plumes (Figure 5-3).

Initially, groundwater screening will be conducted at the Sewage Treatment Plant and Landfill using direct-push equipment and a field GC in order to determine nature and vertical and horizontal extent of contamination in groundwater. Based on the results of the groundwater screening, recommendations will be made on the locations for permanent monitoring wells. These will subsequently be sampled for the off-site analysis of VOCs and NA indicator parameters.

5.2.1.2 Groundwater Screening and Field GC Analysis

Groundwater samples will be collected using direct-push equipment from locations assumed to be outside the limits of the Landfill. Groundwater samples will be analyzed on the former SAFB site using a field GC for PCE, TCE, cis-1,2-DCE, and 1,1-DCE. The sampling points for this area (1A01) are approximately 200 feet apart and have a unique alpha code (A, B, C,…). No additional direct-push samples are anticipated in this area (1A01) other than those shown on Figure 5-2. One groundwater sample will be collected from the borehole for every 15 feet of saturated thickness of the aquifer and

analyzed on the former SAFB site following the procedures presented in Section 6.2.8. A total of 24 direct-push borings are planned for this area.

5.2.1.3 Monitoring Well Installation and Sampling

The locations for additional monitoring wells, to include well clusters, will be selected as needed based upon the results of the direct-push investigation. Recommended monitoring well locations will be identified by BMcD for approval by CENWK. Locations will be selected to best characterize the Sewage Treatment Plant and Landfill based on known or estimated source locations and groundwater flow direction. Monitoring wells will be constructed and developed following the procedures presented in Appendix A (MWIP).

Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is know, will also be sampled for NA indicator parameters using low-flow techniques. Procedures for groundwater sampling are presented in Section 6.2 of this FSP. Preparation and analytical methods are presented in Table 5-1.

5.2.2 SUBSURFACE SOIL

5.2.2.1 Rationale/Design

Subsurface soil samples will be collected to determine the nature and vertical and horizontal extent of contamination, if present. Subsurface soil samples will also aid in the determination of the nature of any contamination present, the risk the contamination may pose to human health and the environment, and the most appropriate method of remediation.

5.2.2.2 Subsurface Soil Collection for Off-Site Analysis

Subsurface soil samples will be collected using direct-push equipment and a Macrocore™ sampler from locations assumed to be outside the limits of the Landfill. Subsurface samples will be analyzed at the off-site laboratory for VOCs, SVOCs, and/or RCRA metals. Locations for subsurface soil sampling are shown on Figure 5-2. The samples to be collected are presented in Table 5-3.

Subsurface soil samples using the direct-push method may be collected on discrete 2- or 4-foot intervals. Three discrete samples will be collected – one from the 0.5- to 2-feet bgs interval, one from the 2- to 10-feet bgs interval, and one from the 10 feet bgs to the top of groundwater. Where samples are collected for VOC analysis, the portion of the sampled interval with the most elevated photoionization detector (PID) reading will be discretely collected for VOCs. Then for the 2- to 10-feet bgs interval, a sample from the

same area in the interval of the soil core will be homogenized and a sample collected for SVOCs and RCRA metals. Samples will be immediately transferred to the appropriate sample container and placed on ice. The geologist will prepare a log in the field of the sampled interval using USACE Forms MRK55 and MRK55-2, as described in the MWIP (Appendix A). Procedures for direct-push soil sampling are presented in Section 6.3.3. Details regarding QA/QC (including blanks) sample collection are presented in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

5.2.3 SURFACE SOIL

5.2.3.1 Rationale/Design

Surface soil samples will be collected to determine the presence and extent of surficial contamination from the land surface to six inches below the surface. 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.

5.2.3.2 Surface Soil Collection for Off-Site Analysis

Surface soil samples will be collected using standard procedures from locations shown on Figure 5-2. These locations are assumed to be outside the limits of the Landfill. Surface soil samples will not be collected within the area of the concrete plant as this area has been extensively disturbed and covered with concrete since the removal of the Sewage Treatment Plant.

Discrete surface soil samples will be collected from 0 to 0.5 feet bgs. Samples will be collected and immediately transferred to the appropriate sample containers for SVOCs and RCRA metals analysis and placed on ice. Procedures for surface soil collection are presented in Section 6.4. Field QC samples will be collected in accordance with the procedures provided in Section 6.10.

5.2.4 SEDIMENT

5.2.4.1 Rationale/Design

Sediment samples will be collected from the drainage areas and ditches upgradient and downgradient of the Sewage Treatment Plant and Landfill area to determine the presence and extent of contamination. Collecting upgradient samples will aid in the determination of whether contamination originates at the Sewage Treatment Plant and Landfill or from natural background or an upgradient source. 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.

5.2.4.2 Sediment Sample Collection for Off-Site Analysis

Sediment samples will be collected from Derussy Ditch north of the Sewage Treatment Plant and Landfill area and from Centennial Ditch east of the Sewage Treatment Plant and Landfill area, as shown on Figure 5-2. These discrete sediment samples will be collected from 0 to 0.5 feet bgs and analyzed at the off-site laboratory for VOCs, SVOCs, and RCRA metals. The samples to be collected are presented in Table 5-3.

Upgradient sediment sample locations will be sampled along Derussy Ditch and Centennial Ditch as shown in Figure 5-2. Upgradient samples will be collected using the same procedures as the investigative sediment samples. Upgradient samples will be analyzed for the parameters of interest and will be used to evaluate sample concentrations at the Sewage Treatment Plant and Landfill due to natural and non-Sewage Treatment Plant and Landfill activities.

Dry sediment samples will be collected according to the procedures provided in Section 6.5.2. Wet sediment samples will be collected according to the procedures provided in Section 6.5.3. Field QC samples will be collected in accordance with the procedures provided in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

5.2.5 SURFACE WATER

5.2.5.1 Rationale/Design

Surface water samples will be collected from the drainage areas and ditches upgradient and downgradient of the Sewage Treatment Plant and Landfill area to determine the presence and extent of contamination. Collecting upgradient samples will aid in the determination of whether contamination originates at the Sewage Treatment Plant and Landfill or from natural background or an upgradient source. 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 surficial transport of contaminants may occur.

5.2.5.2 Surface Water Sample Collection for Off-Site Analysis

Surface water samples will be collected from Derussy Ditch north of the Sewage Treatment Plant and Landfill area and from Centennial Ditch east of the Sewage Treatment Plant and Landfill area, as shown on Figure 5-2. Surface water samples will be collected directly in sample container(s), without the aid of an intermediate sample container, whenever possible. This method eliminates any potential effects of sampling devices or equipment. When collecting both water and sediment samples at a specific location, the water sample will always be obtained first. The samples to be collected are presented in Table 5-3.

Upgradient surface water sample locations will be sampled along Derussy Ditch and Centennial Ditch as shown in Figure 5-2. Upgradient samples will be collected using the same procedures and will be analyzed for the parameters of interest as the investigative surface water samples. The upgradient surface water samples will be used to evaluate sample concentrations at the Sewage Treatment Plant and Landfill due to natural and non-Sewage Treatment Plant and Landfill activities.

Surface water samples will be collected and analyzed at the off-site laboratory for VOCs, SVOCs, and RCRA metals according to the procedures provided in Section 6.6.2. Field QC samples will be collected in accordance with the procedures provided in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

5.3 LOX PLANT

At the LOX Plant (Figure 5-4) the field activities consist of a direct-push investigation with subsurface soil and groundwater sample collection; sediment and surface water sampling along the drainage areas; and surface soil from outside the LOX building. Direct-push groundwater samples will be analyzed on the former SAFB site for selected VOCs, with 10 percent of the samples to be analyzed at the off-site laboratory for VOCs for confirmation. Surface soil (0 to 0.5 feet bgs) will be analyzed at the off-site laboratory for SVOCs. Subsurface soil samples from 0.5 to 2 feet bgs and from 10 feet bgs to the top of groundwater will be analyzed at the off-site laboratory for VOCs. Sediment samples, surface water samples, and subsurface soil samples from 2 feet to 10 feet will be analyzed at the off-site laboratory for VOCs and SVOCs.

The results of the direct-push investigation will be used to determine locations for the installation of additional monitoring wells/clusters. During drilling of selected new monitoring wells, geotechnical samples will be collected from the vadose zone at two locations and will be analyzed for hydraulic conductivity (which includes reporting of dry bulk density and moisture content), and TOC.

If the LOX Plant is determined to be a source of contamination, a bedrock monitoring well will be installed at the LOX Plant site at the location of the highest groundwater screening result from near the soil/bedrock interface. Following the placement of a surface casing five feet into competent bedrock, ten feet of bedrock core will be collected from five feet into the top of competent bedrock to fifteen feet below the top of competent bedrock. The bedrock will be continuously cored, and samples will be collected to determine the characteristics of the bedrock including type, weathering, strength, bedding, and fractures. The borehole will then be reamed to six inches and completed as a bedrock monitoring well. The monitoring well will have five feet of screen set within the bedrock interval.

Following completion of all new monitoring wells within OU 1, the wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for NA indicator parameters using low-flow techniques. The samples to be collected are presented on Figure 5-4 and in Table 5-4.

5.3.1 BEDROCK DATA COLLECTION

5.3.1.1 Rationale/Design

If the LOX Plant is determined to be a source of contamination, information will be required on the nature of the bedrock present below the LOX Plant in order to determine if significant groundwater is present in bedrock and whether contaminants are present.

A boring may be advanced through approximately 60 feet of unconsolidated overburden to five feet within competent bedrock. A six-inch surface casing will be set and cemented in place. The boring will then be advanced 10 feet into competent bedrock. This core will be logged in detail by the site geologist, and the core will be boxed and retained. The borehole will then be reamed to six inches and a two-inch monitoring well with five feet of screen will be installed within the borehole. Appendix A (MWIP) presents detailed information on procedures to be used for drilling, setting the surface casing, bedrock coring, and monitoring well installation.

5.3.2 GROUNDWATER

5.3.2.1 Rationale/Design

Groundwater will be collected and analyzed to determine if the LOX Plant has impacted the groundwater medium in the overburden and the bedrock (if present). Groundwater sample results will be evaluated to determine the nature and possible vertical and horizontal extent of contamination. Groundwater samples will also aid in determination of the risk that the contamination may pose to human health and the environment, and the most appropriate method of remediation.

Initially, groundwater screening will be conducted at the LOX Plant site using direct-push equipment and a field GC in order to determine nature and vertical and horizontal extent of contamination in groundwater. Based on the results of the groundwater screening, recommendations will be made on the locations for permanent monitoring wells. These will subsequently be sampled for off-site analysis of VOCs and NA indicator parameters.

5.3.2.2 Groundwater Screening and Field GC Analysis

Groundwater samples will be collected using direct-push equipment from locations around the LOX Plant and LOX Plant culvert/subsurface drains as shown on Figure 5-4. Groundwater samples will be analyzed on the former SAFB site using a field GC for PCE, TCE, cis-1,2-DCE, and 1,1-DCE. One groundwater sample will be collected from each boring for every 15 feet of saturated thickness of the aquifer following the procedures presented in Section 6.2.8. Additional sample locations may be sampled to better define the contamination present as shown on Figure 5-4.

5.3.2.3 Monitoring Well Installation and Sampling

The locations for additional monitoring wells, to include well clusters, will be selected as needed based upon the results of the direct-push investigation. Recommended monitoring well locations will be identified by BMcD for approval by CENWK. Locations will be selected to best characterize the LOX Plant based on known or estimated source locations and groundwater flow direction. Monitoring wells will be constructed and developed following the procedures presented in MWIP, which is provided as Appendix A.

Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for NA indicator parameters using low-flow techniques. Procedures for groundwater sampling are presented in Section 6.2 of this FSP. Preparation and analytical methods are presented in Table 5-1.

5.3.3 SUBSURFACE SOIL

5.3.3.1 Rationale/Design

Subsurface soil samples will be collected to determine the nature and vertical and horizontal extent of contamination, if present. Subsurface soil samples will also aid in the determination of the nature of any contamination present, the risk the contamination may pose to human health and the environment, and the most appropriate method of remediation.

5.3.3.2 Subsurface Soil Collection for Off-Site Analysis

Subsurface soil samples will be collected using direct-push technology from selected locations within the LOX Plant area. Subsurface soil samples will be collected outside of entrances to the LOX Plant and near the LOX Plant culvert/subsurface drains. Subsurface soil samples will be collected using direct-push equipment and a Macrocore™ sampler and analyzed at the off-site laboratory for VOCs and/or SVOCs. Locations for subsurface soil sampling are shown on Figure 5-4. Additional sampling locations may be

selected based on the results of the planned samples shown on Figure 5-4. The samples to be collected are presented in Table 5-4.

Subsurface soil samples using the direct-push method may be collected on discrete 2- or 4-foot intervals. Three discrete samples will be collected – one from the 0.5- to 2-feet bgs interval, one from the 2- to 10-feet bgs interval, and one from the 10-feet bgs to the top of groundwater. Where samples are collected for VOC analysis, the portion of the sampled interval with the most elevated PID reading will be discretely collected for VOCs. Then for the 2- to 10-feet bgs interval, a sample from the same area in the interval of the soil core will be homogenized and a sample collected for SVOCs. Samples will be immediately transferred to the appropriate sample container and placed on ice. The geologist will prepare a log in the field of the sampled interval using USACE Forms MRK55 and MRK55-2, as described in the MWIP (Appendix A). Procedures for direct-push soil sampling are presented in Section 6.3.3. Details regarding QA/QC (including blanks) sample collection are presented in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

5.3.4 SURFACE SOIL

5.3.4.1 Rationale/Design

Surface soil samples will be collected to determine the presence and extent of surficial contamination from the land surface to six inches below the surface. 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.

5.3.4.2 Surface Soil Collection for Off-Site Analysis

Surface soil samples will be collected using standard procedures from locations shown on Figure 5-4. Additional sampling locations may be selected based on the results of the planned samples shown on Figure 5-4. Discrete surface soil samples will be collected from 0 to 0.5 feet bgs. Samples will be collected and immediately transferred to the appropriate sample containers for SVOCs analysis and placed on ice. Procedures for surface soil collection are presented in Section 6.4. Field QC samples will be collected in accordance with the procedures provided in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

5.3.5 SEDIMENT

5.3.5.1 Rationale/Design

Sediment samples will be collected from the drainage areas and ditches upgradient and downgradient of the LOX Plant area to determine the presence and extent of contamination. Collecting upgradient

samples will aid in the determination of whether contamination originates at the LOX Plant area or from natural background or an upgradient source. 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.

5.3.5.2 Sediment Sample Collection for Off-Site Analysis

Sediment samples will be collected from Tony's Road Ditch north of the LOX Plant and from Centennial Ditch east of the LOX Plant, as shown on Figure 5-4. These discrete sediment samples will be collected from 0 to 0.5 feet bgs and analyzed at the off-site laboratory for VOCs and SVOCs.

Upgradient sediment sample locations will be sampled along Tony's Road Ditch and Centennial Ditch as shown in Figure 5-4. Upgradient samples will be collected using the same procedures and will be analyzed for the parameters of interest as the investigative sediment samples. The upgradient sediment samples will be used to evaluate sample concentrations at the LOX Plant site due to natural and non-LOX Plant activities.

Dry sediment samples will be collected according to the procedures provided in Section 6.5.2. Wet sediment samples will be collected according to the procedures provided in Section 6.5.3. Field QC samples will be collected in accordance with the procedures provided in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

5.3.6 SURFACE WATER

5.3.6.1 Rationale/Design

Surface water samples will be collected from the drainage areas and ditches upgradient and downgradient of the LOX Plant area to determine the presence and extent of contamination. Collecting upgradient samples will aid in the determination of whether contamination originates at the LOX Plant area or from natural background or an upgradient source. 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 surficial transport of contaminants may occur.

5.3.6.2 Surface Water Sample Collection for Off-Site Analysis

Surface water samples will be collected from Tony's Road Ditch north of the LOX Plant and from Centennial Ditch east of the LOX Plant, as shown on Figure 5-4. Surface water samples will be collected

directly in sample container(s), without the aid of an intermediate sample container, whenever possible. This method eliminates any potential effects of sampling devices or equipment. When collecting both water and sediment samples at a specific location, the water sample will always be obtained first.

Upgradient surface water sample locations will be sampled along Tony's Road Ditch and Centennial Ditch as shown in Figure 5-4. Upgradient samples will be collected using the same procedures and will be analyzed for the parameters of interest as the investigative surface water samples. The upgradient surface water samples will be used to evaluate sample concentrations at the LOX Plant site due to natural and non-LOX Plant activities.

Surface water samples will be collected and analyzed at the off-site laboratory for VOCs and SVOCs according to the procedures provided in Section 6.6.2. Field QC samples will be collected in accordance with the procedures provided in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

5.4 BUILDING 837 AND FORMER BUILDING 847

A down-hole geophysics/conductivity survey is planned north of Building 837 (Figure 5-5) to determine the top of bedrock. Two of the geophysics/conductivity locations will also be logged to bedrock using direct-push methods. In addition, subsurface soil samples will be collected and field-tested for the presence of petroleum and chlorinated hydrocarbons using OilScreenSoil™ dye test kits. A bedrock boring will be placed within the bedrock low at a location to be determined by the conductivity survey. The bedrock core location will be, if possible, also be located downgradient of, but not within, any DNAPL. Following the placement of a surface casing five feet into competent bedrock, ten feet of bedrock core will be collected from five feet into the top of competent bedrock to fifteen feet below the top of competent bedrock. The bedrock will be continuously cored and samples will be collected to determine the characteristics of the bedrock including type, weathering, strength, bedding, and fractures. The borehole will then be reamed to six inches and completed as a bedrock monitoring well. The monitoring well will have five foot of screen set within the bedrock interface.

One groundwater sample will be collected for every 15 feet of saturated thickness of the aquifer from each of the nine groundwater sampling locations shown in Figure 5-5. These groundwater samples will be analyzed on the former SAFB site for selected VOCs, with 10 percent of the samples to be analyzed at the off-site laboratory for VOCs for confirmation.

A direct-push boring, which is also one of the logged conductivity borings, will be conducted northeast of Monitoring Well 99M24. Soil will be collected and logged from the ground surface to refusal to

geologically characterize this area. Based upon the geologic characterization and the results of the field analysis of the groundwater samples, two additional monitoring wells, one shallow and one deep, will be installed in a cluster with 99M24. These monitoring wells and the bedrock monitoring well will be sampled and analyzed at the off-site laboratory for VOCs and may be selected to be analyzed for NA indicator parameters.

Additionally, soil samples will be collected from the area surrounding the Tullis Building. KSU is planning to place a day care facility within this building. The surface soil samples will be used to determine if risk is present within this area. Surface soil (0 to 0.5 feet bgs) will be analyzed at the off-site laboratory for SVOCs and RCRA metals. A subsurface soil sample will be collected from 0.5 feet to 2 feet bgs and will be analyzed at the off-site laboratory for VOCs. In addition, the soil will be screened to a depth of 4 feet bgs with a PID. If warranted, additional samples may be collected for analysis of VOCs.

The samples to be collected are presented in Table 5-5.

5.4.1 GEOPHYSICS

5.4.1.1 Rationale/Design

A down-hole geophysics/conductivity survey will be conducted to determine the top of bedrock in the area north of Building 837, which is suspected to be an area of a bedrock low. A bedrock low would indicate an area where dense non-aqueous phase liquids (DNAPLs), if present, may be more likely to accumulate.

5.4.1.2 Geophysical Method

Top of bedrock will be determined through an electrical conductivity (EC) survey to the north of Building 837 (Figure 5-5). A down-hole geophysics/conductivity survey will be conducted from the ground surface until refusal. To correlate the down-hole geophysics/conductivity surveys to the subsurface, two down-hole geophysics/conductivity direct-push borings will be advanced to refusal and continuously logged. The down-hole geophysics/conductivity borings will be used with the existing down-hole geophysics/conductivity borings to determine top of bedrock for the area north of Building 837 and former Building 847.

A five-point grid system will be used to define the study area as shown on Figure 5-5. As a result, spacing between points is approximately 70 feet. Relevant reference points, including the beginning and ending points for each survey line, will be surveyed by an RLS.

5.4.1.3 Data Processing

The data will be recorded and processed in the computer attached directly to the probe system. Preliminary field interpretation of the data will be performed after the initial values have been obtained. A determination will then be made by the data users and decision makers as to whether additional locations are needed. The data will be processed to produce two-dimensional contour plots of apparent conductivity values. Based on the interpretation of the EC data, the Building 837 and Former Building 847 site lithology, including the top of bedrock, can be determined.

5.4.2 BEDROCK DATA COLLECTION

5.4.2.1 Rationale/Design

Information is required on the nature of the bedrock present below the Building 837 and Former Building 847 area to determine if significant groundwater is present in bedrock and whether contaminants are present. The bedrock boring will be placed within the bedrock low at a location to be determined by the conductivity survey. The bedrock core location will be, if possible, also be located downgradient of, but not within, any DNAPL. This location will be approved by CENWK prior to drilling.

Once the location is approved by CENWK, a boring may be advanced through approximately 80 feet of unconsolidated overburden to five feet within competent bedrock. A six-inch surface casing will be set and cemented in place. The boring will then be advanced 10 feet into competent bedrock. This core will be logged in detail by the site geologist, and the core will be boxed and retained. The borehole will then be reamed to six inches and a two-inch monitoring well with five feet of screen will be installed within the borehole. Appendix A (MWIP) presents detailed information on procedures to be used for drilling, setting the surface casing, bedrock coring, and monitoring well installation.

5.4.3 GROUNDWATER

5.4.3.1 Rationale/Design

Groundwater will be collected and analyzed to characterize contamination in groundwater in the Building 837 and Former Building 847 area. Groundwater sample results will be evaluated to determine the nature and possible vertical and horizontal extent of contamination. Groundwater samples will also aid in determination of the risk that the contamination may pose to human health and the environment, and the most appropriate method of remediation. The results of the groundwater samples will be used to evaluate the existing plume.

Initially, groundwater screening will be conducted on the former SAFB site using direct-push equipment and a field GC in order to determine nature and vertical and horizontal extent of contamination in

groundwater. Based on the results of the groundwater screening, recommendations will be made on the locations for permanent monitoring wells. These will subsequently be sampled for off-site analysis of VOCs and NA indicator parameters.

5.4.3.2 Groundwater Screening and Field GC Analysis

Groundwater samples will be collected using direct-push equipment from locations north of Building 837 and Former Building 847 as shown on Figure 5-5. Groundwater samples will be analyzed on the former SAFB site using a field GC for PCE, TCE, cis-1,2-DCE, and 1,1-DCE. One groundwater sample will be collected from each boring for every 15 feet of saturated thickness of the aquifer following the procedures presented in Section 6.2.8. Additional locations, as shown on Figure 5-5 may be sampled to better define contamination in the groundwater.

5.4.3.3 Monitoring Well Installation and Sampling

Two new monitoring wells, one shallow and one deep, will be installed in a cluster with existing Monitoring Well 99M24. Additionally a bedrock monitoring well will be installed within the Building 837 and Former Building 847 area. The locations of any additional monitoring wells, to include well clusters, will be selected as needed based upon the results of the direct-push investigation. Recommended monitoring well locations will be identified by BMcD for approval by CENWK. Locations will be selected to best characterize the Building 837 and Former Building 847 site based on known or estimated source locations and groundwater flow direction. Monitoring wells will be constructed and developed following the procedures presented in Appendix A (MWIP).

Following completion of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells, which will be selected once the configuration of the monitoring network is known, will also be sampled for NA indicator parameters using low-flow techniques. Procedures for groundwater sampling are presented in Section 6.2 of this FSP. Preparation and analytical methods are presented in Table 5-1.

5.4.4 SUBSURFACE SOIL

5.4.4.1 Rationale/Design

Subsurface soil samples will be collected from the area around the Tullis Building to aid in the determination of the nature of any contamination present, the risk the contamination may pose to human health and the environment, and the most appropriate method of remediation. Subsurface soil samples from two borings will be collected and field-tested for the presence of petroleum and chlorinated hydrocarbons using OilScreenSoil™ dye test kits.

5.4.4.2 Subsurface Soil Collection

Subsurface soil samples from near the Tullis Building (1C01AT through 1C01BO) will be collected using direct-push technology. Subsurface soil samples will be collected using direct-push equipment and a Macrocore™ sampler and analyzed at the off-site laboratory for VOCs. Locations for subsurface soil sampling are shown on Figure 5-5. The samples to be collected are presented in Table 5-5.

A subsurface soil sample will be collected from the 0.5- to 2-feet bgs interval using the direct-push method. The portion of the sampled interval with the most elevated PID reading will be discretely collected for analysis of VOCs. Samples will be immediately transferred to the appropriate sample container and placed on ice. In addition, the soil will be screened with a PID to a depth of 4-feet bgs. The geologist will prepare a log in the field of the sampled interval using USACE Forms MRK55 and MRK55-2, as described in the MWIP (Appendix A). Procedures for direct-push soil sampling are presented in Section 6.3.3. Details regarding QA/QC (including blanks) sample collection are presented in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

Subsurface soil samples to be collected for the presence of petroleum and chlorinated hydrocarbons will be collected using direct-push technology from the two down-hole geophysics/conductivity borings (1C01M and 1C01AG) shown on Figure 5-5. Subsurface soil samples using the direct-push method may be collected on discrete 2- or 4-foot intervals. One discrete soil sample will be collected for field testing from each 15 feet of saturated overburden thickness. The portion of the sampled interval with the most elevated PID reading will be discretely collected and field-tested for the presence of petroleum and chlorinated hydrocarbons using OilScreenSoil™ dye test kits as detailed in Section 6.3.3.3. Procedures for direct-push soil sampling are presented in Section 6.3.3.

5.4.5 SURFACE SOIL

5.4.5.1 Rationale/Design

Surface soil samples will be collected to determine the presence and extent of surficial contamination from the land surface to six inches below the surface. 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.

5.4.5.2 Surface Soil Collection for Off-Site Analysis

Surface soil samples will be collected using standard procedures from Locations 1C01AT through 1C01BO shown on Figure 5-5. Discrete surface soil samples will be collected from 0 to 0.5 feet bgs. Samples will be collected and immediately transferred to the appropriate sample containers for SVOCs

and RCRA metals analysis and placed on ice. Procedures for surface soil collection are presented in Section 6.4. Field QC samples will be collected in accordance with the procedures provided in Section 6.10. Preparation and analytical methods are presented in Table 5-1.

5.5 GROUNDWATER PLUME AREAS

VOC-contaminated groundwater is present beneath much of OU 1. Although multiple sources for the groundwater contamination are potentially present, the plumes overlap and at places merge within the aquifer. For this investigation, groundwater contamination at OU 1 has been divided into areas based upon plume configuration. These plume areas are defined based upon current knowledge of the groundwater contamination and are subject to modification based on the results of this investigation. Figure 5-3 shows the distribution of TCE in groundwater as presented in the 2005 RI and the labeled plume areas of the groundwater contamination.

- Plume Area A is located in the southwest portion of OU 1. The highest TCE concentration for Plume Area A is at Monitoring Well 99M04 which is upgradient from Aircraft Wash Area No. 1 and downgradient of the Jet Engine Repair Hangar and Aircraft Wash Area No. 2. Plume Area A extends to the east southeast and to the north.

- Plume Area B is located in the southwest portion of OU 1 and northeast of Plume Area A. The highest TCE concentration for Plume Area B is at Monitoring Well 99M13 located at the Fuel Tank Maintenance Hangar Area. Plume Area B extends to the east and northwest.

- Plume Area C is located in the west central portion of OU 1 and north of Plume Area B. The highest TCE concentration for Plume Area C is at Monitoring Well 99M24 located north of Building 837 and former Building 847. Plume Area C extends to the east beneath Landfill No. 2 and to the northeast towards the former LOX Plant.

- Plume Area D is located in the north central and northeast portion of OU 1 and northeast of Plume Area B. The highest TCE concentration for Plume Area C was collected from a direct-push groundwater sample from Location GP-N45 located north of the former LOX Plant. Plume Area D extends eastward and then northeast on the eastern side of I-135.

- Plume Area E is located in the southeast portion of OU 1 and east of Plume Area A. It is possible that Plume Area E is an extension of Plume Area A. Plume Area E was determined using direct-push data. Plume Area E extends to the northeast.

The samples to be collected are presented in Table 5-6.

5.5.1 GROUNDWATER

5.5.1.1 Rationale/Design

In order to fully characterize the plume areas both horizontally and vertically, an iterative sampling procedures using direct-push sampling equipment and on-site laboratory analysis is planned. This will allow the field sampling crew to make real-time decisions to optimize the use of resources and efficiently delineate the nature and extent of groundwater contamination. The results of the direct-push investigation will be used to determine locations for the installation of additional monitoring wells/well clusters. Groundwater plume definition will aid in determination of the risk that the contamination may pose to human health and the environment, and the most appropriate method of remediation.

Initially, groundwater screening will be conducted on the former SAFB site using direct-push equipment and a field GC in order to determine nature and vertical and horizontal extent of contamination in groundwater. Based on the results of the groundwater screening, recommendations will be made on the locations for permanent monitoring wells. These will subsequently be sampled for off-site analysis of selected analytes.

5.5.1.2 Groundwater Screening and Field GC Analysis

The groundwater direct-push investigation will consist of strategically placing boreholes within the areas shown on Figure 5-3. Groundwater samples will be analyzed on the former SAFB site using a field GC for PCE, TCE, cis-1,2-DCE, and 1,1-DCE. Groundwater samples will also be analyzed on the former SAFB site for carbon tetrachloride within Sample Grid 3C. Samples will be collected and analyzed following the procedures presented in Section 6.2.8. Due to the iterative nature of sample collection activities at many of these areas, not all locations shown will be sampled. Subsequent sections describe specific requirements in more detail. Table 5-6 presents the sampling requirements and nomenclature for groundwater samples.

5.5.1.2.1 Plume Area A

For groundwater Plume Area A, one direct-push area (1A01) is planned (Figure 5-2) to determine if the Sewage Treatment Plant and Landfill have impacted the groundwater. This sampling is described in Section 5.2, as these samples pertain to the direct-push investigation at the Sewage Treatment Plant and Landfill.

5.5.1.2.2 Plume Area B

For groundwater Plume Area B, one line of direct-push sampling (Line 1B01) is planned on the west side of the Burlington Northern Railroad north of the former Sewage Treatment Plant and Landfill. The purpose of this line of direct-push sampling is to determine if the contaminants from Plume Area B have migrated east of the Burlington Northern Railroad tracks. The northern portion of this line will be considered the point of origin and samples will be collected at approximately 200-foot intervals. Along Line 1B01, each 100-foot interval will have a unique alpha code (A, B, C,…), starting with A (point of origin) and continuing southward. No additional samples are anticipated along Line 1B01 shown on Figure 5-3.

5.5.1.2.3 Plume Area C

Six primary direct-push areas are planned for Plume Area C (Figure 5-3).

Area 1C01

Area 1C01 is detailed in Section 5.4, which describes sampling at the Building 837 and former Building 847 area. The purpose of Area 1C01 is to characterize the contamination in groundwater in the Building 837 and former Building 847 area.

Sample Grid 2C

Line 2C20 will be sampled down the presumed center of the plume in the presumed groundwater flow direction to determine the horizontal and vertical extent of Plume Area C (Figure 5-6).

- Line 2C20 will become the center line (x axis) of a rectilinear grid established on 100-foot intervals. Along Line 2C20, each 100-foot interval will have a unique alpha code (A, B, C,…, AA, AB,…). From the point or origin, the y coordinates will be sequentially numbered in the first quadrant (i.e., 21, 22, 23, etc.) and in the fourth quadrant (i.e., 19, 18, 17, etc.), stepping out north and south from Line 2C20.

- Direct-push groundwater sampling will begin along Line 2C20, with samples being collected at 500-foot intervals from the point of origin of the line (2C20A) and working east until contaminants are not detected. One location will additionally be placed so to be near the downgradient end of the plume but still within the plume. Groundwater samples from this location will be collected from each ten foot of saturated thickness.

- Field data will then be evaluated to determine the best locations for the transverse lines. Transverse lines will typically be located north and south from the non-detect, 5 micrograms per

liter (µg/L), 50 µg/L, 500 µg/L, and the highest detection locations. If these positions are not clear along Line 2C20 based on the 500-foot interval data, then additional infill sampling might be required. Transverse lines will not be required west of Point 2C20S.

- Once locations have been established for transverse lines, sampling will "step-out" a distance of 500 feet north and south from Line 2C20. If detections are above 50 µg/L in these samples, the field crew will "step-out" another 500 feet. If the detections are below 50 µg/L and above 5 µg/L, then the field crew will step-out 200 feet. If detections are 5 µg/L or less are identified, the field crew will step-out in 100-foot increments until contaminants are not detected. If the field crew encounters non-detect samples on a major step-out (500 or 200 feet), then they will step back in 100-foot increments until contaminants are detected.

- Once this process is completed on Line 2C20 and the transverse lines, the configuration of the eastern portion of Plume Area C will be identified.

- Additional infill sampling may be performed if required to delineate nature and extent in more detail.

Sample Grid 3C

Sample Grid 3C will be centered over Monitoring Well 99M23, which has been reported to contain detections of carbon tetrachloride (Figure 5-6). The objective will be to determine the extent of carbon tetrachloride contamination in this area.

- Line 3C20 will become the center line (x axis) of a rectilinear grid (3C) established on 100-foot intervals. Along Line 3C20, each 100-foot interval will have a unique alpha code (AA, AB, AC,…to the northeast and Z, Y, X…to the southwest). From the point of origin, the y coordinates will be sequentially numbered in the first and second quadrants (i.e., 21, 22, 23, etc.) and in the third and fourth quadrants (i.e., 19, 18, 17, etc.) stepping out southeast and northwest from Line 3C20.

- Initially, direct-push samples will be collected at 200-foot intervals from the point of origin (3C20AA) until carbon tetrachloride is not detected. The field sampling team will step-out 200 feet to the northwest, northeast, southeast, and southwest from Point 3C20AA. If detections are found above 50 µg/L in these samples, the field crew will step-out another 200 feet in the same direction. If detections are less than 50 µg/L, then the field crew will step-out only 100 feet. If the field crew encounters non-detect samples for carbon tetrachloride on a major step-out (200

feet), then they will step back in 100 feet increments until contaminants are detected. By this process, the extent of carbon tetrachloride contamination will be identified.

- Additional infill sampling may be performed if required to delineate nature and extent in more detail.

Line 4C01

The fourth primary line of direct-push sampling, Line 4C01, is also planned north of the potential source of contamination to determine the horizontal and vertical extent of contamination to the north-northwest of Plume Area C. The southern portion of this line will be considered the point of origin and samples will be collected at approximately 200-foot intervals until a non-detect is identified. Along Line 4C01, each 100-foot interval will have a unique alpha code (A, B, C,…), starting with A (point of origin) and continuing northwest. No additional samples are anticipated along Line 4C01 shown on Figure 5-3.

Line 5C01

The fifth primary line of direct-push sampling, Line 5C01, is also planned north of the potential source of contamination to determine the horizontal and vertical extent of contamination to the northwest of the LOX Plant and to determine if Plume Areas C and D are connected. The southern portion of this line will be considered the point of origin and samples will be collected at approximately 200-foot intervals until a non-detect is identified to the northwest. Along Line 5C01, each 100-foot interval will have a unique alpha code (A, B, C,…), starting with A (point of origin) and continuing northwest. If the point of origin is not a non-detect, additional samples will be collected in the southeasterly direction at approximately 200-foot intervals as shown on Figure 5-3 until a non-detect is identified. No additional samples are anticipated along Line 5C01 shown of Figure 5-3.

Line 6C01

The sixth primary line of direct-push sampling, Line 6C01, is planned northeast of the potential source of contamination to determine the horizontal and vertical extent of contamination to the northeast of Building 837. The southern portion of this line will be considered the point of origin and samples will be collected at approximately 200-foot intervals. Along Line 6C01, each 100-foot interval will have a unique alpha code (A, B, C,…), starting with A (point of origin) and continuing northeast. No additional samples are anticipated along Line 6C01.

5.5.1.2.4 Plume Area D

For groundwater Plume Area D, five primary direct-push areas are planned (Figure 5-3).

Area 1D01

Area 1D01 is detailed in Section 5.3, as those samples pertain to the LOX Plant. The purpose of Area 1D01 is to determine the horizontal and vertical extent of contamination in the LOX Plant area.

Line 2D01

Line 2D01 is planned just north of a potential source of contamination (the LOX) indicated by a groundwater sample collected from Probe N45 to determine the horizontal and vertical extent of contamination north of the LOX Plant area. The nature of the materials landfilled in this area may cause refusal in certain places well above the water table. The southern portion of this line will be considered the point of origin and samples will be collected at approximately 200-foot intervals until a non-detect is identified to the northwest. Along Line 2D01, each 100-foot interval will have a unique alpha code (A, B, C,…), starting with A (point of origin) and continuing northwest. If the point of origin is not a non-detect, additional samples will be collected in the southeasterly direction at approximately 200-foot intervals until a non-detect is identified. No additional samples are anticipated along Line 2D01 shown on Figure 5-3.

Line 3D01

The third primary line of direct-push sampling, Line 3D01, is also planned east of the potential source of contamination bisecting the Burlington Northern Railroad. The purpose of direct-push sampling Line 3D01 is to determine the width of the plume, as well as the vertical extent in the area east of the LOX Plant. The southern portion of this line will be considered the point of origin and samples will be collected at approximately 200-foot intervals as shown on Figure 5-3 until a non-detect is identified to the northwest. Along Line 3D01, each 100-foot interval will have a unique alpha code (A, B, C,…), starting with A (point of origin) and continuing northwest. If the point of origin is not a non-detect, additional samples will be collected in the southeasterly direction at approximately 200-foot intervals until a non-detect is identified. No additional samples are anticipated along Line 3D01 shown on Figure 5-3.

Line 4D01

The fourth primary line of direct-push sampling, Line 4D01, is planned east of the presumed source of contamination along the west side of I-135. The purpose of direct-push sampling Line 4D01 is to determine whether the contamination has migrated to I-135. The southern portion of this line will be considered the point of origin and samples will be collected at approximately 200-foot intervals until a non-detect is identified to the northwest. Along Line 4D01, each 100-foot interval will have a unique alpha code (A, B, C,…), starting with A (point of origin) and continuing northwest. If the point of origin is not a non-detect, additional samples will be collected in the southeasterly direction at approximately

200-foot intervals as shown on Figure 5-3 until a non-detect is identified. No additional samples are anticipated along Line 4D01 shown on Figure 5-3.

Sample Grid 5D

Grid 5D will be sampled down the presumed center of the plume in the presumed groundwater flow direction (Figure 5-7) to determine the horizontal and vertical extent of contamination in the residential area northeast of I-135.

- Line 5D20 will become the center line (x axis) of a rectilinear grid established on 100-foot intervals. Along Line 5D20, each 100-foot interval will have a unique alpha code (A, B, C,…). From the point or origin, the y coordinates will be sequentially numbered in the first quadrant (i.e., 21, 22, 23, etc.) and in the fourth quadrant (i.e., 19, 18, 17, etc.), stepping out northwest and southeast from Line 5D20.

- Direct-push groundwater sampling will begin along Line 5D20, with samples being collected at 500-foot intervals from the point of origin of the line (5D20A) and working northeast until contaminants are not detected. One location will additionally be placed so to be near the downgradient end of the plume but still within the plume. Groundwater samples from this location will be collected from each ten foot of saturated thickness.

- Field data will then be evaluated to determine the best locations for the transverse lines. Transverse lines will typically be located northwest and southeast from the non-detect, 5 µg/L, 50 µg/L, 500 µg/L, and the highest detection locations. If these positions are not clear along Line 5D20 based on the 500-foot interval data, then additional infill sampling might be required.

- Once locations have been established for transverse lines, sampling will “step-out” a distance of 500 feet northwest and southeast from Line 5D20. If detections are above 50 µg/L in these samples, the field crew will “step-out” another 500 feet. If the detections are below 50 µg/L and above 5 µg/L, then the field crew will step-out 200 feet. If detections of 5 µg/L or less are identified, the field crew will step-out in 100-foot increments until contaminants are not detected. If the field crew encounters non-detect samples on a major step-out (500 or 200 feet), then they will step back in 100-foot increments until contaminants are detected.

- Once this process is completed on Line 5D20 and the transverse lines, the configuration of the eastern portion of Plume Area D will be identified.

- Additional infill sampling may be performed if required to delineate nature and extent in more detail

5.5.1.2.5 Plume Area E

For groundwater Plume Area E, one primary direct-push grid is planned (Figures 5-3 and 5-9) to determine the horizontal and vertical extent of contamination east-northeast of the Sewage Treatment Plant and Landfill. Grid 1E will be sampled down the presumed center of the plume in the presumed groundwater flow direction.

- Line 1E20 will become the center line (x axis) of a rectilinear grid established on 100-foot intervals. Along Line 1E20, each 100-foot interval will have a unique alpha code (A, B, C,…, AA, AB,…). From the point or origin, the y coordinates will be sequentially numbered in the first quadrant (i.e., 21, 22, 23, etc.) and in the fourth quadrant (i.e., 19, 18, 17, etc.), stepping out northwest and southeast from Line 1E20.

- Direct-push groundwater sampling will begin along Line 1E20, with samples being collected at 500-foot intervals from the point of origin of the line (1E20A) and working northeast until contaminants are not detected. One location will additionally be placed so to be near the downgradient end of the plume but still within the plume. Groundwater samples from this location will be collected from each ten foot of saturated thickness.

- Field data will then be evaluated to determine the best locations for the transverse lines. Transverse lines will typically be located northwest and southeast from the non-detect, 5 µg/L, 50 µg/L, 500 µg/L, and the highest detection locations. If these positions are not clear along Line 1E20 based on the 500 feet interval data, then additional infill sampling might be required.

- Once locations have been established for transverse lines, sampling will step-out a distance of 500 feet north and south from Line 1E20. If detections are above 50 µg/L in these samples, the field crew will step-out another 500 feet. If the detections are below 50 µg/L and above 5 µg/L, then the field crew will step-out 200 feet. If detections of 5 µg/L or less are identified, the field crew will step-out in 100-foot increments until contaminants are not detected. If the field crew encounters non-detect samples on a major step-out (500 or 200 feet), then they will step back in 100-foot increments until contaminants are detected.

- Once this process is completed on Line 1E20 and the transverse lines, the configuration of the eastern portion of Plume Area E will be identified.

- Additional infill sampling may be performed if required to delineate nature and extent in more detail.

5.5.1.3 Monitoring Well Installation and Sampling

Two new monitoring wells, one shallow and one deep, will be installed in a cluster with Monitoring Well 99M24. The locations for additional monitoring wells, to include well clusters, will be selected as needed based upon the results of the direct-push investigation. Clusters will, depending upon the saturated thickness of the aquifer, include either shallow and deep wells (<30 feet of saturated thickness), or shallow, intermediate, and deep wells (>30 feet of saturated thickness). Groundwater monitoring wells will be placed within the plumes and outside the edges of the plumes to monitor contamination presence and movement. BMcD will evaluate all available groundwater data and recommend monitoring well locations and screen depths, which will be submitted to CENWK for their review and approval. Monitoring wells will be constructed and developed following the procedures presented in Appendix A (MWIP).

Following completion and development of all new monitoring wells within OU 1, these wells will be sampled for VOCs using PDB samplers. Twenty percent of these new monitoring wells will also be sampled for NA indicator parameters using low-flow techniques. Upon completion of the RI Addendum/FS field investigation, selected newly-installed monitoring wells will be incorporated into the long term monitoring program. Long term monitoring at the SAFB consists of semiannual sampling for VOCs using PDBs with 20 percent of the monitoring wells also sampled for NA indicator parameters. Procedures for groundwater sampling are presented in Section 6.2 of this FSP. Preparation and analytical methods are presented in Table 5-1.

5.5.1.4 Hydrologic Parameter Collection

To better define the hydrogeologic properties of the aquifer and to collect data required to support the groundwater model. The following data will be collected:

- Four slug tests will be conducted in the shallow, less-permeable aquifer in order to collect hydraulic conductivity data. Monitoring wells to be slug tested will be chosen after installation of the monitoring wells.

- Two pumping tests will be conducted in the alluvial aquifer in order to determine hydraulic parameters. One will be placed south of Plume Area D near I-135 in the finer-grained alluvium, and the other will be placed downgradient of Plume Area D in the coarser-grain alluvium (Figure 5-3). Prior to installation of the wells for the pumping tests, groundwater screening will be

conducted using direct-push equipment in order to assure that the pumping tests are conducted in areas of no contamination. In addition, a groundwater sample from the deep interval of the aquifer will be sent to the off-site laboratory for VOCs analysis for confirmation.

- Four gauging stations will be established in order to collect information on surface water discharge. Procedures for stream gauging are presented in Section 6.7 of this FSP.

5.6 DEBRIS REMOVAL AT THE NATIONAL GUARD FACILITY

The debris present at the National Guard Facility will be removed according to the procedures in Section 6.13. This area is located in a gully immediately west of common Landfill No. 1 (Figure 5-9).

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6.0 FIELD OPERATIONS AND SAMPLING PROCEDURES

Each sample, field measurement, and field activity will be properly documented to facilitate timely, correct, and complete analyses, and support actions concerning OU 1 at the SAFB. 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 B.

6.1 GEOPHYSICS

6.1.1 Electrical Conductivity

The measurement of the electrical resistivity (the inverse of conductivity) has long been used as a logging tool in open boreholes. These resistivity logs can be extremely useful as an aid to the investigator in logging the lithology of the borehole. However, conductivity can be measured with a probe, without the need for drilling of open boreholes as conduits for the logging tool. Soil conductivity can be obtained using direct-push probes equipped with a conductivity sensor. This percussion probe unit operates by applying an oscillating force or percussion to the top of the tool string being advanced into the ground.

The EC probe comes in two different configurations, dipole array and Wenner array, with the same theory of operation. A current is sent through the formation between two probe contact points. The current is measured along with the voltage that results. The conductivity is a ratio of current to voltage times an electrical constant. The resulting reading is in milli-Siemens per meter (mS/m).

The soil conductivities vary for each type of media encountered. Silts or clays will have a higher EC; however, in the case of sand and gravel deposits, the signal will read as a lower EC.

The collection of select continuous soil cores in conjunction with EC probe data can be used to verify representative EC values for an area of investigation.

An EC survey will be conducted to determine the top of bedrock near the Building 837 and former Building 847 area.

Following are the procedures necessary to conduct the EC investigation:

1. Stake/flag locations to be surveyed using the EC probe. Values will be obtained at grid points based on a five-point grid system. As a result, spacing is approximately 70 feet between points. The general outlines of the grid will be marked prior to the EC survey.

2. Advance the 1 1/2-inch probe through the ground using a hydraulically driven percussion probing machine.

3. Apply downward pressure or percussion to the top of the probe rod at a rate of approximately 30 Hertz.

4. Add sections of probe rod until refusal is met. A depth measurement is obtained from the stringpot system configured to measure the distance from the driving mechanism to ground surface.

5. Record and process readings on a notebook computer directly attached to the probe system.

A preliminary field interpretation of the data will be performed after the initial values have been obtained. A determination will then be made by the data users and decision makers as to whether additional locations are needed. The data will be processed to produce two-dimensional contour plots of apparent conductivity values. Based on the interpretation of the EC data, the site lithology, including the top of bedrock, can be determined.

6.2 GROUNDWATER

6.2.1 Sample Collection and Field and Laboratory Analysis

Groundwater samples will be collected from direct-push boreholes and from all newly installed monitoring wells. Groundwater samples will be collected from direct-push locations according to procedures in Section 6.2.8 and analyzed on the former SAFB site for selected VOCs. Groundwater samples for VOCs will be collected from new monitoring wells using PDBs according to Section 6.2.6. Samples for NA indicator parameters will be collected using stainless steel or polyvinyl chloride (PVC) bladder pumps. 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 Section 6.2.7. Groundwater samples from 10 percent of the direct-push groundwater sampling locations and all groundwater samples from monitoring wells will be shipped off the former SAFB site to be analyzed for VOCs and NA indicator parameters at the primary contract laboratory. Twenty percent of these new monitoring wells will also be sampled for NA indicator parameters. Procedures for groundwater sampling are presented in Section 6.2 of this FSP. Preparation and analytical methods are presented in Table 5-1.

Groundwater and QC samples will be collected and containerized in the order of the volatilization sensitivity of the analytical parameters. In general, the following order will be followed: VOCs, SVOCs,

RCRA metals, and NA indicator parameters. This order may be modified based on site conditions. Original and QA/QC samples will be placed in identical containers and preserved in an identical manner. In the event that there is insufficient volume to collect for all specified parameters and designated QC samples, samples for the analyses will be prioritized in coordination with the BMcD Project Manager and project chemist. This hierarchy of samples for low recharge wells will take into account site-specific priorities, sample size, effect of turbidity on results, etc.

6.2.2 Monitoring Well Installation

Procedures for monitoring well installation at SAFB are covered in detail in the Monitoring Well Installation Plan (MWIP) presented in Appendix A.

6.2.3 Fluid Level and Total Depth Measurement

Fluid levels and total monitoring well depth will be measured prior to collection of groundwater samples. Electronic oil/water interface probes will be used as needed. In monitoring wells with watertight caps, the cap will be removed and fluid level measurements repeated at regular intervals until the readings stabilize. Once the well cap has been removed or the protective cover lid opened, a PID will be used to measure the organic vapor content at the well head. All fluid levels will be measured to the reference mark on the top of the riser pipe. If no notch is present on the north side of the casing, a notch shall be made using a decontaminated metal file. Water levels will also be measured from bedrock coreholes and direct-push boreholes.

6.2.3.1 Equipment

Equipment that may be needed for fluid level and total depth measurements is summarized below:

- Electronic water level indicator
- Steel tape
- Applicable decontamination equipment (refer to Section 6.8.1)
- PID

6.2.3.2 Procedures

The following procedure will be used to measure fluid levels using an electronic water level indicator:

1. Prior to measuring the water level in the first well of the day, decontaminate the cable and probe as described in Section 6.8. Wipe the cable with paper towels as it is rewound onto the reel.

2. Remove cap and record PID measurement.

3. Turn on the meter and push the instrument test button to check the batteries.

4. Lower the probe into the monitoring well or boring by pulling the cable from the hand-held reel until the indicator light or audible signal responds.

5. Move the cable up and down to determine the top of the fluid. Note the exact length of cable extended from the tip of the sensor to the reference point. Record the cable length to the nearest 0.01 foot, the monitoring well or boring number, and the time and date of the measurement.

6. Check for the presence of non-aqueous phase liquids (NAPLs) using an interface probe in all new wells. If using the oil/water interface probe, determine if light or dense immiscible fluids are present by slowly lowering the cable into the monitoring well or boring until the bottom is reached while watching to see if the instrument responds to an immiscible fluid/water interface. If the instrument indicates that an interface exists, repeat Step 5 to determine the depth to the interface. If measurable immiscible fluid is not present, but the instrument probe shows visible evidence, document this.

7. Measure the total depth by gently lowering the steel tape to the bottom of the monitoring well or boring until the cable is slack. Reel in the slack cable and note the length of cable extended from the tip of the tape to the reference point. This measurement will be compared with previous measurements to determine if sediment has deposited at the bottom of the well. Total depths of the wells will be measured prior to the placement of PDBs.

8. Decontaminate the tape, probe, and cable prior to measuring the next boring or monitoring well or storing.

Water levels will be compared with previous water levels whenever possible. If a large difference in water level is noted from the previous measurement, the water level will be re-measured. Piezometric surface maps will be drawn in the field during water level measurement collection to ensure accuracy of water level measurements.

The total depth measurement of a monitoring well will be compared with the constructed total depth. A lesser total depth is an indication that sediment may have accumulated in the monitoring well and this will be reported to the FSM.

6.2.4 Aquifer Testing

Aquifer testing is addressed in Section 3.5 of the MWIP (Appendix A).

6.2.5 Field Measurements

Immediately after removal of the well cap, the air near the cap and in the well casing will be monitored using a PID. This information will be utilized in conjunction with the APP to determine the personal safety level required during sampling. These readings will be recorded in the field logbook. If readings above background are recorded, air monitoring will continue throughout the sampling event.

Field measurement of temperature, pH, specific conductance, DO, ORP, alkalinity, and turbidity will be collected during purging of each well and prior to collection of each groundwater sample. Ferrous iron will also be measured for evaluation of NA indicator parameters. All measurements except ferrous iron will be measured inside a flow-through chamber during purging and care will be taken to ensure that no air is introduced into the sampling line through the sampling elbow. Tighten or replace the sampling elbow if air bubbles are introduced. All field parameters will be measured as stated in Section 6.2.8.2.

6.2.5.1 Equipment

Equipment that may be needed for field measurements is summarized below:

- PID
- Combination meter (i.e., YSI 556 Multiprobe System [MPS] or similar instrument) capable of measuring pH, specific conductance, turbidity, temperature, DO, and ORP
- Ferrous iron colorimeter
- Flow-through cell
- Graduated cylinder
- Buckets
- Gloves
- Pump controller
- Compressed air source

6.2.5.2 Calibration

The combination meter will be calibrated at the beginning of each day using calibration solutions provided by the meter's manufacturer. In addition, ORP will be checked for accuracy using standard reduction-oxidation (redox) solution (200-275 millivolts [mV] at 25 degrees Celsius [^{o}C]). Calibration checks will be performed at midday and at the end of the day, recalibrating as necessary during the

midday check. Calibration checks and recalibration will also be performed any time the readings appear to be abnormal.

The DO will be checked before and after sampling each well. An accuracy check will be performed on the ferrous iron colorimeter once per day. The manual will be consulted if the reading is not within ±0.25 milligrams per liter (mg/L) of the standard solution.

All calibrations and calibration checks will be recorded in the field logbook and appropriate field forms. Extreme cold or hot weather is known to affect meters. In these instances, calibration of the meter will be checked more frequently. Equipment technical manuals will be available in the field for all field measurement instruments. Field personnel should consult the manual for additional technical details.

6.2.6 Passive Diffusion Sampler Procedures

6.2.6.1 Introduction

The process of PDB sampling is based on the phenomena of diffusion, the tendency of chemicals to equally distribute themselves within unconfined conditions. Because chemical concentration gradients are inherently unstable and under the influence of random motion, chemicals naturally disperse to form a uniform concentration. Because there are more solute molecules moving in areas of higher concentration, it is more likely that a molecule will wander out of the area than it is for one to wander in, so chemicals distribute themselves until equal concentration is achieved through out the available space.

Diffusion is achieved through selective permeation; a barrier is established through which some chemicals can pass and others cannot. Thus the equalization of some compounds is allowed while other compounds are excluded. In PDB sampling, low-density polyethylene (LDPE) is used which allows the migration of small molecules while stopping larger ones.

6.2.6.2 Obtaining and Placing PDBs

PDB samplers, specifically designed for the collection of VOC samples, and associated hanging lines (leaders), weights and mesh bags are commercially available. The typical PDB is flat, 24 inches long and 1.5 inches wide giving a volume of approximately 270 milliliters (mL), sufficient to fill six 40 mL VOA vials. These bags can be obtained ether pre-filled or empty. For this project, pre-filled bags will be used.

PDB samplers (one or two) will be placed in the monitoring wells at depths to be determined for the first sampling event in order to sample a vertical profile. Additional bags will be placed where required for the collection of QA/QC and MS/MSD samples.

6.2.6.3 Initial Placement of Leader and Weight

1. Leaders, weights, and mesh bags should be ordered from the supplier of the PDB samplers to ensure they are inert and do not leach analytes. Leaders should be ordered an extra ten feet long to allow extra length for adjustment and securing.

2. If the screened interval is known, leaders should be premeasured, installed and insertion depth marked. The following conditions of bag placement should be met in the following order:

   i) Bags should be placed so they are completely inside the screened interval.

   ii) At least two feet of water column should be present above the bag to inhibit loss of analytes by off gassing.

   iii) The weight should be at least a foot off of the bottom of the well to reduce the possibility of stirring up sediment when placing or retrieving the bag.

3. Measure water level to ensure that PDB sampler(s) will be at least two feet below the surface of the water.

4. Attach the mesh bag to the leader, if no attachment point is available thread a zip tie through several loops of the mesh and secure it to provide an attachment loop.

5. Leaders should be threaded through the vent hole in the well cap and secured with a cable stay. Extra leader should be cut off and discarded.

6.2.6.4 Insertion of Bags

Bags are placed in the wells inside a protective mesh bag and suspended from weighted stainless steel wire leaders. The procedure for installing pre-filled PDB samplers is given below. Nitrile gloves should be worn while handling the leader, mesh bags and PDB samplers.

1. Remove the mesh bag from leader by disconnecting the lanyard and cutting the zip tie securing the bottom of the bag to the leader. Coil the leader and weight and secure, place in trash bag or Ziploc® bag to protect from contamination. If the well cap is attached to the leader it should be left outside the bag to protect the leader from surface contamination.

2. Secure the PDB sampler to the mesh using a zip tie, with the cap of the bag protruding from the mesh. Place the zip tie in the joint between the cap and the bag, do not put the zip tie through the

loop created by the flip top lid and its seat, as this may cause the lid to open allowing contamination of the bag or loss of the bag. Tying the bottom of the mesh bag closed by weaving a zip tie through the mesh is recommended.

3. Reattach the mesh bag to the lanyard using the looped zip tie at the top. If an attachment to the PDB sampler is provided, secure it with the lanyard as well. Secure the mesh bag to the leader near the bottom of the bag using a zip tie.

4. Lower the leader with the bag into the well and secure the well cover.

6.2.6.5 Recovery of Bags and Collection of Samples

Once equilibrium has been has been established (at least three weeks), a sample can be collected. To collect samples use the following steps:

1. Determine the depth to water prior to removing the PDB samplers.

2. Open the well and draw up the leader until the PDB sampler is withdrawn from the well. If two or three bags are present suspend these additional bags in the well by placing the cap back on the well to secure the leader until the first bag is sampled.

3. Remove the mesh bag from leader by disconnecting the lanyard and cutting the zip tie securing the bottom of the bag to the leader. Coil the leader and weight and secure, place in trash bag or Ziploc® bag to protect from contamination. If the well cap is attached to the leader it should be left outside the bag to protect the leader from surface contamination.

4. Hold the PDB sampler in the mesh bag by the cap and gently tap the bag to dislodge any air bubbles that may be clinging to the sides of the bag.

5. Sampling is a two-man job. One person should hold the bag and the other the vials. Full PDB samplers are difficult to handle, leaving them in the mesh bag while sampling adds rigidity and aids in control. Use a discharge straw to decant water from the PDB sampler to the vials. Fill each vial cap to provide enough water for “rounding off” the sample in order to fill each vial without any bubbles. There should be enough water to get six vials, but with spillage and “rounding off”, five is the practical maximum.

6. Once all the samples have been taken, discard the rest of the water in the bag in accordance with the procedures for handling investigative-derived waste (IDW) provided in Section 9.0.

7. Remove the PDB sampler from the mesh bag and discard it.

8. Label, pack and ship samples.

6.2.6.6 QC

QC samples will be collected during PDB sampling efforts. Trip blanks, duplicates and MS/MSD samples will be taken as directed Section 6.10. QA/QC and MS/MSD samples will be collected from a second PDB sampler, which will be hung immediately below the PDB sampler from which the primary samples will be collected. When interpreting the results of the QA/QC samples, consideration will be given for the possibility of contaminant stratification due to the varying depths of the multiple PDBs.

An ERB will be collected from an unused PDB sampler at the time these are being placed into the monitoring wells. This will involve removing water from an unused PDB sampler and sending it to the analytical laboratory for analysis of VOCs.

6.2.6.7 Required Equipment and Supplies

Initial placement of leader and weight:

- Gloves
- Field notebook
- Tape measure
- Water level meter
- Tools (screwdriver, knife, wire cutters)
- Leaders, lanyards, weights, mesh bags
- Cable stays
- Zip ties

Insertion of bags:

- Gloves
- Field notebook
- Laboratory-grade deionized water
- PDBs (pre-filled)
- Knife/wire cutters
- Zip ties
- Ziploc® bags

Reagent Blanks sampling supplies:

- Gloves
- Field notebook
- Sample bottles
- Sample labels
- Chain-of-custody (COC) form
- Cooler
- Double bagged ice
- Strapping tape
- Shipping form

Recovery of bags and taking of samples:

- Gloves
- Field notebook
- Sample bottles
- Sample labels
- Ziploc® bags
- Zip ties
- Knife/wire cutters
- 5-gallon bucket with lid (for IDW)
- COC forms
- Coolers
- Double bagged ice
- Strapping tape
- Shipping forms

6.2.7 Low-Flow Purging Procedures

Low-flow purging will be conducted on newly installed monitoring wells that are to be sampled for NA indicator parameters. The USACE-CENWK has adapted a revised Standard Operating Procedure (SOP) for groundwater low-flow purging (USACE-CENWK, 2002). This revised purging method is a low-flow, low-stress method, which should result in the collection of a representative sample from the aquifer. This method can be used with either dedicated or non-dedicated bladder pumps.

The collection of groundwater samples from monitoring wells using this method will be accomplished in four general steps:

1. Determine the sustainable purge flow rate for the well
2. Obtain a stabilized water level in the well
3. Obtain stabilized water quality parameters
4. Collect groundwater samples

Stabilization parameters will be collected with the use of a multiprobe meter and a flow-through cell. This will facilitate the collection of temperature, pH, specific conductance, ORP, and DO data from each monitoring well sampled with a bladder pump. Turbidity will also be measured. Following parameter stabilization, ferrous iron will be determined by use of a Hach colorimeter and alkalinity will be determined using a Hach digital titrator. During purging and sampling of each well, field parameters and water elevations will be recorded every five minutes on the field groundwater sampling report along with the date, time, and other pertinent sampling information. All data will be recorded on both the field groundwater sampling report (Appendix B) and in the field logbook.

The bladder pump intake will be located at the same depth as was the PDB sampler. In those monitoring wells with two PDB samplers, the bladder pump intake will be positioned at the same depth within the screen as the deepest of the two PDB samplers.

Monitoring wells will be purged using the low-flow methodology. Once field parameters stabilize over at least three consecutive readings while a stabilized water elevation is maintained, the final set of field parameters (temperature, pH, specific conductance, DO, ORP, and turbidity) are recorded, samples are collected for field alkalinity and ferrous iron determination, the flow-through cell is disconnected, and samples for the laboratory are collected at a pump rate at or below the rate where water elevation stability was obtained. A final water level after completion of sampling will also be recorded on the log sheet.

6.2.7.1 Procedures for Sustainable Recovery Wells

In these procedures, a “sustainable recovery” well is defined as a well in which stabilized water level can be obtained during pumping at any given constant flow rate at an elevation above the pump intake such that there is sufficient volume for all required samples (including any extra volume required for QA/QC purposes), plus two sampling system volumes. A sampling system volume is the sum of the volume of the pump bladder, the volume of the discharge tubing, and the volume of the flow-through cell. “Excessive drawdown” is defined as drawdown at any given, constant flow rate such that a stabilized

water level cannot be obtained at an elevation above the pump intake such that there is sufficient volume for all required samples, plus two sampling system volumes.

"Standard" Sustainable Recovery Wells

In this procedure, a "standard" sustainable recovery well is defined as a well in which a stabilized water level can be obtained during pumping at any given, constant flow rate at an elevation above the pump intake such that there is sufficient volume for all required samples, plus two sampling system volumes, at a pumping rate equal to or greater than 100 mL/min. The procedures for "standard" sustainable recovery wells are as follows:

1. Obtain well casing and borehole diameters and filter pack percent porosity from well construction records, if available (may be needed for calculations if the well is determined to be a low-recovery well).

2. If using a non-dedicated bladder pump, the following steps apply:
   - Measure the water level from the top of the casing to the nearest 0.01 foot.
   - Determine the depth at which the non-dedicated bladder pump intake should be placed. Measure the length of the pump from intake to the tubing attachment. Measure the length of tubing needed to set the pump at the desired depth within the screened interval.
   - Slowly lower the pump into the well casing to the desired depth in the screened interval, taking care not to encounter the bottom of the well and cause unnecessary agitation of sediment. Affix the pump in this position by securing the tubing at the top of the well casing. Record the depth of the pump intake from the top of the casing.

3. If using a dedicated bladder pump, the following steps apply:
   - Obtain the well depth and the depth of the pump intake from well construction records (if available).
   - Measure the depth to water from the top of the casing to the nearest 0.01 foot.

4. Determine the saturated casing volume and saturated borehole volume (saturated casing volume + saturated filter pack volume) (this may be needed for calculations if the well is determined to be a low-recovery well).

5. Determine the saturated casing volume above the pump intake (this may be needed for calculations if the well is determined to be a low-recovery well).

6. Determine the sampling system volume (volume capacity of pump, tubing, and flow-through cell) (this may be needed for calculations if the well is determined to be a low-recovery well).

7. Determine the volume necessary to collect all required samples, including QA/QC samples (this may be needed for calculations if the well is determined to be a low-recovery well).

8. If the sustainable flow rate is not known for the well, begin purging at 100 mL/min. For wells with historical sustainable flow rate data, use the historical rate.

9. Ensure that no air bubbles are in the pump tubing.

10. Measure and record the water level and an initial set of water quality indicator parameter measurements.

11. Determine the initial purge flow rate from the well.

12. Determine whether the initial purge flow rate causes excessive water level drawdown in the well. Measure and record the water level and water quality indicator parameters at 500 mL or five minute intervals. The water level will be considered stable if water level readings do not decrease over three successive measurements (it is acceptable for the water level to remain unchanged or to increase) and if the volume of water in the casing above the pump intake is equal to or greater than the volume needed for all required samples plus two sampling system volumes.

13. If the initial purge rate of 100 mL/min does not cause excessive drawdown and is an appropriate rate for project analytes and purposes, document that sustainable recovery has been achieved at this rate and go to step #17 below and obtain stabilized indicator parameter readings.

14. If the initial purge rate of 100 mL/min does not cause excessive drawdown and a higher rate is desirable for project-specific reasons, adjust the flow rate and determine whether sustainable recovery can be obtained using the higher flow rate. Record each adjustment made to the pumping rate, the water level, and the indicator parameter readings measured immediately after each adjustment. The water level and water quality parameters should be measured and recorded approximately every five minutes. When sustainable recovery has been documented at the higher flow rate, go to step #17 below and obtain stabilized indicator parameter readings.

15. If the initial purge rate of 100 mL/min causes excessive drawdown and the well is less than 25 to 30 feet deep, the procedure may be repeated with a “mini” bladder pump to determine whether

sustainable recovery can be obtained at flow rates less than 100 mL/min (see "alternate" sustainable recovery well procedures below).

16. If the initial purge rate of 100 mL/min causes excessive drawdown and alternative equipment with flow rates less than 100 mL/min cannot be used, go to the low-recovery procedure (see Section 6.2.7.2).

17. Once a stabilized water level has been obtained, the field indicator parameters will be monitored for stabilization. If the flow rate is equal to or greater than 100 mL/min, measure and record the water quality indicator parameters at five minute intervals. If the flow rate is less than 100 mL/min, measure and record the water quality indicator parameters at time intervals of 500 mL divided by the purge rate. Field indicator parameter measurements will be considered stable when three consecutive measurements within the following ranges are obtained:
    - Turbidity: < 50 Nephelometric Turbidity Units (NTUs)
    - DO: ± 0.1 mg/L for DO values less than 1 mg/L, or ± 10 percent for DO values greater than 1 mg/L
    - Eh (ORP): ± 10 mV
    - Specific Conductance: ± 1 percent of full-scale reading (instrument repeatability) or default ± 20 micro-mhos per centimeter (umhos/cm)
    - pH: ± 0.1 unit
    - Temperature: ± 0.5 ^{o}C

18. Once stabilized field indicator parameter measurements have been obtained, samples may be collected.

19. If the other parameters stabilize, but turbidity readings less than 50 NTU cannot be attained, the BMcD project manager will be contacted. The BMcD project manager will then make a recommendation to the USACE project manager on how to proceed.

<u>"Alternate" Sustainable Recovery Wells</u>

An "alternate" sustainable recovery well is defined as a well in which a stabilized water level can be obtained during pumping at any given, constant flow rate at an elevation above the pump intake such that there is sufficient volume for all required samples, plus two sampling system volumes, at a pumping rate less than 100 mL/min using alternate equipment capable of a lower flow rate (e.g., "mini" bladder pump). The procedures for "alternate" sustainable recovery wells are as follows:

1. If a purge rate of 100 mL/min causes excessive drawdown and the well is less than 25 to 30 feet deep, the standard sustainable recovery procedure may be repeated using a "mini" bladder pump to determine whether sustainable recovery can be obtained at flow rates less than 100 mL/min.

2. If stabilized water level can be obtained at a pumping rate less than 100 mL/min using alternative equipment, go to step #17 above and obtain stabilized indicator parameter readings. Note for flow rates of less than 100 mL/min, parameter measurement interval is determined by 500 mL divided by the purge rate.

6.2.7.2 "Low-Recovery" Wells

A "low-recovery" well is defined as a well in which a stabilized water level cannot be obtained at an elevation above the pump intake such that there is sufficient volume for all required samples, plus two sampling system volumes, regardless of pumping rate or equipment type. If a purge rate of 100 mL/min causes excessive drawdown and/or alternate equipment with flow rates less than 100 mL/min cannot be used, then the following procedure will be used:

1. The following information will be needed:
   - Obtain well casing and borehole diameters and filter pack percent porosity from well construction records.
   - Determine saturated casing volume and saturated borehole volume (casing volume + saturated filter pack volume)
   - Determine the saturated casing volume above the pump intake
   - Determine the sampling system volume (volume capacity of pump, tubing and flow-through cell)
   - Determine the volume necessary to collect all required samples, including QA/QC samples

2. Determine whether the saturated casing volume above the pump intake is sufficient for at least two sampling system volumes plus required samples.

3. If the casing volume above the pump intake is sufficient for at least two sampling system volumes plus required samples, purge slowly at a constant flow rate; measure and record water level and field indicator parameters every 500 mL until two (or available) system volumes have been removed; collect samples; and document conditions and procedures. Note that the water level will not be stable (i.e., drawdown will occur) and indicator parameters may not be stable.

4. If the casing volume above the pump intake is not sufficient for at least two sampling system volumes plus required samples, but is sufficient for at least one sampling system volumes plus required samples, purge slowly at a constant flow rate; measure and record water level and field indicator parameters every 500 mL until one (or available) system volumes have been removed; collect samples; and document conditions and procedures. Note that the water level will not be stable (i.e., drawdown will occur) and indicator parameters may not be stable.

5. If the casing volume above the pump intake is sufficient for all required samples only, determine whether it is acceptable to collect samples without purging. If this is acceptable for project purposes, collect samples at a constant flow rate without purging, and document conditions and procedures.

6. If the casing volume above the pump intake is not sufficient for all required samples, then the BMcD project manager will be contacted to determine whether samples can be prioritized and it is acceptable to collect priority samples without purging. If this is acceptable for project purposes, collect the priority samples at a constant flow rate without purging, and document conditions and procedures.

7. If the casing volume above the pump intake is not sufficient for all required samples, samples can not be prioritized, and/or it is not acceptable for project purposes to collect samples without purging, do not sample, document conditions, and contact the BMcD project manager.

6.2.7.3 Required Instruments

The following instruments will be used to collect field parameters when conducting low-flow purging and sampling:

- YSI 556 MPS with flow-through cell (DO, ORP, pH, conductivity, and temperature)
- Hach 2100P Portable Turbidity Meter (turbidity)
- Ferrous Iron Colorimeter
- Alkalinity Titrator

6.2.7.4 Instrument Calibration Procedures

The YSI 556MPS will be calibrated at the beginning of each day using calibration solutions provided by the meter's manufacturer. In addition, ORP will be checked for accuracy using standard redox solution (200-275 mV at 25 ^{o}C). Calibration checks will be performed at midday and at the end of the day,

recalibrating as necessary during the midday check. Calibration checks and recalibration will also be performed any time the readings appear to be abnormal.

The DO will be checked before and after sampling each well. An accuracy check will be performed on the ferrous iron colorimeter once per day. The manual will be consulted if the reading is not within ±0.25 mg/L of the standard solution.

The Hach 2100P turbidity meter will be checked against a set of standards. This instrument is factory calibrated and the calibration cannot be adjusted in the field. In the event the instrument fails to conform, the BMcD project manager will be contacted for guidance.

All calibrations and calibration checks will be recorded in the field logbook and on the Daily Calibration Log (Appendix B). Extreme cold or hot weather is known to affect meters. In these instances, calibration of the meter will be checked more frequently. Equipment technical manuals will be available in the field for all field measurement instruments. Field personnel should consult the manual for additional technical details.

In the event any instrument fails to conform to required calibration checks, and if the field team cannot solve the problem, the BMcD project manager will be contacted for guidance.

6.2.7.5 Equipment Decontamination Procedures

All sampling and investigation equipment will be decontaminated prior to beginning investigation activities, between borings, between locations, and upon completion of investigation activities in accordance with the procedures in Section 6.8.

6.2.7.6 QC

QC samples will be collected according to the requirements in Section 6.11.

6.2.8 Groundwater Screening Using Direct Push

Prior to any field work involving intrusive subsurface activities, utility clearance will be required as discussed in Section 6.11. At selected direct-push borehole locations, groundwater samples will be collected and screened for VOCs using a portable on-site GC. Groundwater screening will be used to determine the presence and extent (if present) of VOC contamination at SAFB. If results so indicate, additional groundwater screening samples will be proposed to the USACE Project Manager to adequately define a contaminant plume prior to the placement of monitoring wells.

To obtain groundwater samples, a groundwater sampling tool with a drop screen with an expendable point is attached to the lead direct-push rod and driven to the top of bedrock. The groundwater sampling tool is then opened, allowing groundwater to enter the sampling tool. Tubing is inserted into the rods, and a groundwater sample is withdrawn. One groundwater sample will be collected from the borehole for every 15 (or 10) feet of saturated thickness of the aquifer and analyzed on the former SAFB site for selected VOCs. The number of samples collected will be determined by dividing the thickness of the saturated aquifer by 15 (or 10) and rounding appropriately (i.e. for a borehole with 34 feet of saturated thickness, two samples will be collected; for a borehole with 40 feet of saturated thickness, three samples will be collected). The deepest groundwater sample will be collected from near the top of bedrock. Once all groundwater samples have been collected, the groundwater sampling tool and rods are then withdrawn from the ground.

6.2.8.1 Equipment

Equipment needed to collect and analyze groundwater screening samples:

- Direct-push rig
- A truck or van fully-equipped with GC capabilities for groundwater screening (GC may be on the former SAFB site in a trailer or equivalent)
- Sample containers
- Applicable decontamination equipment (refer to Section 6.8.1)
- Applicable safety equipment (refer to the APP)

6.2.8.2 Groundwater Field Measurement Procedures and QC Criteria

Groundwater screening samples collected for on-site analysis will be analyzed using a field GC equipped with an electron capture detector (ECD).

At the beginning of the field effort, an initial calibration of the GC will be performed using standards of known concentrations. A minimum of three concentrations will be used to establish the calibration curve (response) for each target analyte. Continuing calibrations will be performed prior to resuming daily analytical testing and approximately every four hours thereafter to verify the on-going validity of using the initial calibration curve. The guidelines for analysis notebook documentation for screening samples is presented in the QAPP.

QA/QC groundwater screening samples will be collected to assess the accuracy and precision of the sample data generated. Duplicate samples and method blanks will be analyzed on the former SAFB site

on 10 percent of the groundwater screening samples collected. Duplicate samples will be used to assess the field GC's analytical precision and the field samplers' technique.

To help ensure the validity of on-site analyses, confirmation samples will be selected from groundwater samples to be analyzed by AML, a laboratory approved by the USACE and certified by the State of Kansas. A minimum of 10 percent of the sample locations and at least one sample per day will be selected for laboratory analysis. The confirmation samples for analysis will be selected after receipt of the field screening data by the FSM. An effort will be made to select a representative subset of samples with regard to location, depth, concentration, etc. Confirmation samples will be selected to be representative of the range of detections/non-detections encountered. Confirmation samples will be analyzed from both the most contaminated media encountered and low-level or non-detect media with a representation of the range in between. QA samples (split samples of confirmation samples) will be submitted to the Chemical QA Branch Lab for analysis at a rate of 10 percent of the confirmation samples analyzed. All off-site laboratory QC requirements described in the QAPP will apply to these off-site samples.

6.2.8.3 Documentation

The location, depth, and time of collection for each groundwater screening sample will be documented in the field logbook or the boring log. Unique sample numbers will be assigned to each groundwater screening sample collected.

A sample log also will be maintained by the GC operator to document the analytical conditions under which the samples were analyzed. Entries for each day's activities in the sample log will be signed by the GC operator. Any anomalies from the SAP will be noted in the logbook.

6.2.8.4 Groundwater Sampling Procedures

At selected direct-push borehole locations, groundwater samples will be collected and screened for VOCs using a portable on-site GC. One groundwater sample will be collected from the borehole for every 15 (or 10) feet of saturated thickness of the aquifer and analyzed on the former SAFB site for selected VOCs. The number of samples collected will be determined by dividing the thickness of the saturated aquifer by 15 (or 10) and rounding appropriately (i.e. for a borehole with 34 feet of saturated thickness, two samples will be collected; for a borehole with 40 feet of saturated thickness, three samples will be collected). The deepest groundwater sample will be collected at the bedrock interface. The samples will be collected according to the following procedure:

1. Attach a groundwater sampling tool (drop screen with an expendable point) to the lead direct-push rod.

2. Drive the screen to the top of bedrock. If refusal is met at an unexpected depth, abandon the borehole, offset 10 feet from the original borehole and re-drive the screen. Retract the rods four feet to allow the screen to drop out of the rods.

3. Wait several minutes for the groundwater to enter the rods through the screen.

4. Place a decontaminated stainless steel check valve in the end of new disposable 1/4-inch tubing and insert into the rods.

5. Raise and lower the tubing using an up and down motion at the surface to fill the tubing with groundwater for the first interval and containerize.

6. Retract tubing, remove the check valve assembly, and decant groundwater from the bottom portion of the tubing into 40-mL vial for on-site analysis by GC.

7. Dispose of tube in accordance with the procedures in Section 9.0.

8. Pull up the rods and screen to the desired depth of the next sample interval.

9. Attach the check valve assembly to a new set of tubing and insert the tubing into the rods.

10. Raise and lower the tubing using an up and down motion at the surface to fill the tubing with groundwater. Purge two liters of groundwater and containerize.

11. Repeat steps 4 through 10 until all desired sampled have been collected. For each additional sample interval, one additional liter of groundwater will be purged.

12. Abandon the borehole by backfilling with granular bentonite.

If groundwater does not enter the rods within a reasonable amount of time, a temporary piezometer may be installed. Within 24 hours the temporary piezometer will be checked for groundwater and, if sufficient groundwater is available, sampled. The temporary piezometer will then be pulled and the borehole abandoned.

If DNAPL is encountered during the collection of groundwater samples, a sample of the DNAPL will be collected. No further groundwater samples will be collected from that borehole from above depth of the

DNAPL and the borehole will be abandoned. Any samples not collected from above the depth of the DNAPL will be obtained by offsetting approximately five feet from the original borehole and driving to the needed sample depth.

6.2.8.5 Decontamination

Decontamination of direct-push equipment will be conducted in accordance with the procedures in Section 6.8. Waste generated during the decontamination procedures will be managed in accordance with the procedures discussed in Section 9.0.

6.2.9 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 or BMcD will be contacted immediately and then the USACE Project Manager. New equipment will be ordered immediately for next-day delivery. Of the field parameters measured, the DO meter is historically the most likely to malfunction. If the DO meter is not working properly, subsequent wells will be purged and sampled at or below historical purge rates until 125 percent of the maximum volume purged during the previous three sampling events is removed. All other stabilization parameters must also meet stabilization criteria prior to commencing sampling.

Any other equipment malfunctions will be brought to the attention of the USACE 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 and on the DQCR.

6.2.10 Sample Containers and Preservation Techniques

Table 5-1 summarizes sample container types, sample volumes/weights, preservation techniques, and sample holding times for the analytical methods. Sample holding time begins with the collection of samples and continues through extraction and analysis. Sample containers will be pre-cleaned and treated according to specifications for the analytical methods. In addition, pre-preserved sample containers will be used for analytical methods requiring preservation. Samples not preserved or analyzed in accordance with these requirements may require resampling and reanalysis.

6.2.11 Field QA/QC Sampling Procedures

Details regarding QA/QC sample collection are presented in Section 6.10.

6.2.12 Decontamination Procedures

Decontamination of groundwater sampling equipment will be conducted in accordance with the procedures in Section 6.8. Waste generated during the decontamination procedures will be managed in accordance with the procedures detailed in Section 9.0.

6.2.13 Well Identification Procedures

Monitoring wells will be sequentially identified, preceded by the designation "99M" for consistency with the previous investigations. New monitoring wells to be installed during the field activities associated with this RI Addendum/FS will begin with "41"; therefore the next monitoring well to be installed at SAFB will be identified as "99M41". Nested wells (well clusters) will have the same number, but will also have a sequential alpha code (i.e., a, b, c), designating the respective water-bearing zone (shallow, intermediate, or deep).

6.3 SUBSURFACE SOIL

6.3.1 Soil Sampling Requirements

Subsurface soil samples using the direct-push method will be collected on discrete 2- or 4-foot intervals. Three discrete intervals may be sampled – 0.5- to 2-feet bgs interval, 2- to 10-feet bgs interval, or 10-feet bgs to the top of groundwater. Where samples are collected for VOC analysis, the portion of the sampled interval with the most elevated PID reading will be discretely collected for VOCs. Then a sample from the same area in the interval of the soil core will be homogenized and a sample collected for the remaining parameters, such as SVOCs and RCRA metals, as appropriate according to the requirements for the specific area being investigated. Samples will be immediately transferred to the appropriate sample container and placed on ice. At selected locations soil will be continuously sampled to the top of bedrock for logging and screening purposes.

6.3.2 Utility Clearance

Prior to any field work involving intrusive subsurface activities, utility clearance will be required as discussed in Section 6.11.

6.3.3 Soil Sample Collection – Direct-Push Sampling

Shallow soil exploration will be conducted using truck or van-mounted direct-push sampling equipment (e.g., Geoprobe®). Subsurface soil samples for chemical analyses will be collected using either a large-bore or Macro-Core® sampler. Direct-push sampling utilizes a hydraulically-powered percussion/probing machine to advance probe rods containing acetate liners into the unconsolidated subsurface material.

6.3.3.1 Equipment

The following equipment may be needed during direct-push sampling:

- Sample containers
- Easy-Draw™ Syringes
- Sudan IV® dye test
- Camera and color film
- Munsell Soil Color Chart
- Munsell Rock Color Chart
- Soil boring logs and data forms
- 6-foot ruler
- Field logbook
- Hand sprayer or wash bottle
- Garbage bags
- Hand lens
- Caution tape
- Spray paint and flagging tape
- Lath
- Aluminum foil
- Utility knife
- Stainless steel compositing bowl
- Stainless sampling knife and spoon
- A truck or van fully-equipped for direct-push sampling
- Applicable decontamination equipment (refer to Section 6.8.1)
- Applicable safety equipment (refer to the APP)

6.3.3.2 Soil Sample Collection Procedures for Off-Site Analysis

Prior to direct-push subsurface soil sampling activities, the depth to groundwater will be determined. Analytical samples may be collected from the 0.5 to 2 feet bgs, 2 to 10 feet bgs, and 10 feet bgs to the top of groundwater intervals using the large-bore (1-3/8 inch outside diameter [OD]) or Macro-Core® samplers (2-inch OD) with acetate liners. If the water table is encountered, soil sampling will be discontinued. No soil samples will be collected below the water table. The liner will be split using a decontaminated utility knife (or equivalent) or the sample will be extruded from the sleeve and placed on clean plastic. PID readings will be obtained from the length of the sample. Samples (and any associated

QA/QC samples) for VOC analyses will be collected first from the interval displaying the highest PID reading or exhibiting visual signs of contamination as follows:

A field team member, wearing clean, disposable, gloves will remove the Easy-Draw™ Syringe from the package container and adjust the sampler for the five gram position. The syringe will then be adjusted for use in either dense clay, sandy soil, or for all other soil types. The syringe will then be pushed into the sample interval that had the highest PID reading until the soil column inside the syringe has forced the plunger to the stopping point. The syringe will then be pulled from the sample interval and all soil debris outside and extending beyond the mouth of the sampler will be removed. The syringe will then be removed from the handle and will be inserted into an open 40-mL vial that contains 10 mLs of reagent - grade water. The vial will then be capped immediately and placed in a cooler containing ice. There will be three vials collected for each sample interval. In the event no contamination or elevated PID readings are detected, the sample will be collected midway along the sampling interval.

For all other analyses, the sample will be homogenized to create a representative sample volume. Homogenization will be accomplished by filling a decontaminated stainless steel bowl with the remainder of the sample interval (or a representative portion thereof). The sample volume used should be sufficient to fill all required sample containers (see Table 5-1), including those for any associated QA/QC. The sample will be thoroughly and completely mixed with a stainless steel spoon. Adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material over. The soil will then be transferred into the appropriate sample containers. The sample will be immediately on ice in a cooler. If an insufficient volume of soil is collected during sampling, the borehole will be offset and another sampler will be driven to the same subsurface soil sampling interval.

6.3.3.3 Soil Sample Collection Procedures for OilScreenSoil™ Dye Test

The OilScreenSoil™ field screening test is a qualitative test that screens for the presence of petroleum hydrocarbons and chlorinated solvents in soil. The OilScreenSoil™ test kit utilizes Sudan IV dye which changes color in the presence of petroleum hydrocarbon or chlorinated solvents. The following procedure will be used to conduct the Sudan IV dye field tests:

1. Collect one soil sample for every 15 feet of soil above the water table according to procedure in Section 6.3. Soil samples will be collected from the portion of each interval with the highest PID reading.

2. Transfer soil from the sample container into the Oil ScreenSoil™ test jar and fill to the “soil” fill line, while wearing clean disposable gloves.

3. Fill the Oil ScreenSoil™ test jar with potable water to the "water" fill line.

4. Replace the lid on the Oil ScreenSoil™ test jar and shake for a minimum of 60 seconds.

5. Evaluate the results as described below.

The Sudan IV dye stains all hydrocarbons red. If no red is immediately visible in the jar, the presence of any pink coloration on the expanded polystyrene bead included in the kit that floats on top of the water indicates the presence of petroleum hydrocarbons at low concentrations (500 to 1,500 parts per million [ppm] total petroleum hydrocarbon [TPH]). A red ring or spots at the surface of the water or on the sides of the container indicate free product petroleum at higher concentrations (around 2,500 ppm TPH). DNAPLs may be detected by the presence of red spots clinging to the sides of the jar or as a red ring at the bottom of the jar. The coloration in the kit increases with higher levels of TPH.

6.3.4 Boring Logs

For each borehole, a geologic log will be prepared in the field by a BMcD geologist using USACE Forms MRK55 and MRK55-2, as described in the MWIP (Appendix A).

6.3.5 Soil Sampling for Physical/Geotechnical Analyses

Soil samples collected from boreholes may be retained for selected physical analyses that can be performed on disturbed soil samples. Disturbed and undisturbed soil samples collected for physical/geotechnical analysis will be collected as discussed in the MWIP (Appendix A).

6.3.6 Soil Sampling for Chemical Analyses

Soil samples will be collected for chemical analysis following the procedure outlined in Sections 6.3.3. For a push sampler, cut the liner longitudinally from the top to the bottom of the liner, or extrude the sample onto clean plastic.

6.3.7 Sample Containers and Preservation Techniques

Table 5-1 summarizes sample containers, preservation techniques, and sample holding times for the analytical methods.

6.3.8 Field QC Sampling Procedures

Details concerning QA/QC sample collection is provided in Section 6.10.

6.3.9 Borehole Abandonment

Borehole abandonment will be conducted in accordance with Kansas Administrative Regulations (KAR) 28, Title 30-7 as described in the MWIP (Appendix A).

6.3.10 Decontamination Procedures

Decontamination of subsurface soil sampling equipment will be conducted in accordance with the procedures in Section 6.8. Waste generated during the decontamination procedures will be managed in accordance with the procedures discussed in Section 9.0.

6.4 SURFACE SOIL

6.4.1 Surface Soil Sampling Equipment

Typical surface soil sampling equipment may include the following:

- Stainless steel scoop, trowel, or shovel
- Stainless steel push sampler
- Indelible marking pen
- Stainless steel compositing bowl and spoon
- Sample containers
- Munsell Soil Color Chart
- Garbage bags
- Field logbook
- Applicable decontamination equipment (refer to Section 6.8.1)
- Applicable safety equipment (refer to the APP)

6.4.2 Sampling Methods for Surface Soil

6.4.2.1 Methods to Collect Discrete Surface Soil Samples

The following procedure will be used to collect discrete surface soil samples (samples from a single location):

1. Remove all surface vegetation or non-soil material with a trowel or shovel over an area with a diameter of approximately 6 inches.

2. Using a stainless steel sampling knife, sampler, or by hand wearing a clean, disposable glove, collect soil from 0 to 6 inches bgs. Transfer the soil to a stainless steel sample bowl.

3. Wearing clean, disposable gloves, remove sticks, rocks, and other debris from the soil in the sampling bowl.

4. Homogenize the sample by mixing the soil in the sample bowl with a stainless steel spoon, or by hand, wearing clean gloves (no VOCs samples are planned). Thoroughly and completely mix the sample by stirring the soil material in a circular fashion and occasionally turning the material over.

5. Fill the sample containers with the homogenized soil, label, and place immediately in a cooler on ice.

6. Describe the sample in the field logbook.

7. Fill the hole with stockpiled soil. If not enough soil remains after sampling, the hole will be filled with potting soil or equivalent.

8. Decontaminate sampling equipment between each sample location.

6.4.3 Field Measurement Procedures and Criteria

No field measurements of surface soils are planned.

6.4.4 Sampling for Physical/Geotechnical Analyses

No physical/geotechnical analyses are planned for surface soil.

6.4.5 Sampling for Chemical Analyses

All surface soil samples, except those collected for VOC analysis, will be homogenized as described above and transferred into the appropriate sample containers.

6.4.6 Sample Containers and Preservation Techniques

Table 5-1 summarizes sample containers, preservation techniques, and sample holding times for the analytical methods.

6.4.7 Field QC Sampling Procedures

Details concerning QA/QC sample collection are provided in Section 6.10.

6.4.8 Decontamination Procedures

Decontamination of surface soil sampling equipment will be conducted in accordance with the procedures in Section 6.8. Waste generated during the decontamination procedures will be managed in accordance with the procedures discussed in Section 9.0.

6.5 SEDIMENT

6.5.1 Sediment Sampling Equipment

The following equipment may be needed for dry or wet sediment sampling:

- Stainless steel trowel or shovel
- Stainless steel push sampler (dry)
- Teflon ladle or other sediment sampling device (wet)
- Stainless steel compositing bowl and spoon
- Sample containers
- Munsell Soil Color Chart
- Field logbook
- Garbage bags
- Waders, if necessary (wet)
- Applicable decontamination equipment (refer to Section 6.8.1)
- Applicable safety equipment (refer to the APP)

6.5.2 Methods for Collecting Discrete Dry Sediment Samples

Discrete dry sediment samples will be collected from dry surface water drainage channels in the same manner as discrete surface soil samples (Section 6.4.2.1). Equipment will be decontaminated between each discrete sampling location.

6.5.3 Sampling Methods for Underwater (Wet) Sediments from On-Site and Off-Site Drainage Channels

Sampling will be conducted from downstream locations to upstream locations, where applicable, to avoid effects of soil and water disturbance related to the sampling. Surface water samples will be collected prior to sediment samples if both are to be collected in the same water body. The following procedure will be used to collect sediment samples under water:

1. Submerge a pre-cleaned teflon ladle or other sediment sampling device with minimal disturbance to the sediment surface.

2. Scrape sediment into the ladle using a slow scooping motion.

3. Retrieve the ladle, minimizing disturbance to the bottom sediments.

4. For VOC samples, place sediment immediately in sample containers. Place immediately on ice.

5. Place the remaining sediment in a clean, stainless steel bowl.

6. Repeat Steps 1 through 5 until a sufficient amount of sediment has been collected.

7. Decant excess water from the bowl into the water body. Remove sticks, rocks, and other debris while wearing clean, disposable gloves.

8. To create a representative sample for the other analytical parameters, the remaining sample will be homogenized by mixing the contents of the sample bowl with a stainless steel spoon, or by hand, wearing clean gloves. Thoroughly and completely mix the sample by stirring the soil material in a circular fashion and occasionally turning the material over.

9. Transfer the sediment to the appropriate sample containers using a decontaminated, stainless steel, sampling knife.

10. Document the characteristics of the sediment in the field logbook.

Decontaminate non-disposable sampling equipment between each sample location.

6.5.4 Sampling for Chemical Analyses

All sediment samples will be homogenized as described above, except for samples for VOCs which will not be homogenized) and transferred into the appropriate sample containers.

6.5.5 Sample Containers and Preservation Techniques

Table 5-1 summarizes sample containers, preservation techniques, and sample holding times for the analytical methods.

6.5.6 Field QC Sampling Procedures

Details concerning QA/QC sample collection is provided in Section 6.10.

6.5.7 Decontamination Procedures

Decontamination of sediment sampling equipment will be conducted in accordance with the procedures in Section 6.8. Waste generated during the decontamination procedures will be managed in accordance with the procedures discussed in Section 9.0.

6.6 SURFACE WATER

6.6.1 Surface Water Sampling Equipment

The following equipment will be needed for surface water sampling:

- Sample containers
- Nitrile gloves
- Waders, if necessary
- Field logbook
- Garbage bags
- Applicable decontamination equipment (refer to Section 6.8.1)
- Applicable safety equipment (refer to the APP)

6.6.2 Sampling Methods for Surface Water - General

Prior to sample collection, characteristics of the surface water body (size, depth, flow direction) will be recorded in the field logbook. Sampling will be conducted from downstream locations to upstream locations, where applicable, to avoid effects of sediment and water disturbance related to the sampling. Surface water samples will be collected prior to sediment samples if both are to be collected in the same water body.

Whenever possible, sample containers will be filled directly, and an intermediate container will not be utilized.

Unfiltered surface water samples will be collected according to the following procedure:

1. Collect those samples last which have prepreserved containers. Submerge the sample container in the water with the cap in place, taking care to minimize surface disturbance.

2. With the open end of the bottle pointed in the upstream direction, 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 water sample from within approximately 1 foot of the water surface. Replace the cap after the container is filled, prior to returning the container to the water surface.

3. Retrieve the sample container from the surface water with minimal disturbance.

4. Preserve the sample as necessary and immediately place the sample in a cooler on ice.

6.6.3 Field Measurement Procedures and Criteria

Field measurements of temperature, pH, and specific conductance will be collected from the surface water body at each surface water sample location. No QA/QC measurements are required. The procedure will be the same as specified in Section 6.2.3 except that the probes will be placed directly in the water.

6.6.4 Sample Containers and Preservation Techniques

Table 5-1 summarizes sample containers, preservation techniques, and sample holding times for the analytical methods.

6.6.5 Field QC Sampling Procedures

Details concerning QA/QC sample collection are provided in Section 6.10.

6.6.6 Decontamination Procedures

Typically, in surface water sample collection there are no non-disposable or non-dedicated tools which contact the sample. However, in the instance that there is a need to decontaminate equipment, the procedures described in Section 6.9 will be used.

6.7 STREAM GAUGING PROCEDURES

Stream gauges will be installed on Dry Creek, Centennial Ditch, and Tony's Road Ditch in order to collect discharge data to support the development of the groundwater model. Locations are presented on Figure 5-6. These stream gauges will continuously collect a digital record of discharge for a period of at least one year.

V-notch weirs will be installed to measure the surface discharge at the four selected locations. These weirs will restrict the size of the stream channel, creating an impoundment upstream of the weir, permitting the measurement of the flow rate through the structure, which is a function of depth of flow through the weir. A data logger will be used to provide a continuous record of the depth of flow through the weir.

In its simplest form, a weir consists of a bulkhead of timber, metal, or concrete with an opening of fixed dimensions cut in its top edge. The opening is called the weir notch; its bottom edge is the weir crest; and

the depth of flow over the crest (measured at a specified distance upstream from the bulkhead) is the head (H). The overflowing sheet of water is called the nappe.

The V-notch (90 degree) weirs will be constructed and installed as follows:

1. Construct the V-notch weir using 1/2-inch or thicker plywood. Cut a 90-degree notch on the top of the plywood, which has its width across the top of the plywood equal to twice its depth. Cut a lip in the plywood notch between 1 and 2 millimeters (mm) wide, with the downstream face of the plywood angling 60 degrees away from the lip.

2. Place the plywood with the notch on top into the stream/drainage channel. The weir should be set at a right angle to the direction of flow in a reach of channel that is straight for a distance upstream from the weir at least ten times the length of the weir crest. Use a level to ensure the weir is upright.

3. The apex of the v-notch weir should be set at a height above the stream bed that will ensure an adequate fall on the downstream side. Avoid restrictions in the channel below the weir that would cause submergence. The crest must be placed higher than the maximum downstream water surface to allow air to enter below the nappe.

4. Seal the edges and underneath side of the plywood with clay by pushing the clay in the desired areas to prevent water from leading around the edges or underneath side. If necessary, install sand bags on both sides an along the bottom of the plywood to secure it in place.

5. Install a data logger to measure the H at a location which is at a distance upstream of the weir of at least 4H.

6. The H data can be converted to discharge using the Thompson Equation:

$$Q = 2.4381H^{5/2}$$

Q = discharge (cubic feet/second) and H = head (feet)

7. The logger data will be down-loaded periodically (at least monthly) to ensure no loss of collected data.

8. The data logger and weir will be inspected periodically for wear and/or damage and will be replaced/repaired as necessary.

6.8 DECONTAMINATION PROCEDURES

All sampling and investigation equipment will be decontaminated prior to beginning investigation activities, between borings, between locations, and upon completion of investigation activities.

6.8.1 Equipment

Typical decontamination equipment includes the following items:

- Deionized water
- Non-chlorinated potable water
- Isopropanol, pesticide-grade
- Wash bottles
- Buckets
- Scrub brushes
- Non-phosphate laboratory-grade detergent
- Plastic sheeting
- Garbage bags

6.8.2 Decontamination of Non-Dedicated Bladder Pumps

Sampling equipment will be decontaminated according to the following procedure:

1. Leave or attach approximately 4 feet of air supply and water discharge tubing to the pump. Place the pump inside a 5-foot section of 2-inch inside diameter (ID) PVC pipe that has one end capped.

2. Attach the air supply tube to the controller, which is attached to the compressed air source, and direct the discharge tube back into the pipe to recirculate the wash water. Fill the PVC pipe with deionized water, adding approximately one-half teaspoon of non-phosphate, laboratory-grade detergent (e.g. Liquinox®).

3. Turn on the pump and circulate the wash water for approximately one minute.

4. Direct the discharge into a bucket and pump all detergent water from the PVC pipe.

5. Pump 3 to 5 liters of deionized water through the pump, adding water to the pipe as needed, to rinse the detergent from the pump.

6. Retain decontamination fluids for disposal as described in Section 9.0.

6.8.3 Decontamination of Other Sample-Contacting Equipment

Non-disposable and other non-dedicated equipment which contact the sample will be decontaminated prior to the collection of each sample. This equipment includes, but is not limited to, sampling knives and spoons, split-sampling barrels, direct-push shoes and subs, and containers.

Sampling equipment will be decontaminated according to the following procedure:

1. Fill a nonmetallic wash tub or bucket to a depth of about 6 inches with deionized water. Mix a detergent solution in the tub. The solution shall consist of approximately 1 tablespoon of non-phosphate laboratory-grade detergent (e.g. Liquinox®) per gallon of water.
2. Scrub all sampling equipment with a stiff-bristled brush and detergent solution.
3. Transfer the equipment to another wash tub partially filled with deionized water and rinse.
4. Rinse the sampling equipment with fresh deionized water.
5. If sampling for organics, rinse the equipment with pesticide-grade isopropanol and perform a final rinse of deionized water.
6. Place the equipment on clean plastic and allow it to air dry.
7. Store the equipment covered with plastic or aluminum foil upon the completion of decontamination.
8. Retain decontamination fluids for disposal as described in Section 9.0.

6.8.4 Decontamination of Non-Sample-Contacting Equipment

Down-hole sampling tools such as drill string, augers, and direct-push rods, as well as drill rigs and direct-push trucks/vans, will be decontaminated between each borehole according to the following procedure:

1. Construct a three-sided decontamination pad using planks as a frame and plastic sheeting as the bottom. The pad should be constructed on a slight slope with the open side facing uphill.
2. Back the drill rig or direct-push rig into the decontamination pad or place equipment in a rack off the ground inside the pad.

3. Use hot, pressurized, non-chlorinated water to completely remove all visible soil and contamination from all surfaces. Include the inside of all drill string, augers, and direct-push rods. If necessary, use a stiff-bristled brush to remove soil and contamination.

4. Place the equipment on clean plastic and allow to air dry.

5. Store equipment and cover with plastic after decontamination.

6. Retain all decontamination fluids for disposal as described in Section 9.0.

6.9 BACKGROUND SAMPLE COLLECTION

Background at SAFB has been adequately defined, so no further background samples are planned.

6.10 FIELD QA/QC SAMPLE COLLECTION

Field duplicates, confirmation samples, and QA samples will be analyzed on a 10 percent frequency basis. MS/MSD samples will be analyzed on at least a 5 percent frequency to ensure that one MS/MSD sample will be included in each analytical batch. ERBs will be analyzed on a 5 percent frequency basis, as necessary, for non-dedicated sampling equipment. Trip blanks will accompany each cooler containing aqueous samples for VOC analysis. All coolers containing MEE samples will contain a separate trip blank which will be analyzed for these three compounds. Temperature blanks will accompany each cooler shipped to the laboratory. QC data will be used to determine the accuracy and precision of the on-site and/or off-site laboratory. Field screening data will not require all of the same QC samples as fixed laboratory data. Field duplicates will be collected on a 10 percent frequency basis for field screening data. QA/QC samples may be collected more frequently to ensure that the required percentages will be analyzed.

Field Duplicate Samples

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. Field duplicate water sample containers will be filled immediately following the filling of the original sample containers. Field duplicate soil samples will be collected from the same section or area as the original sample. Each field duplicate sample for VOC analysis will consist of parallel portions of the soil sample. The remaining sample will be homogenized as described in the appropriate sampling procedures section 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 will be

sent to the primary laboratory (AML) or on-site laboratory (groundwater only), as applicable, and analyzed for the same analytical parameters. All field samples will be identified with unique sample identification numbers as described in Section 7.4.1. Sample locations where field duplicate samples are collected will be documented in the field logbook.

Confirmation Samples

To help ensure the validity of on-site analyses, confirmation samples will be selected from groundwater samples to be analyzed by AML, a laboratory approved by the USACE and certified by the State of Kansas. A minimum of 10 percent of the sample locations and at least one sample per day will be selected for laboratory analysis. The confirmation samples for analysis will be selected after receipt of the field screening data by the FSM. An effort will be made to select a representative subset of samples with regard to location, depth, concentration, etc. Confirmation samples will be selected to be representative of the range of detections/non-detections encountered. Confirmation samples will be analyzed from both the most contaminated media encountered and low-level or non-detect media with a representation of the range in between. QA samples (split samples of confirmation samples) will be submitted to the Chemical QA Branch Lab for analysis at a rate of 10 percent of the confirmation samples analyzed. All off-site laboratory QC requirements described in the QAPP will apply to these off-site samples.

QA Samples for Chemical QA Branch Lab

QA samples may be collected from the same location and in the same manner as field duplicate samples at a rate of 10 percent. QA samples will be placed in identical containers and preserved in the same manner as field duplicate samples. QA samples will be identified with unique sample identification numbers as described in Section 7.4.1.3. Sample locations where QA samples are collected will be documented in the field logbook. QA samples will be sent to USACE's Chemical QA Branch Lab for analysis.

MS/MSDs (Spike Samples)

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 VOCs 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 7.4.1.3. 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 analyzed 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, information is obtained on analytical precision.

CENWK projects generally require a site-specific MS/MSD 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 at a frequency greater than 5 percent. The analytical laboratory should be consulted regarding their MS/MSD batching needs when requesting sample analysis for short holding time methods.

ERBs

ERBs will be prepared for non-dedicated sampling equipment used to collect samples for chemical analyses to evaluate potential cross-contamination between samples caused by residual contamination on the sampling equipment. To prepare an ERB on a bladder pump, the decontaminated bladder pump will be internally rinsed with deionized water by pumping the water through the pump. The batch number of the water used to prepare the ERB will be noted in the field logbook. The ERB will be placed directly into the containers specified for unfiltered groundwater samples and will be analyzed for the same parameters as the primary sample. The USACE Project Manager may elect to send splits of ERBs to USACE's Chemical QA Branch Lab.

Trip Blanks

Trip blanks for VOCs in aqueous samples will be prepared by the laboratory and will accompany sample containers transported to SAFB. The trip blanks will remain at SAFB during sampling activities. One trip blank set will be included in each cooler shipped to the laboratory that contains aqueous samples for VOC analysis. All coolers containing MEE samples will contain a separate trip blank which will be analyzed for these three compounds. The results from these analyses will be used to determine whether VOCs were introduced into aqueous samples as a result of site conditions, conditions during sample shipment, and/or laboratory operations.

Temperature Blanks

Temperature blanks will consist of small containers filled with water. A temperature blank will be included in each cooler. 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., $\pm 4^{o}C$) were met.

6.11 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 Kansas One-Call, a utility location service, and individual property owners. A 48-hour notification is required for Kansas One-Call prior to commencing intrusive activities. Upon arrival at the former SAFB site, the FSM will obtain site utility maps from individual property owners. A hand-held magnetometer or utility probe will be utilized in the field prior to any intrusive subsurface activities to verify that the specified locations are clear of utility lines.

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 APP. 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 approved by the USACE and BMcD Project Managers. The Field Safety Checklist, Intrusive Activities, provided in the APP, will be completed for each area being investigated.

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 USACE Project Manager within 24 hours; however approval prior to executing the work need not be obtained.

6.12 SURVEYING

For all of the following field activities, a RLS will survey pertinent site locations to allow the locations to be properly placed on site figures using geographical information systems (GIS):

- Surface Soil Sampling
- Sediment and Surface Water Sampling
- Geophysical Surveying (EC Survey)
- Subsurface Soil Sampling
- Installation of Monitoring Wells and/or Piezometers
- Other Discrete 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 msl and reported using North American Vertical Datum 88 (NAVD 88). For all monitoring wells, the reference notch in the top of the riser pipe and the monitoring well monument in the concrete base will be surveyed to the nearest 0.01 foot relative to msl and reported using NAVD 88. Additional survey requirements are presented in Section 7.0 of the MWIP, which is provided as Appendix A.

6.13 DEBRIS REMOVAL

The following procedures will be followed during the removal of the drums and other debris located in the gully west of Landfill No. 1:

1. Coordinate access to the area with the SAA.
2. Take photographs to document site conditions prior to commencing work in the area.
3. Locate the area using global positioning system (GPS) so the area can be located again, if necessary.
4. Using appropriate equipment, remove any drums and other debris visible at the ground surface.
5. During debris removal, use a PID to monitor the organic vapor content of the breathing zone, debris, and associated soil.
6. Discontinue drum and debris removal, and contact both the CENWK and BMcD project managers if any of the following conditions are present:
   - If PID readings above background are measured.
   - Any of the visible drums are found to contain liquid.
   - Upon removal of the visible surface drums, additional drums are uncovered.
   - Upon removal of the visible debris, soil staining is observed.
   - Any other conditions are observed that may indicate the drum debris and/or associated soil is contaminated.
7. Dispose of the surface debris as non-hazardous material.
8. Take photographs to document site conditions following completion of work in the area.

9. Prepare a letter for CENWK describing the actions taken.

* * * * *

7.0 FIELD OPERATIONS DOCUMENTATION

Each sample, field measurement, and field activity will be properly documented to facilitate timely, correct, and complete analyses, and support actions concerning SAFB. 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 B.

7.1 DQCRS

Field activities will be recorded daily by the FSM on DQCR forms to verify that all procedures outlined in the FSP and QAPP are implemented. The following field activities will be summarized on the DQCR form:

- Site Information
  In order to accurately track field activities from one site location to another, site-specific information will be recorded on the DQCR form. Information such as site location, project number, area of investigation, date, time, crew numbers, names of crew members, and the name of the FSM will be recorded on these forms.

- Weather Conditions
  General weather conditions such as air temperature, relative wind speed and direction, and relative humidity will be estimated daily and recorded on the DQCR forms. Any change in weather conditions encountered during the day will be recorded on the DQCR.

- Subcontractors and Equipment
  The subcontractors performing work associated with the investigation at SAFB will be tracked by recording on the DQCR form the subcontractors company name, crew size, and a list of the major equipment used during daily field activities.

- Summary of Work Performed
  A brief description of the daily field activities performed at SAFB will be recorded on the DQCR form. For field measurements, the numerical value and units will be recorded on the DQCR form.

- Instrument Calibration
  Instrumentation used for sampling and personal protection, and verification of instrument calibration during daily field activities will be recorded on the DQCR form. Additional instruments used will be written in the space provided. Further information on

calibration procedures will be recorded on the calibration log for each instrument used during daily field activities.

- Health and Safety Requirements
  The level of protection used during daily field activities and any other health and safety modifications from the APP will be recorded in the DQCR form. Modifications that may occur during field activities, including upgrading to higher levels of protection based on air-monitoring data and other chemical or physical hazards encountered at SAFB that were not previously known to exist, will also be recorded on the DQCR form.

- Sample Numbers Collected Including QA/QC Samples
  Samples collected, including QA/QC samples and the relationship of the QA/QC samples to the original samples, will be recorded on the DQCR form under the "Summary of Work Performed" heading.

- Deviations from the Approved Work Plan, FSP, and QAPP
  Any anticipated deviation in field activities that is not specified in the Work Plan, FSP and QAPP will be recorded on the DQCR form. The actual deviation will not be performed until a written request is submitted by the Project Manager to the USACE and approval, written or verbal, has been granted by the USACE Project Manager.

- Problems Encountered/Corrective Action Taken
  During daily field activities, any problems encountered and the corrective actions taken for each incident will be recorded on the DQCR form. For each problem encountered, the Project Manager will be notified and the date and time recorded of when notification was given.

- Work Status for the Following Day
  A summary of field activities planned for the following day will be recorded on the DQCR form.

The FSM will verify completion by signing and dating the DQCR form. The DQCR form will be completed daily. The DQCRs and any attachments will be submitted at least once a week to the USACE. Copies of the completed forms will be placed in the project file. A DQCR form can be found in Appendix B.

7.2 FIELD LOGBOOK AND/OR SAMPLE FIELD SHEETS

Information pertinent to the investigation will be recorded in a bound logbook with consecutively numbered water-resistant pages. The field personnel responsible for the entries will sign and date each entry or page. All logbook entries will be made in indelible ink. The time and date of each entry will be noted in the logbook.

General rules cannot specify the exact information that must be entered in a logbook for a particular site. However, the logbook should contain sufficient information so that field activities can be reconstructed. Logbooks will be kept in the field personnel's possession or a secure place during the investigation. Following the investigation, logbooks will become part of the project file. The following list contains typical field logbook entries.

- 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 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

Sample field sheet will also be completed for the monitoring wells installed at the site. A copy of a Groundwater Sample Report form is presented in Appendix B.

7.3 PHOTOGRAPHIC RECORDS

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 (signature)
- 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.

7.4 SAMPLE DOCUMENTATION

7.4.1 Sample Numbering System

All samples will be identified with a unique sample number. Sample numbers will be used on all sample labels, COCs, field logbooks, and all other applicable documentation. As described below, the sample numbering system will be comprised of the sample group, sample designator, QA/QC designator(s), if appropriate, and sample depth (if applicable). Hyphens will be inserted between each of the fields used. The general format will be “sample group-sample designator-QA/QC designators-sample depth.”

7.4.1.1 Sample Group

The sample group will consist of a unique two to six alpha-numeric character designation. Two types of sample groups are planned – one for direct-push investigations (e.g., 1A01A) and one based solely on the area being investigated (e.g., LOX). The sample group designation for the direct-push investigations consists of a sub-plume area number (e.g., 1), followed by the associated plume area designator (e.g., A), followed by a numeric character corresponding to the y-coordinate of the sample point (e.g., 01), followed by an alphabetical character corresponding to the x-coordinate of the sample point (e.g., A). The sample group designation "1A01A" would indicate a sampling point associated with the first direct-push sampling area of Plume Area A with y-coordinate 01 and an x-coordinate A. All direct-push and surface soil sample points (GW, SS, and SB) have this type of sample group designation.

The sample group based solely on the area being investigated consists of an area designation (e.g., LOX) followed by a sequential sample point number (e.g., 07). The sample group designation "LOX-07" would indicate a sampling point associated with the seventh non-direct-push sample location at the LOX Plant. All sediment and surface water samples have this type of sample group designation.

7.4.1.2 Sample Designator

The sample designator will consist of a four digit character designation composed of a two-digit matrix abbreviation and a sequential (and unique) two digit number for the sampling point or depth, as appropriate. The abbreviations used for the matrices are provided below:

Abbreviation	Matrix
SB	Subsurface Soil
SS	Surface Soil
SD	Sediment
SW	Surface Water
GW	Groundwater
CH	Core Hole

Sequential sample numbers for each sample point may range from 01 to 99. The sample designation "1A01A/GW13" would represent a groundwater sample associated with the first direct-push sampling area of Plume Area A with y-coordinate 01 and an x-coordinate A collected from a depth of 13 feet bgs. Further, the sample group designation "LOX-07/SW01" would indicate a surface water sample associated with the seventh non-direct-push sample location at the LOX Plant.

7.4.1.3 QA/QC Designators

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.

Other QA/QC samples, including rinsates, trip blanks, MS/MSD samples and samples submitted to the Chemical QA Branch Lab, 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
R	ERB
X	MS/MSD
QA	QA Sample for Chemical QA Branch Lab

As an example, a sample identified as "LOX-01/SS02-QA" would be a surface-soil sample submitted to the Chemical QA Branch Lab from sampling point 01 at the LOX Plant.

Trip blanks will be placed in each cooler containing aqueous 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).

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".

7.4.2 Sample Labels and/or Tags

Each sample removed from SAFB and transferred to a laboratory for analysis will be identified with a sample label containing specific information regarding the sample. Each completed sample identification label will be securely fastened to the sample container. Complete sample labels will include the following information:

- 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

7.4.3 COC Records

The COC will be employed as physical evidence of sample custody. Field personnel will initiate a COC with acquisition of the sample. Transferred possession of samples will be recorded on the COC by both the person relinquishing and the person receiving the samples by signing, dating, and noting the time the transfer of possession takes place. Samples are considered to be a person's custody if they are within that person's line of sight, kept in a locked room or vehicle, or adequately sealed with custody seals as discussed in Section 7.4.4.

A COC will be prepared for each cooler shipped or transported to the laboratory. All samples packed in the cooler will be recorded on the COC accompanying that cooler.

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 June 5, 2007, that contains two COCs, the document control numbers will be 060507A and 060507B. For sample shipments to the Chemical QA Branch Lab, a prefix of "QA" will be added to the document control number (i.e., QA-060607A).

The following information is to be included on the COC:

- Sample numbers
- Signature(s) of field personnel
- Date of collection
- Time (military) of collection
- Sample type (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
- Laboratory Information Management System (LIMS) number for Chemical QA Branch Lab

- Document control number

After completing the COC, the original (white copy) will be enclosed in a plastic bag and secured to the inside of the cooler lid.

7.4.4 Custody Seals

From the time the coolers are packed until they are opened in the laboratory, custody seals will be used to preserve the integrity of the cooler during shipment. Custody seals must be attached so that it is necessary to break the seals to open the cooler. The custody seals will be covered with clear tape. All samples shipped overnight to the laboratory will be shipped in coolers sealed on two opposite sides with custody seals. As long as the COCs are sealed inside the sample cooler and custody seals remain intact, commercial carriers and laboratory couriers are not required to sign the custody form.

7.5 FIELD ANALYTICAL RECORDS

The guidelines for analysis notebook documentation for screening samples is presented in the QAPP.

7.6 DOCUMENTATION PROCEDURES/DATA MANAGEMENT AND RETENTION

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 COC. Enter the COC document control number in the field logbook.
4. Prepare the samples for shipment.
5. Complete all necessary forms.

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.

7.6.1 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
- Field instrument operating manuals (PID, YSI 556 MPS, etc.)
- List of important phone numbers
- Shipping forms
- Equipment calibration records
- Health and safety forms (see the APP)
- Applicable field forms (see Appendix B)
- Applicable laboratory forms (see the QAPP)

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, Cooler Receipt Forms, requests for chemical analysis, and the laboratory results

- Physical laboratory data file including requests for physical analysis and the laboratory results

- Field data file including boring log originals, field logbooks, field transmittals, photographs and negatives, 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
- Drawing and plan file including original report exhibits, original maps, and miscellaneous plans and drawings related to the field investigation

7.7 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.

* * * * *

8.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

The sample packaging and shipping procedure to be used for the shipment of samples by an overnight carrier 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. All samples will be packaged and shipped within 24 hours of collection.

The following procedure will be used to pack samples being shipped by overnight carrier:

1. Arrange sample containers in groups by sample number. Group aqueous VOC samples so they can be placed into common shipping containers.

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. 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. Remove as much air as possible from the plastic bag prior to sealing.

4. Tape drains shut on shipping cooler.

5. Place an absorbent pad in the bottom of the cooler, followed by a layer of bubble wrap.

6. Insert a plastic trash bag into the cooler.

7. 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. Place one trip blank set in each cooler containing aqueous VOC samples. Place one temperature blank in each cooler.

8. Add ice (double packaged in sealable plastic bags).

9. Sign the COC and indicate the time and date the cooler is sealed. Record the time in the field logbook.

10. Separate the copies of the COCs. Seal the top form (original) in a large, sealable, plastic bag and tape them to the inside of the cooler lid.

11. Complete shipping paperwork (if applicable). Include air bill number and name of carrier on the COC, and record the information in the field logbook.

12. 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. Field samples will be shipped to AML. QA samples will be sent to the Chemical QA Branch Lab. Laboratory shipping addresses are provided in Section 2.0.

13. 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.

14. Affix signed custody seals over lid openings (opposite corners of the cooler). Cover the seals with clear, plastic tape.

15. A Federal Express air-bill will be completely filled out for both laboratories. The cooler(s) will be delivered directly to a Federal Express agent or to an authorized agent for shipment. The full service Fedex office in Salina, Kansas is located at 3450 Centennial Road. It accepts express shipments until 6:00 p.m. For additional questions regarding shipping, contact Federal Express at 1-800-463-3339.

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9.0 INVESTIGATIVE-DERIVED WASTES

During field investigations at SAFB, various activities such as direct-push soil and groundwater sampling, soil boring and monitoring well installation, surface and subsurface soil sampling, sediment sampling, surface water sampling, 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 KARs Title 28, Article 31, Chapter 4; and good engineering judgement. The generation, storage, transportation, disposal, and management of solid and liquid IDW at SAFB are described in the following sections.

9.1 LIQUID IDW

9.1.1 Containerization, Labeling, and Storage of Liquid IDW

Liquid IDW will include development, decontamination, and purge water. Based on existing groundwater monitoring data and field screening data which will be collected as part of the field effort, it will be possible to pre-characterize virtually all liquid IDW generated. Most of the liquid IDW generated will not be hazardous waste and will be stored in a frac tank, which will be located on the site. Any liquid IDW suspected of being hazardous waste will be containerized separately in drums. Drums and polyethylene tanks could be used for interim storage and transport of liquid IDW. Labeling will be in accordance with the guidelines outlined below. Containers will be closed and secured except when adding to or disposing of the contents. Manufacturer DOT specifications will be followed when sealing containers.

United Nations (UN)-approved drums (49 CFR 173.3), polyethylene tanks, and 5-gallon plastic buckets will be used to collect liquid IDW, depending on the volume and rate of generation and on the accessibility of the IDW source. Liquid IDW collected in 5-gallon buckets will be transferred to drums or polyethylene tanks as soon as possible after collection. Any liquid IDW suspected of being or characterized as hazardous waste will be containerized in UN-approved drums.

Containers of liquid IDW 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) (boring number plus a sequential number); facility name; monitoring well, direct-push, or borehole number; date of generation; container contents; estimated quantity; and the USACE POC.

For example:

Container Number	99M41-2
Facility Name	LOX
Well or Borehole Number	99M41
Date(s) of generation (MM-DD-YY)	12-25-06
Container Contents	Purge Water
Estimated Quantity	55 Gallons
USACE POC Name and Phone Number	Robyn Kiefer (816) 389-3615

Containers will be marked with 2-inch letters and numbers using a waterproof paint pen. An IDW Inventory Worksheet (Appendix B) will be maintained by the FSM to facilitate identification and tracking of liquid IDW for appropriate disposal. This inventory will include all of the above information, the location of the container, and initials of the responsible USACE POC. In addition to the IDW Inventory Worksheet, the total number of containers of liquid IDW generated will be noted in the field notebook on a daily basis. Containers of liquid IDW determined to be hazardous waste or non-hazardous waste that cannot be discharged into the sanitary sewer or discharged on site will be relabeled in a manner consistent with applicable state and federal requirements including, but not limited to, the RCRA, the Toxic Substances Control Act (TSCA), and the DOT (40 CFR 171-179).

Containers of liquid IDW will be temporarily stored at the site until characterized. Containers of liquid IDW that will be stored during winter months should be underfilled to allow for expansion during freezing. Issues to consider in identifying storage areas include the potentials for unauthorized access to the site, flooding, and freezing. Provision will be made for secondary containment at the location where liquid IDW is being stored.

For short-term storage on site prior to characterization, properly labeled and closed containers of liquid IDW will be left in an upright position on wooden pallets placed on level ground. When containers of solid IDW are staged with containers of liquid IDW, they will be clustered together with any liquid-filled containers on the interior of the cluster. It may not be possible to locate a secure IDW staging area with perimeter fencing. At a minimum, warning tape and temporary orange barrier fencing will be placed around the cluster of containers.

Containers of liquid IDW 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. If it is

anticipated that liquid-filled containers will remain in storage for 30 days or longer, the containers will be positioned to allow inspection from all sides to monitor for leakage.

9.1.2 Liquid IDW Evaluation

Based on an evaluation of the site history, no listed waste is present at the former SAFB. Therefore, the laboratory analytical data from the IDW will be reviewed according to the *KDHE SOP for Characterization and Disposal of IDW* (BER-08) as presented in Appendix C. This procedure requires the determination of whether the liquid IDW sample concentrations are above or below the pre-treatment standards or the Toxicity Characteristic Leaching Procedure (TCLP) thresholds established by 40 CFR 261.24. This procedure provides a decision tree for determining the correct waste disposal method. A determination will be made whether the liquid IDW is above the USEPA maximum contaminant levels (MCLs) and the TCLP thresholds.

Following 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 analysis. When IDW is to be characterized for VOCs analysis, one representative sample will be collected from each container of IDW. The composite sample will be analyzed for the same constituents analyzed for investigation activities performed at the specific area of investigation. If during field investigations, field screening results and/or PID readings indicate elevated levels of contaminant concentrations at some investigation points, then the IDW from these investigation points will be containerized and analyzed separately from the other liquid IDW.

The chemical analyses selected will depend upon the requirements of the disposal option, a review of historical analytical data, and the COPCs for the environmental investigation activities. The selected analyses could include one or more of the following:

- pH by SW-846 Method 9040
- DO by field measurements in accordance with USEPA Method 360.1
- Temperature by field measurements in accordance with USEPA Method 170.1
- Total suspended solids by USEPA Method 160.2
- Total petroleum hydrocarbons (TPH) by methods organic analysis (OA)1 and OA2
- Ignitability by SW-846 Method 1010
- Corrosivity by SW-846 Method 1110
- SVOCs by SW-846 Method 8270
- VOCs by SW-846 Method 8260B
- Inductively coupled plasma (ICP) Metals by SW-846 Method 6010

- Arsenic by SW-846 Method 7060
- Mercury by SW-846 Method 7470
- Lead by SW-846 Method 7421 or 6010
- Selenium by SW-846 Method 7740

Sample analytical results along with the completed IDW Inventory Worksheets will be forwarded to the USACE POC for review. The results will be compared with the MCL values and the City of Salina pre-treatment values. After review of the analytical results, the USACE POC will determine the appropriate management option and report the information to the KDHE and the USEPA, as part of the associated sampling report. Depending on the characterization/classification status, USACE may consult with the KDHE and/or 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, KAR 28-29-101, and KAR 28-31-3. The evaluation and classification of the liquid IDW will determine disposal options.

9.1.3 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 either to the Salina wastewater treatment system with permission from the City of Salina and USACE or on site. Non-hazardous liquid IDW will be disposed on a quarterly basis at a minimum.

- Non-hazardous liquid IDW (special waste above MCLs but below the TCLP thresholds) may be discharged to the Salina wastewater treatment system with the City of Salina's approval after receiving authorization from the KDHE Bureau of Water (BOW) / Bureau of Waste Management (BWM). BMcD personnel will be responsible for obtaining authorization from the KDHE BOW/BWM. If it is determined that the liquid IDW requires treatment prior to disposal via the wastewater treatment system, BMcD will determine the most appropriate treatment technology to employ.

- Liquid IDW purge water and product removed from monitoring wells containing free-phase petroleum products will be disposed appropriately.

- If the liquid IDW is deemed to be hazardous (above TCLP thresholds), then container labeling will be amended accordingly and the containers will be transported and disposed by a permitted

waste hauler in accordance with federal, state, and local regulations. For off-site disposal, BMcD may assist the generator of the waste (USACE) with manifesting and disposal. All off-site disposal of IDW must be authorized by the KDHE BOW or BWM.

9.2 SOLID IDW

During environmental investigation activities at SAFB, various 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. Based on the results of previous investigations, the expectation is that virtually all soil cuttings generated during field activities will be either non-hazardous or have slightly elevated concentrations of contaminants which might classify the material as special waste. Very little of this material, if any, will be classified as hazardous waste. All solid IDW of this type will be containerized and disposal options evaluated based upon laboratory and site historical data. 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 rendered nonhazardous through the removal of gross contamination. The PPE IDW will be double bagged and deposited daily at the designated dumpster at BMcD's on-site trailer/office. All gross contamination removed from the PPE IDW in accordance with the APP (BMcD, 2007a) will be placed with the appropriate IDW.

9.2.1 Containerization, Labeling, and Storage of Solid IDW

Solid IDW, consisting of soil cuttings and excess soil sample material, will be placed in rolloff boxes equipped with liners and tarps. UN-approved drums and/or 5-gallon plastic buckets will be used for interim handling and transport of solid IDW, depending on location. Any soil suspected of being characterized as hazardous waste will be drummed rather than being placed in the rolloff boxes. Containers will be closed and sealed except when adding to or disposing of the contents. Manufacturer DOT specifications will be followed when sealing containers. Solid PPE IDW will be double bagged in plastic trash bags.

Solid IDW will be containerized on an investigation-area basis. Solid IDW requiring characterization from a given area of investigation will not be mixed with that from another area, as per the *Management of Investigation Derived Waste During Site Inspections* EPA/540/G-91/009 (USEPA, 1991). However, solid IDW from multiple soil borings or direct-push activities within a single area of investigation may be combined into a single waste stream. OU 1 will be considered a single area of investigation.

Containers of solid IDW 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) (boring number plus a sequential number); site name; monitoring well, direct push, or borehole number; date of generation; container contents; estimated quantity; and the USACE POC.

For example:

Container Number	99M41-2
Site	LOX
Well or borehole number	99M41
Date of generation (MM-DD-YY)	12-25-06
Container Contents	Drill Cuttings
Estimated Quantity	55 Gallons
USACE POC Name and Telephone Number	Robyn Kiefer (816) 389-3615

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

Solid IDW determined to be hazardous (based on the outcome of laboratory analysis) 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.

Containers of solid IDW will be temporarily stored at the BMcD trailer/office until characterized. If deemed necessary, the USACE will designate a winter storage location. Issues to consider in identifying storage areas include the potentials for freezing, unauthorized access, and flooding.

For short-term storage on site, properly labeled and closed containers of solid IDW will be left in an upright position on wooden pallets placed on level ground. When containers of solid IDW are staged with containers of liquid IDW, they will be clustered together with any liquid filled containers on the interior of the cluster. Warning tape will be placed around the cluster of containers.

Containers of solid IDW 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.

Used PPE, disposable equipment, and other potentially contaminated material will be disposed on a daily basis. Plastic trash bags containing used PPE, disposable equipment, and other potentially contaminated material will be placed in the designated dumpster at the on-site trailer/office.

9.2.2 Solid IDW Evaluation

As the first step of evaluation of solid IDW, site history will be reviewed to determine if the generated waste is a listed waste per 40 CFR 261 Subpart D and is, therefore, handled according to 40 CFR 262; or if the waste is excluded from regulation as a hazardous waste under 40 CFR 261.4(b). If it is determined that the generated waste is not a listed waste, then the laboratory analytical data from the IDW will be reviewed according to the *KDHE SOP for Characterization and Disposal of IDW* (BER-08) as presented in Appendix C. Next it will be determined whether the composite solid IDW sample concentrations are above or below the TCLP thresholds established by 40 CFR 261.24 and at sites where the KDHE provides oversight, if the results are above or below the KDHE RSK Levels. This procedure provides a decision tree for determining the correct waste disposal method.

Analytical data from environmental investigation activities will also be reviewed to determine how to conceptually group the solid IDW into waste stream(s). Grouping will be conducted as follows:

1. Review analytical results for specific waste sources to determine whether waste from different borings, wells, etc. can be grouped for an individual source.

2. If waste streams can be grouped for an individual source, analytical results will be compared against other sources to determine if they can also be grouped.

3. Once grouped in waste streams, a single composite sample for all analytes with the exception of VOC analytes, will be collected for definition of the waste stream characteristics. For definition of VOC waste stream characteristics, a sample will be collected from each IDW container. IDW samples will be collected within two weeks of the completion of field activities.

The chemical analyses selected will depend upon the requirements of the disposal option and a review of historical investigation area analytical data. For solid IDW, TCLP extraction by SW 846 Method 1311 may be required followed by one or more of the following analyses:

a. SVOCs by SW-846 Method 8270
b. VOCs by SW-846 Method 8260B
c. ICP Metals by SW-846 Method 6010

d. Arsenic by SW-846 Method 7060 or 6010

e. Mercury by SW-846 Method 7470

f. Lead by SW-846 Method 7421 or 6010

g. Selenium by SW-846 Method 7740 or 6010

Sample analytical results along with completed IDW Inventory Worksheets will be forwarded to the USACE POC for review upon receipt of the analytical data. The results of the above analyses will be utilized to determine if the solid IDW is non-hazardous waste, special (non-hazardous contaminated) waste, or hazardous waste by the USACE. These types of wastes are defined in 40 CFR 261, KAR 28-29-101, and KAR 28-31-3. The KDHE guidelines for disposal of soil are listed in Appendix C. The evaluation and classification of the solid waste will determine disposal options.

9.2.3 Disposal of Solid IDW

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

- Non-hazardous solid IDW (for example, soil cuttings) may be spread on the ground near the point of origin when possible. When the soil cannot be spread near the point of origin due to reasons including pavement or aesthetics, then the soil may be taken to an area approved by the USACE Project Manager.

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

- Solid IDW classified as Special Waste will be managed and disposed by a permitted waste hauler in accordance with local, state, and federal regulations and KAR 28-29-101 and KAR 28-29-109.

- If the solid IDW is deemed to be hazardous, container labeling will be amended accordingly. If the solid IDW is above the KDHE RSK levels or TCLP thresholds established by 40 CFR 261.24 implementing RCRA, (see Appendix C-KDHE General Solid IDW Disposal Process Flowchart), then authorization may be required from the KDHE project manager prior to disposal. For off-site disposal, the contactor may assist the generator of the waste (USACE) with manifesting and disposal. Characteristic hazardous waste enters the RCRA hazardous waste management system and may be transported to and consolidated at a permitted treatment, storage, or disposal (TSD) facility, as directed by the USACE POC. All off-site disposal of IDW must be authorized by the KDHE BWM.

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10.0 FIELD ASSESSMENT/THREE-PHASE INSPECTION PROCEDURES

10.1 CONTRACTOR QUALITY CONTROL (CQC)

To ensure that quality is maintained for all field work performed by BMcD personnel on site, a three phase chemical quality assurance process will be implemented. This process will consist of a preparatory phase, an initial phase, and a follow-up phase. The FSM will act as BMcD's Contractor Chemical QA (CCQA) Representative.

10.1.1 PREPARATORY PHASE

The FSM will coordinate all project-related field efforts with the sampling team during the preparatory phase. This phase will be implemented prior to the beginning of any definable feature of work at the site. During a preparatory meeting, the FSM will review all anticipated work activities, demonstrate all field activities, and complete a full set of sample custody forms with the project team. This meeting will be repeated for any new sampling team that arrives on site during the field activities. The field sampling team will review the SAP and APP in detail. The FSM will also visually inspect project materials and equipment, and examine all areas of work.

The FSM will organize the project-related documents that are needed at the site into a project file. The field project file will include the items discussed in Section 7.6.1.

10.1.2 INITIAL PHASE

The FSM will be responsible for overseeing all initial features of work that will be conducted at SAFB. The FSM will be responsible for overseeing the following field activities:

- Sampling activities
- Sample documentation
- Sample custody and handling
- Instrument calibration and use
- Field documentation

10.1.3 FOLLOW-UP PHASE

The FSM is responsible for the continued daily oversight of field activities.

10.1.4 CCQA DOCUMENTATION

A summary of all field activities will be recorded on a DQCR form by the FSM.

10.2 SAMPLING APPARATUS AND FIELD INSTRUMENTATION CHECKLIST

The FSM will prepare an equipment checklist for all equipment and supplies necessary for field activities. The checklist will contain:

- Field screening equipment as specified in the FSP and APP
- Field sampling equipment as specified in Section 6.0 of this FSP
- Decontamination equipment as specified in Section 6.8.1 of this FSP
- Packing and shipping equipment and supplies
- PPE as specified in the APP

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11.0 NONCONFORMANCE/CORRECTIVE ACTION

Discrepancies discovered by field, laboratory, or office personnel will be immediately brought to the attention of the BMcD Project Manager. The BMcD Project Manager will, if possible, take immediate corrective action. The BMcD Project Manager will submit a memo to the MP Program Manager and the USACE Project Manager detailing the problem and the solution implemented. If the problem is not readily correctable, the BMcD Project Manager will contact the MP Program Manager and the USACE Project Manager, explain the discrepancy, and reach a mutually agreeable solution. The BMcD Project Manager will then implement the solution and submit a memo to the MP Program Manager and the USACE Project Manager detailing the problem and resolution.

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TABLES

Table 5-1
Preparation and Analytical Methods, Preservatives, Holding Times, Sample Containers, and Sample Volume/Weights
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method[1]	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Soil/Sediment	VOCs	Low	SW-846 5035A/8260B	3 40-ml vials with Teflon-lined septa and open screw-caps, pre-weighed, and containing magnetic stir bars AND 1 container of sample filled with no headspace for determination of moisture content	Frozen (-7 ºC to -15 ºC) 4 ºC	14 Days Analyzed
	SVOCs	Low	SW-846 3550B/8270D	4-ounce clear wide-mouth glass jars with Teflon-lined septa caps	4 ºC	14 Days to Extraction/40 Days for Analysis following extraction
	Metals[2] (including mercury)	Low	SW-846 3020A/6020A SW-846 7471A (Mercury)	4-ounce clear wide-mouth glass jars with Teflon-lined septa caps	4 ºC	6 Months Analyzed (except Mercury) Mercury 28 Days Analyzed
Water	VOCs	Low	SW-846 5030B/8260B	3 x 40-ml glass Teflon-lined septa caps	No Headspace, HCl to pH <2, 4 ºC If sample effervesces, 4 ºC	14 Days Analyzed (Preserved) 7 Days Analyzed (Unpreserved)
	SVOCs	Low	SW-846 3510B/8270D	2 x 1-Liter amber glass bottles Teflon-lined caps	4 ºC	7 Days to Extraction/40 Days for Analysis following extraction

Table 5-1
Preparation and Analytical Methods, Preservatives, Holding Times, Sample Containers, and Sample Volume/Weights
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method[1]	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Water	MEE	Low	RSK-175	3 x 40-ml glass Teflon-lined septa caps	No Headspace, HCl to pH <2, 4 ºC	14 Days Analyzed
	Metals[2] (including mercury)	Low	SW-846 3020A/6020A SW-846 7470A (Mercury)	1 500-ml HDPE	HNO_3 to pH < 2 4 ºC	6 Months Analyzed (except Mercury) Mercury 28 Days Analyzed
	Anions	Low	EPA Method 300.0			
	Nitrate and Nitrite			1 250-ml HDPE	4 ºC	48 hours Analyzed
	Chloride and Sulfate			1 250-ml HDPE	4 ºC	28 Days Analyzed
	Sulfide	Low	EPA Method 376.1	1 Liter HDPE	Zinc acetate, NaOH to pH > 9, 4 ºC	7 Days Analyzed
	TOC	Low	SW-846 9060	1 125-ml HDPE	H_2SO_4 to pH < 2, 4 ºC	28 Days Analyzed

[1]When two methods are presented, the first method is the preparation method and the second method is the analytical method.
[2]Metals for the RI activities include RCRA Metals. Metals for the natural attenuation indicator parameters include iron.

ºC = Degrees Celsius
HCl = Hydrochloric Acid
HDPE = High Density Polyethylene
HNO3 = Nitric Acid
H2SO4 = Sulfuric Acid
MEE = MEE
ml = milliliters
NaOH = Sodium Hydroxide
SVOCs = Semivolatile Organic Compounds
TOC = Total Organic Carbon
VOCs = Volatile Organic Compounds

Table 5-2
Sampling Requirements
Jet Engine Repair Hangar and Aircraft Wash Area No. 2
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters	QA/QC Sample Designator		
Area	Sample Point	Sample Designator	Sample Interval	Matrix	Off-Site VOCS (Note 1)	Off-Site Duplicate	QA Sample	MS/MSD
JET	99MXX	GW01	NA	Groundwater	X			

Notes:
1. Off-site VOCs analysis will be performed using Method SW-846 5030B/8260B.
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
QA - quality assurance
QC - quality control
VOCs - volatile organic compounds

Table 5-3
Sampling Requirements
Sewage Treatment Plant and Landfill
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters				QA/QC Sample Designator			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	Off-Site RCRA Metals (Note 5)	On-Site Duplicate (Note 6)	Off-Site Duplicate (Notes 7, 12)	QA Sample (Notes 8, 12)	MS/MSD (Notes 9, 12)
1A01	A	GWXX	TBD	Groundwater	X	X			GWXXDUP	GW11	GW01QA	GW01X
		GWYY	TBD	Groundwater	X							
		(Notes 10, 11)	(Note 10)	Groundwater	X							
	B	GWXX	TBD	Groundwater	X							
		GWYY	TBD	Groundwater	X	X						
		(Notes 10, 11)	(Note 10)	Groundwater	X							
	C	GWXX	TBD	Groundwater	X							
		GWYY	TBD	Groundwater	X							
		(Notes 10, 11)	(Note 10)	Groundwater	X	X						
	Note 13	GWXX	TBD	Groundwater	X							
		GWYY	TBD	Groundwater	X				GWYYDUP	GW22	GW02QA	
		(Notes 10, 11)	(Note 10)	Groundwater	X							
1A01	A	SS01	0 - 6"	Soil			X	X		SS11	SS01QA	
(Note 14)		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	C	SS01	0 - 6"	Soil			X	X				SS01X
		SB01	0.5 - 2'	Soil		X						SB01X
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	E	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	H	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	I	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						

Table 5-3
Sampling Requirements
Sewage Treatment Plant and Landfill
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters				QA/QC Sample Designator			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	Off-Site RCRA Metals (Note 5)	On-Site Duplicate (Note 6)	Off-Site Duplicate (Notes 7, 12)	QA Sample (Notes 8, 12)	MS/MSD (Notes 9, 12)
1A01	J	SS01	0 - 6"	Soil			X	X				
(Note 14)		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	L	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	P	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	Q	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	R	SS01	0 - 6"	Soil			X	X		SS11	SS01QA	
		SB01	0.5 - 2'	Soil		X				SB11	SB01QA	
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
	W	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						

Table 5-3
Sampling Requirements
Sewage Treatment Plant and Landfill
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters				QA/QC Sample Designator			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	Off-Site RCRA Metals (Note 5)	On-Site Duplicate (Note 6)	Off-Site Duplicate (Notes 7, 12)	QA Sample (Notes 8, 12)	MS/MSD (Notes 9, 12)
1A01	X	SS01	0 - 6"	Soil			X	X				
(Note 14)		SB01	0.5 - 2'	Soil		X						
		SB02	2 - 10'	Soil		X	X	X				
		SB03	10' - TOGW	Soil		X						
STP	01	SW01	NA	Surface Water		X	X	X				
		SD01	0 - 6"	Sediment		X	X	X				
	02	SW01	NA	Surface Water		X	X	X				
		SD01	0 - 6"	Sediment		X	X	X				
	03	SW01	NA	Surface Water		X	X	X		SW11	SW01QA	
		SD01	0 - 6"	Sediment		X	X	X		SD11	SD01QA	
	04	SW01	NA	Surface Water		X	X	X				
		SD01	0 - 6"	Sediment		X	X	X				
	05	SW01	NA	Surface Water		X	X	X				
		SD01	0 - 6"	Sediment		X	X	X				
	06	SW01	NA	Surface Water		X	X	X				SW01X
		SD01	0 - 6"	Sediment		X	X	X				SD01X

Table 5-3
Sampling Requirements
Sewage Treatment Plant and Landfill
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters				QA/QC Sample Designator			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	Off-Site RCRA Metals (Note 5)	On-Site Duplicate (Note 6)	Off-Site Duplicate (Notes 7, 12)	QA Sample (Notes 8, 12)	MS/MSD (Notes 9, 12)

Notes:
This table shows the general sampling requirements and sample labeling scheme. Due to the interative nature of the field activities at this location, this table will not list all sample requirements for collection in the field. These are unknown at this time.

1. On-site VOCs includes tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, and 1,1-dichloroethene.
2. One groundwater sample per 10 on-site gas chromatograph analyses will be sent to an off-site laboratory as a confirmation sample.
3. Off-site VOCs analyses will be performed using Method SW-846 5035A/8260B (soil) and 5030B/8260B (water).
4. Off-site SVOCs analyses will be performed using Method SW-846 3550B/8270D (soil) and 3510B/8270D (water).
5. Off-site RCRA metals analyses will be performed using Method SW-846 3010/6010B and 7471A (soil) and SW-846 3010A/6010C and 7470A (water).
6. One on-site duplicate will be analyzed per 10 on-site analyses.
7. One off-site duplicate will be analyzed per 10 off-site analyses.
8. Each off-site duplicate will also have a QA split sample sent to the USACE QA Laboratory.
9. One set of MS/MSD samples will be analyzed per 20 off-site analyses.
10. One groundwater sample will be collected per each 15-foot interval of saturated thickness. The number of groundwater samples collected at each sample point will depend on the saturated thickness of the aquifer.
11. XX, YY, …. indicate depth bgs of sample collection.
12. QA/QC samples for groundwater to be numbered per sample depth interval with "11" and "01"as deepest sample depth interval.
13. See Figure 5-2 for other sample points.
14. Soil samples from 0.5 - 2', 2 - 10', and 10' - the top of groundwater will be collected from the intervals with the highest PID reading.

bgs - below ground surface
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
QA - quality assurance
QC - quality control
PID - photoionization detector
RCRA - Resource Conservation and Recovery Act
SVOCs - semi-volatile organic compounds
TBD - to be determined
TOGW - top of groundwater
USACE - United States Army Corps of Engineers
VOCs - volatile organic compounds
" - inches
' - feet

Table 5-4
Sampling Requirements
Liquid Oxygen Plant
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters			QA/QC Sampler Designators			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
1D01	I	GWXX	TBD	Groundwater	X	X		GWXXDUP	GW11	GW01QA	GW01X
		GWYY	TBD	Groundwater	X						
		(Notes 9, 10)	(Note 9)	Groundwater	X						
	K	GWXX	TBD	Groundwater	X						
		GWYY	TBD	Groundwater	X	X		GWYYDUP	GW22	GW02QA	
		(Notes 9, 10)	(Note 9)	Groundwater	X						
	M	GWXX	TBD	Groundwater	X						
		GWYY	TBD	Groundwater	X						
		(Notes 9, 10)	(Note 9)	Groundwater	X						
	Note 12	GWXX	TBD	Groundwater	X						
		GWYY	TBD	Groundwater	X						
		(Notes 9, 10)	(Note 9)	Groundwater	X						
1D01	AA	SS01	0 - 6"	Soil			X		SS11	SS01QA	
(Notes 13		SB01	0.5 - 2'	Soil		X			SB11	SB01QA	
and 14)		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	AQ	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	AZ	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	BI	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	BJ	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					

Table 5-4
Sampling Requirements
Liquid Oxygen Plant
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters			QA/QC Sampler Designators			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
1D01 (Notes 13 and 14)	BL	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	BS	SS01	0 - 6"	Soil			X		SS11	SS01QA	
		SB01	0.5 - 2'	Soil		X			SB11	SB01QA	
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	BT	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	CA	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	CC	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	CE	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	CH	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	CI	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					

Table 5-4
Sampling Requirements
Liquid Oxygen Plant
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters			QA/QC Sampler Designators			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
1D01 (Notes 13 and 14)	CJ	SS01	0 - 6"	Soil			X				
		SB01	0.5 - 2'	Soil		X					
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
	CQ	SS01	0 - 6"	Soil			X				SS01X
		SB01	0.5 - 2'	Soil		X					SB01X
		SB02	2 - 10'	Soil		X	X	X			
		SB03	10' - TOGW	Soil		X					
LOX	01	SW01	NA	Surface Water		X	X				
		SD01	0 - 6"	Sediment		X	X				
	02	SW01	NA	Surface Water		X	X				
		SD01	0 - 6"	Sediment		X	X				
	03	SW01	NA	Surface Water		X	X				
		SD01	0 - 6"	Sediment		X	X				
	04	SW01	NA	Surface Water		X	X		SW11	SW01QA	
		SD01	0 - 6"	Sediment		X	X		SD11	SD01QA	
	05	SW01	NA	Surface Water		X	X				
		SD01	0 - 6"	Sediment		X	X				
	06	SW01	NA	Surface Water		X	X				
		SD01	0 - 6"	Sediment		X	X				
	07	SW01	NA	Surface Water		X	X				
		SD01	0 - 6"	Sediment		X	X				
	08	SW01	NA	Surface Water		X	X				SW01X
		SD01	0 - 6"	Sediment		X	X				SD01X
LOX	99MXX	GW01	NA	Groundwater		X					

Table 5-4
Sampling Requirements
Liquid Oxygen Plant
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters			QA/QC Sampler Designators			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)

Notes:
This table shows the general sampling requirements and sample labeling scheme. Due to the interative nature of the field activities at this location, this table will not list all sample requirements for collection in the field. These are unknown at this time.

1. On-site VOCs includes tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, and 1,1-dichloroethene.
2. One groundwater sample per 10 on-site gas chromatograph analyses will be sent to an off-site laboratory as a confirmation sample.
3. Off-site VOCs analyses will be performed using Method SW-846 5035A/8260B (soil) and 5030B/8260B (water).
4. Off-site SVOCs analyses will be performed using Method SW-846 3550B/8270D (soil) and 3510B/8270D (water).
5. One on-site duplicate will be analyzed per 10 on-site analyses.
6. One off-site duplicate will be analyzed per 10 off-site analyses.
7. Each off-site duplicate will also have a QA split sample sent to the USACE QA Laboratory.
8. One set of MS/MSD samples will be analyzed per 20 off-site analyses.
9. One groundwater sample will be collected per each 15-foot interval of saturated thickness. The number of groundwater samples collected at each sample point will depend on the saturated thickness of the aquifer.
10. XX, YY, …. indicate depth bgs of sample collection.
11. QA/QC samples for groundwater to be numbered per sample depth interval with "11" and "01"as deepest sample depth interval.
12. See Figure 5-4 for other sample points.
13. Soil samples from 0.5 - 2', 2 - 10', and 10' - the top of groundwater will be collected from the intervals with the highest PID reading.
14. Additional soil sample locations will be added as needed.

bgs - below ground surface
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
PID - photoionization detector
QA - quality assurance
QC - quality assurance
SVOCs - semi-volatile organic compounds
TBD - to be determined
TOGW - top of groundwater
USACE - United States Army Corps of Engineers
VOCs - volatile organic compounds
" - inches
' - feet

Table 5-5
Sampling Requirements
Building 837 and Former Building 847
OU 1 Remedial Investigaiton Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters				QA/QC Sample Designator			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	RCRA Metals (Note 5)	On-Site Duplicate (Note 6)	Off-Site Duplicate (Notes 7, 12)	QA Sample (Notes 8, 12)	MS/MSD (Notes 9, 12)
1C01	H	GWXX	TBD	Groundwater	X	X			GWXXDUP	GW11	GW01QA	GW01X
		GWYY	TBD	Groundwater	X							
		(Notes 10, 11)	(Note 10)	Groundwater	X							
	J	GWXX	TBD	Groundwater	X							
		GWYY	TBD	Groundwater	X	X			GWYYDUP	GW22	GW02QA	
		(Notes 10, 11)	(Note 10)	Groundwater	X							
	K	GWXX	TBD	Groundwater	X							
		GWYY	TBD	Groundwater	X							
		(Notes 10, 11)	(Note 10)	Groundwater	X	X						
	Note 13	GWXX	TBD	Groundwater	X							
		GWYY	TBD	Groundwater	X							
		(Notes 10, 11)	(Note 10)	Groundwater	X							
1C01	AT	SS01	0 - 6"	Soil			X	X		SS11	SS01QA	
(Note 14)		SB01	0.5 - 2'	Soil		X						
	AU	SS01	0 - 6"	Soil			X	X				SS01X
		SB01	0.5 - 2'	Soil		X						SB01X
	AV	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	AW	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	AX	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	AY	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	AZ	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BA	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BB	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BC	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BD	SS01	0 - 6"	Soil			X	X		SS11	SS01QA	
		SB01	0.5 - 2'	Soil		X						

Table 5-5
Sampling Requirements
Building 837 and Former Building 847
OU 1 Remedial Investigaiton Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters				QA/QC Sample Designator			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	RCRA Metals (Note 5)	On-Site Duplicate (Note 6)	Off-Site Duplicate (Notes 7, 12)	QA Sample (Notes 8, 12)	MS/MSD (Notes 9, 12)
	BE	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BF	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BG	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BH	SS01	0 - 6"	Soil			X	X				SS01X
		SB01	0.5 - 2'	Soil		X						SB01X
	BI	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BJ	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BK	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BL	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BM	SS01	0 - 6"	Soil			X	X		SS11	SS01QA	
		SB01	0.5 - 2'	Soil		X						
	BN	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
	BO	SS01	0 - 6"	Soil			X	X				
		SB01	0.5 - 2'	Soil		X						
B837	99MXX	GW01	NA	Groundwater		X						

Table 5-5
Sampling Requirements
Building 837 and Former Building 847
OU 1 Remedial Investigaiton Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

					Parameters				QA/QC Sample Designator			
Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site SVOCs (Note 4)	RCRA Metals (Note 5)	On-Site Duplicate (Note 6)	Off-Site Duplicate (Notes 7, 12)	QA Sample (Notes 8, 12)	MS/MSD (Notes 9, 12)

Notes:
This table shows the general sampling requirements and sample labeling scheme. Due to the interative nature of the field activities at this location, this table will not list all sample requirements for collection in the field. These are unknown at this time.

1. On-site VOCs include tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, and 1,1-dichloroethene.
2. One groundwater sample per each ten on-site GC analyses will be sent to an off-site laboratory as a confirmation sample.
3. Off-site VOC analysis will be performed using Method SW-846 5030B/8260B.
4. Off-site SVOCs analyses will be performed using Method SW-846 3550B/8270D (soil) and 3510B/8270D (water).
5. Off-site RCRA metals analyses will be performed using Method SW-846 3010/6010B and 7471A (soil) and SW-846 3010A/6010C and 7470A (water).
6. One on-site duplicate will be conducted per 10 on-site analyses.
7. One off-site duplicate will be conducted per 10 off-site analyses.
8. Each off-site duplicate will also have a QA split sample sent to the USACE QA Lab.
9. One set of MS/MSD samples will be collected per each 20 off-site VOC analyses.
10. One groundwater sample will be collected per each 15 ft interval of saturated thickness. The number of groundwater samples collected at each sample point will depend on the saturated thickness of the aquifer.
11. XX, YY, …. indicate depth bgs of sample collection.
12. QA/QC samples to be numbered per sample depth interval with "11" and "01"as deepest sample depth interval.
13. See Figure 5-5 for other sample points.

bgs - below ground surface
MS - matrix spike
MSD - matrix spike duplicate

NA - Not Applicable
QA - quality assurance
TBD - to be determined
VOCs - volatile organic compounds

Table 5-6
Sampling Requirements
Groundwater Plume Areas
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

						Parameters			QA/QC Sample Designators			
Plume	Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site NA Indicator Parameters (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
A	1A01	Detailed in Table 5-3										
A	JET	Detailed in Table 5-2										
B	1B01	A	GWXX	TBD	Groundwater	X	X		GWXXDUP	GW11*	GW01QA	GW01X
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		C	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X	X		GWYYDUP	GW22	GW02QA	
			(Notes 9,10)	(Note 9)	Groundwater	X						
		E	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		G	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		I	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		K	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		M	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		O	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		Q	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
C	1C01	Detailed in Table 5-5										

Table 5-6
Sampling Requirements
Groundwater Plume Areas
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

						Parameters			QA/QC Sample Designators			
Plume	Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site NA Indicator Parameters (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
C	2C20	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		F	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		K	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		Note 12	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
C	3C20	AA	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		AC	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		Y	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		Note 12	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
C	4C01	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		C	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		E	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						

Table 5-6
Sampling Requirements
Groundwater Plume Areas
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

						Parameters			QA/QC Sample Designators			
Plume	Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site NA Indicator Parameters (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
C	5C01	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		C	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		E	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		G	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		I	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		K	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
C	6C01	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		C	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		E	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		G	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						

Table 5-6
Sampling Requirements
Groundwater Plume Areas
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

						Parameters			QA/QC Sample Designators			
Plume	Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site NA Indicator Parameters (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
C	6C01	I	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		K	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		M	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		O	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
C	837/847	Detailed in Table 5-5										
D	1D01	Detailed in Table 5-4										
D	2D01	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		C	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		E	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		G	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		I	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						

Table 5-6
Sampling Requirements
Groundwater Plume Areas
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

						Parameters			QA/QC Sample Designators			
Plume	Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site NA Indicator Parameters (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
D	3D01	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		C	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		E	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		G	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		I	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		K	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		M	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		O	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
D	4D01	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		C	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						

Table 5-6
Sampling Requirements
Groundwater Plume Areas
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

						Parameters			QA/QC Sample Designators			
Plume	Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site NA Indicator Parameters (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
		E	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		G	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		I	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		K	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		M	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		O	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
D	5D20	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		F	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		Note 13	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
D	LOX	Detailed in Table 5-4										
E	1E20	A	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		F	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						

Table 5-6
Sampling Requirements
Groundwater Plume Areas
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

						Parameters			QA/QC Sample Designators			
Plume	Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site NA Indicator Parameters (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)
		K	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		Note 14	GWXX	TBD	Groundwater	X						
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
Pump Tests	DP	PT01	GWXX	TBD	Groundwater	X	X (Note 15)					
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
		PT02	GWXX	TBD	Groundwater	X	X (Note 15)					
			GWYY	TBD	Groundwater	X						
			(Notes 9,10)	(Note 9)	Groundwater	X						
Various	Wells	99MXXx	GW01	NA	Groundwater		X	X (Note 16)				

Table 5-6
Sampling Requirements
Groundwater Plume Areas
OU 1 Remedial Investigation Addendum/Feasibility Study
Former Schilling Air Force Base, Kansas

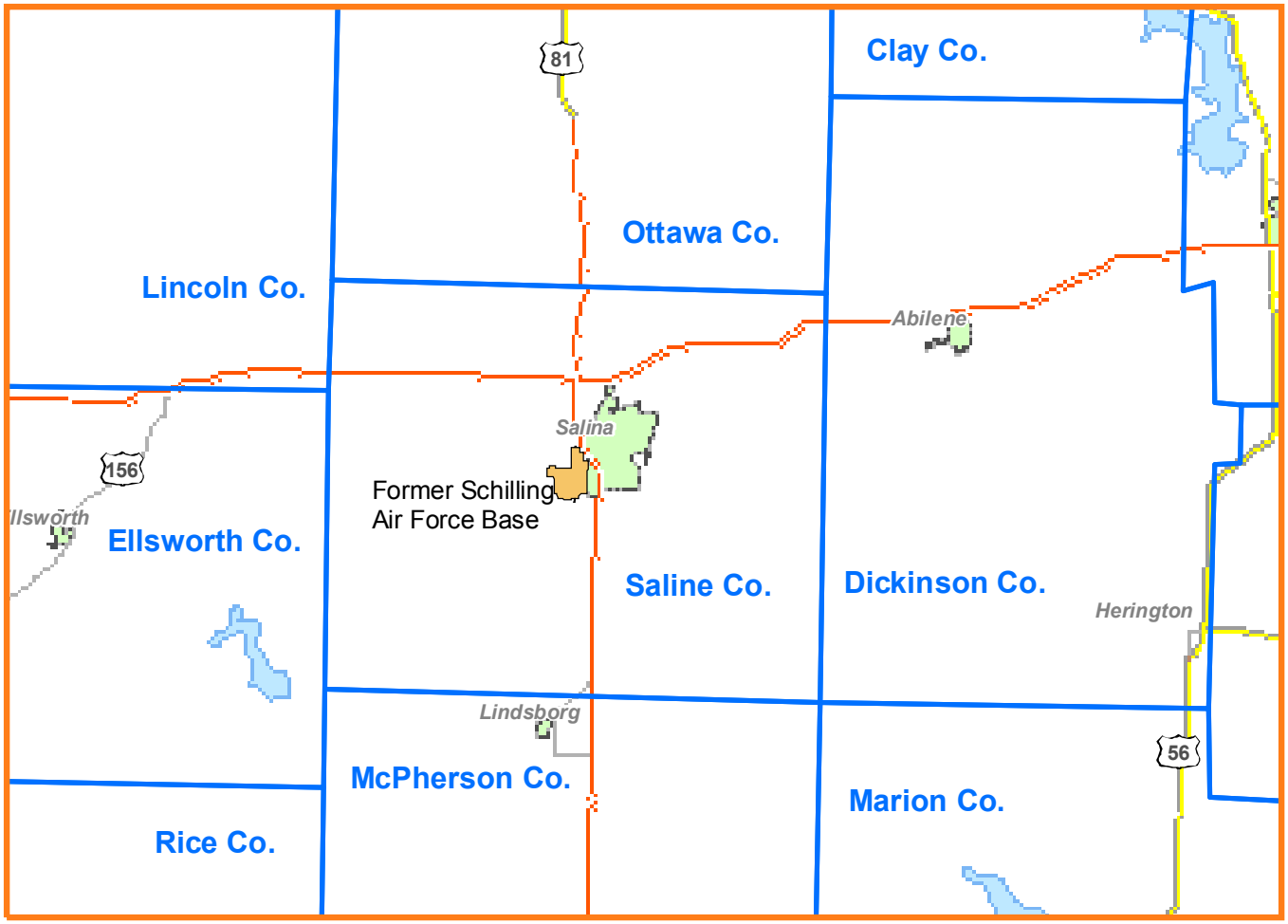
						Parameters			QA/QC Sample Designators			
Plume	Area	Sample Point	Sample Designator	Sample Interval (bgs)	Matrix	On-Site VOCs (Note 1)	Off-Site VOCs (Notes 2, 3)	Off-Site NA Indicator Parameters (Note 4)	On-Site Duplicate (Note 5)	Off-Site Duplicate (Notes 6, 11)	QA Sample (Notes 7, 11)	MS/MSD (Notes 8, 11)

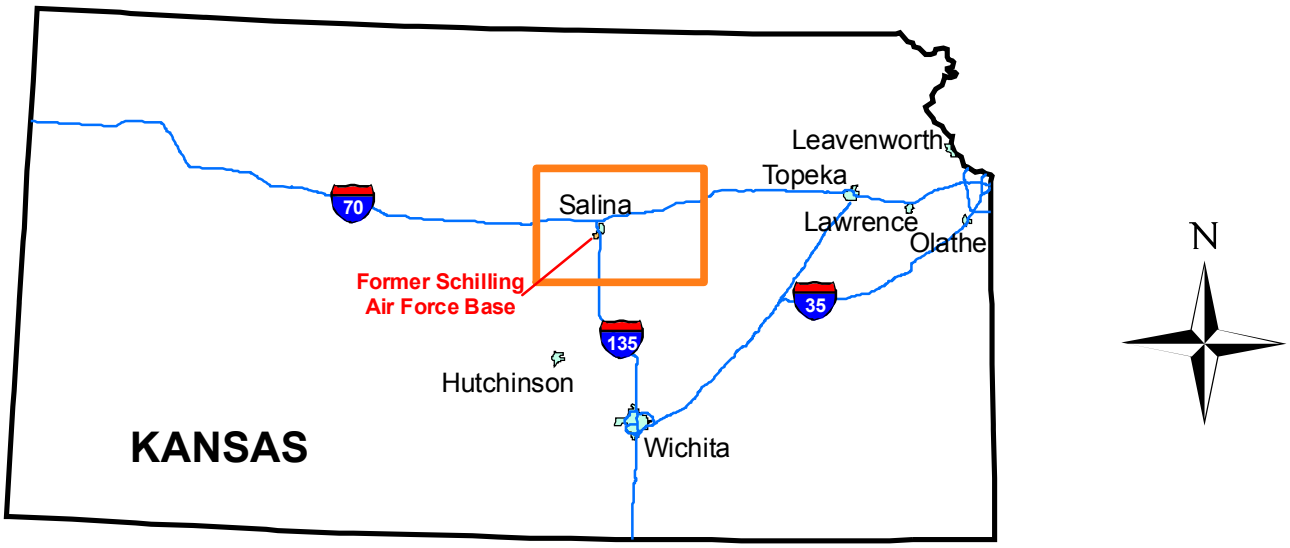
Notes:
This table shows the general sampling requirements and sample labeling scheme. Due to the interative nature of the field activities at this location, this table will not list all sample requirements for collection in the field. These are unknown at this time.

1. On-site VOCs includes tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, and 1,1-dichloroethene except for those samples associated with Area 3C20, which will also include carbon tetrachloride.
2. One groundwater sample per 10 on-site GC analyses will be sent to an off-site laboratory as a confirmation sample.
3. Off-site VOCs analysis will be performed using Method SW-846 5030B/8260B.
4. Natural attenuation indicator parameters include methane, ethane, ethene, iron, nitrate, nitrite, sulfate, sulfide, alkalinity, chloride, dissolved oxygen, and oxidation-reduction potential, and TOC.
5. One on-site duplicate will be analyzed per 10 on-site analyses.
6. One off-site duplicate will be analyzed per 10 off-site analysis.
7. Each off-site duplicate will also have a QA split sample sent to the USACE QA Laboratory.
8. One set of MS/MSD samples will be analyzed per each 20 off-site VOC analyses.
9. One groundwater sample will be collected per each 15-foot interval of saturated thickness with three exceptions. One boring per Sample Grid 2C, Sample Grid 5D, and Sample Grid 1E will be sampled at approximately 10 foot intervals. The number of groundwater samples collected at each sample point will depend on the saturated thickness of the aquifer.
10. XX, YY, …. indicate depth bgs of sample collection.
11. QA/QC samples to be numbered per sample depth interval with "11" and "01" as deepest sample depth interval.
12. See Figure 5-6 for other potential sample points.
13. See Figure 5-7 for other potential sample points.
14. See Figure 5-8 for other potential sample points.
15. The off-site VOC confirmation sample will be conducted on the deepest sample interval.
16. Only 20 percent of monitoring wells will be analyzed for off-site NA parameters.

bgs - below ground surface
MS - matrix spike
MSD - matrix spike duplicate
NA - not applicable
QA - quality assurance
TBD - to be determined
TOC - total organic carbon
USACE - United States Army Corps of Engineers
VOCs - volatile organic compounds

FIGURES





Burns & McDonnell
SINCE 1898

Figure 1-1

SITE LOCATON MAP

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

U:\Schilling\ARC\ArcDocs\Historical Review\Fig1-1_SiteLocationMap.mxd dls mh 08/18/2006

Authority / Lead Organization:
U.S. Army Corps of Engineers – Kansas City District
Project Manager: Robyn Kiefer (816-389-3615)

Regulatory Review and Concurrence:
Kansas Department of Health & Environment
Jorge Jacobs (785-296-8801)
United States Environmental Protection Agency
Ken Rapplean (913-551-7769)

Primary Contractor:
Malcolm Pirnie, Inc.
Role: Program Management and Quality Control
Program Manager: John Logigian (914-641-2690)

Primary Contractor:
US Army Corps of Engineers
Vicksburg, Mississippi
Role: Quality Assurance Sample Preparation and Analysis
Project Contact: Dr. Tony Bednar (601-634-3652)

Investigative Organization:
Burns & McDonnell Engineering Company, Inc.
Role: Document Preparation, Sample Collection, and Data Reporting
Project Manager: Tracy Cooley (816-822-3369)
Technical Lead: Ed Lindgren (816-822-3595)
QC Coordinator: Sharon Shelton (816-822-3168)
Project Geologist: Martha Hildebrandt (816-822-3891)
Project Hydrogeologist: Tom Zychinski (636-305-0077)
Project Chemist: Shauna Lawrence (816-822-3940)
Project Safety and Health Manager: Eric Wenger (816-822-3894)
Malcolm Pirnie, Inc.
Role: Risk Assessment
Project Risk Assessor: Richard Califano (201-398-4307)

Investigative Organization QA Officer:
Burns & McDonnell Engineering Company, Inc.
Colm Chomicky (816-822-3889)

Subcontractors:

Analytical Management Laboratories, Inc
Role: Sample Preparation and Analysis
Project Contact: Dr. Tenasi Viswanathan (913-829-0101)

GeoCore Services, Inc
Role: Drilling and Monitoring Well Installation
Project Contact: Dale Robl (785-826-1616)

Environmental Priority Service, Inc.
Role: Direct Push and On-Site Analysis
Project Contact: Pat Martin (785-823-6205)

Carlson-Baughman
Role: Surveyor
Project Contact: Mark Carlson (785-628-3219)

Burns & McDonnell
SINCE 1898

Figure 2-1
PROJECT ORGANIZATIONAL CHART
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

K:\ENV\MALCOLM PIRNIE INC\Site\42244\Deliver\OU1 RI Plans\FSP\Draft Final\FSP Figures\Figure 2-1.vsd

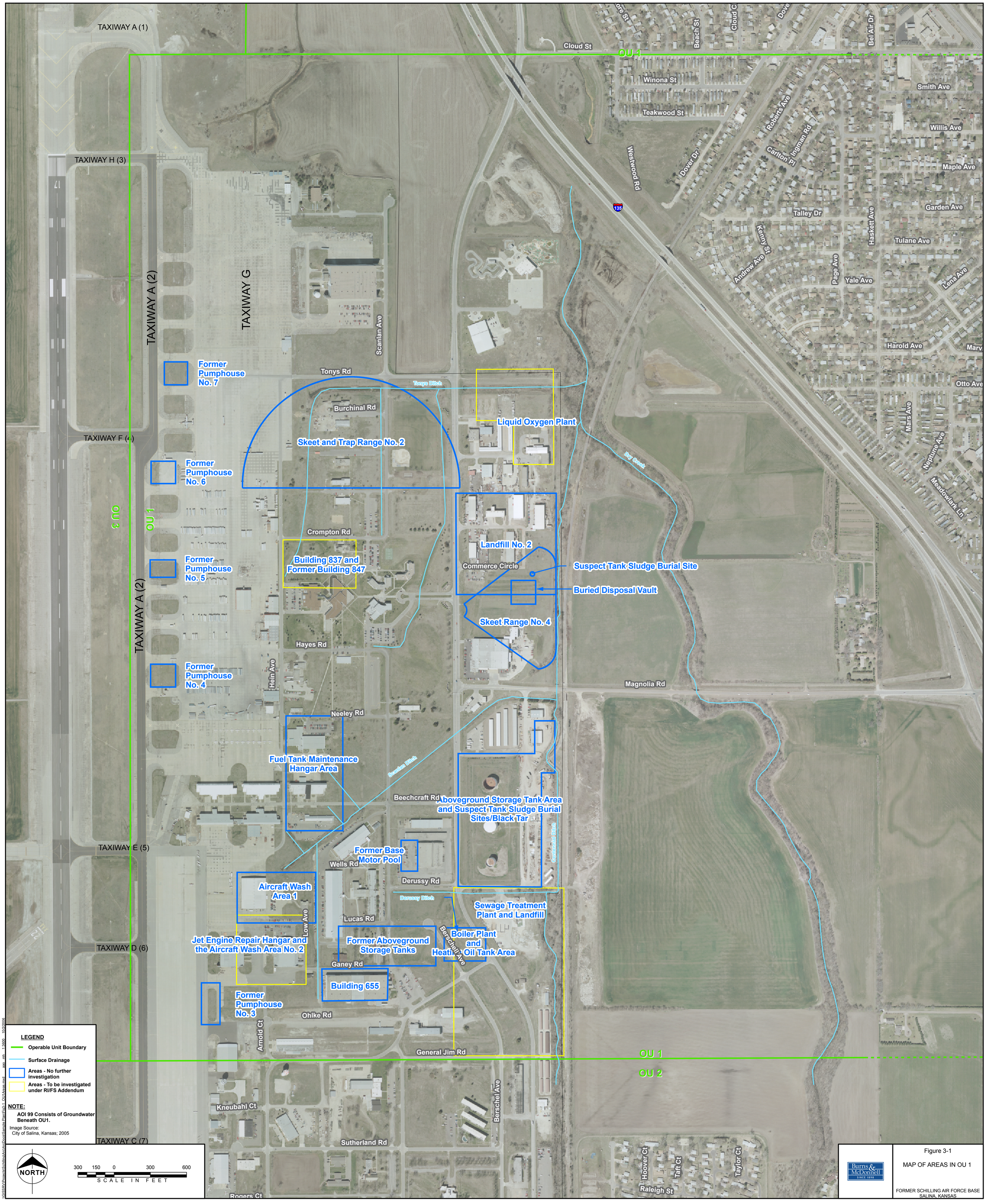
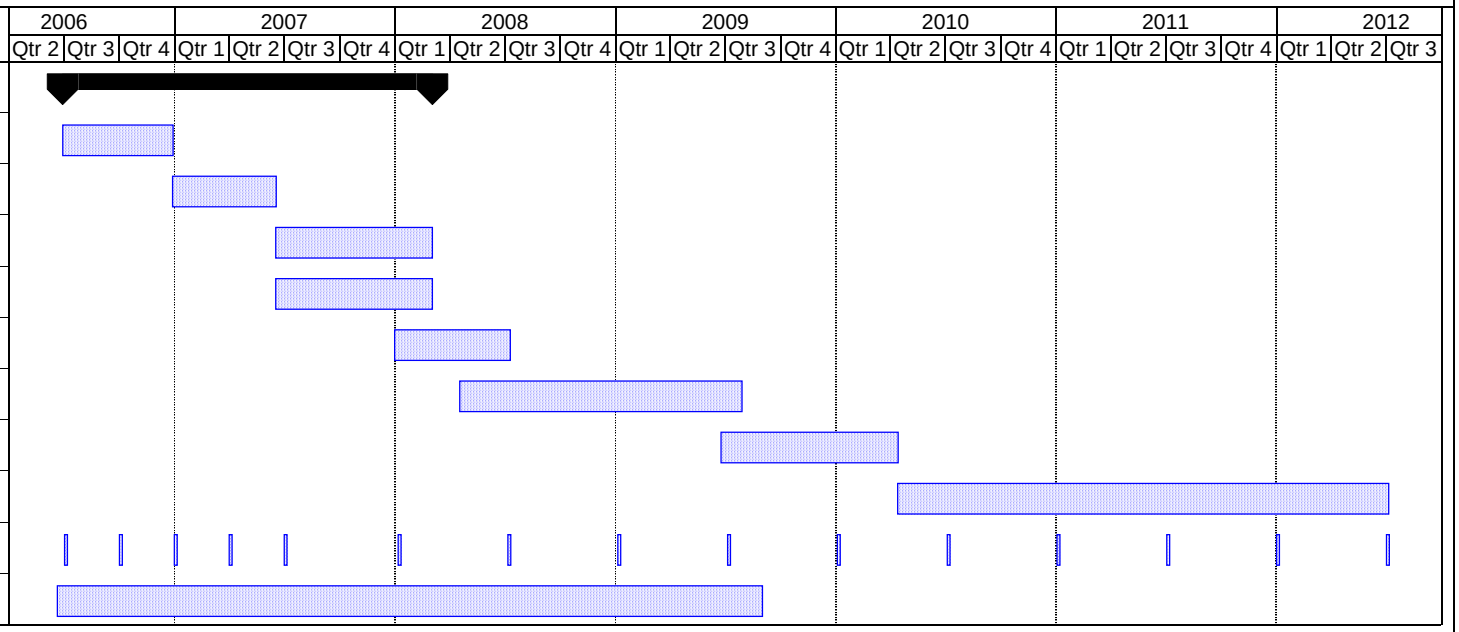

TAXIWAY A (1)
TAXIWAY H (3)
TAXIWAY A (2)
TAXIWAY G
TAXIWAY F (4)
TAXIWAY E (5)
TAXIWAY D (6)
TAXIWAY C (7)
OU 1
OU 2
OU 3
Cloud St
Winona St
Teakwood St
Westwood Rd
Dover Dr
Roberts Ave
Ingman Rd
Carlton Pl
Smith Ave
Willis Ave
Maple Ave
Garden Ave
Tulane Ave
Lena Ave
Harold Ave
Otto Ave
Talley Dr
Kenny St
Andrew Ave
Page Ave
Yale Ave
Haskett Ave
Mars Ave
Neptune Ave
Meadowlark Ln
Scanlan Ave
Tonys Rd
Tonys Ditch
Burchinal Rd
Crompton Rd
Hayes Rd
Hein Ave
Neeley Rd
Sermon Ditch
Beechcraft Rd
Wells Rd
Derussy Rd
Derussy Ditch
Lucas Rd
Low Ave
Ganey Rd
Ohlke Rd
Arnold Ct
General Jim Rd
Kneubahl Ct
Sutherland Rd
Rogers Ct
Berschel Ave
Centennial Ditch
Dry Creek
Magnolia Rd
Commerce Circle
Hoover Ct
Taft Ct
Taylor Ct
Raleigh St
Former Pumphouse No. 7
Former Pumphouse No. 6
Former Pumphouse No. 5
Former Pumphouse No. 4
Former Pumphouse No. 3
Skeet and Trap Range No. 2
Liquid Oxygen Plant
Building 837 and Former Building 847
Landfill No. 2
Suspect Tank Sludge Burial Site
Buried Disposal Vault
Skeet Range No. 4
Fuel Tank Maintenance Hangar Area
Aboveground Storage Tank Area and Suspect Tank Sludge Burial Sites/Black Tar
Former Base Motor Pool
Aircraft Wash Area 1
Jet Engine Repair Hangar and the Aircraft Wash Area No. 2
Former Aboveground Storage Tanks
Boiler Plant and Heating Oil Tank Area
Sewage Treatment Plant and Landfill
Building 655
LEGEND
Operable Unit Boundary
Surface Drainage
Areas - No further investigation
Areas - To be investigated under RI/FS Addendum
NOTE:
AOI 99 Consists of Groundwater Beneath OU1.
Image Source:
City of Salina, Kansas; 2005
NORTH
300 150 0 300 600
SCALE IN FEET
Burns & McDonnell
SINCE 1898
Figure 3-1
MAP OF AREAS IN OU 1
FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

Figure 3-2
OU 1 Schedule
Former Schilling Air Force Base
Salina, Kansas

ID	Task Name
1	**Remedial Investigation (RI)**
2	RI Addendum Work Plan
3	RI Addendum Field Work
4	RI Report Addendum
5	BLRA Addendum
6	Feasibility Study
7	Decision Document
8	Remedial Design
9	Remedial Action
10	**Groundwater Monitoring**
26	Interim Remedial Action



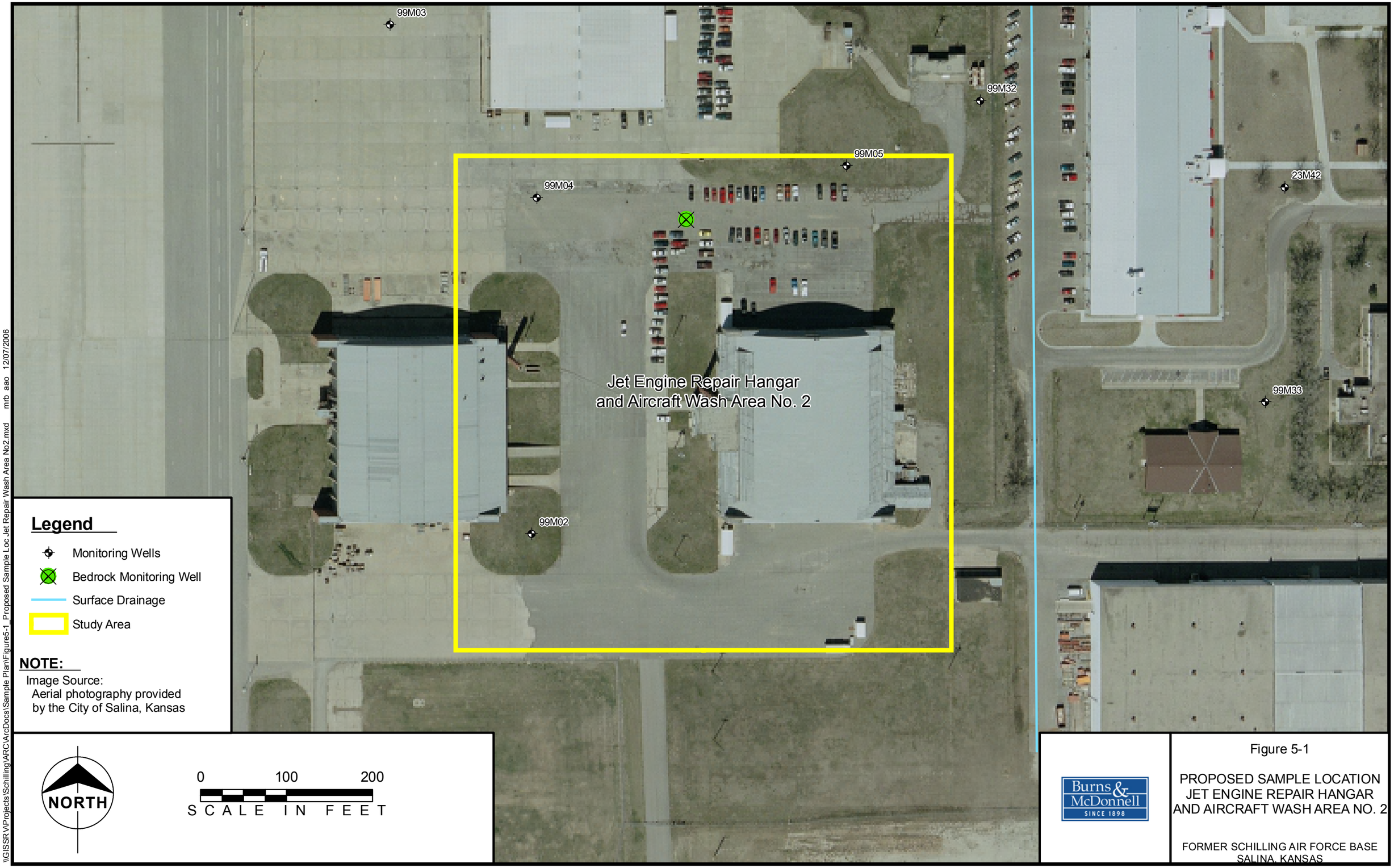


Figure 5-1

PROPOSED SAMPLE LOCATION
JET ENGINE REPAIR HANGAR
AND AIRCRAFT WASH AREA NO. 2

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

\\GISSR\Projects\Schilling\ARC\ArcDocs\Sample Plan\Figure5-1_Proposed Sample Loc Jet Repair Wash Area No2.mxd mrb aao 12/07/2006

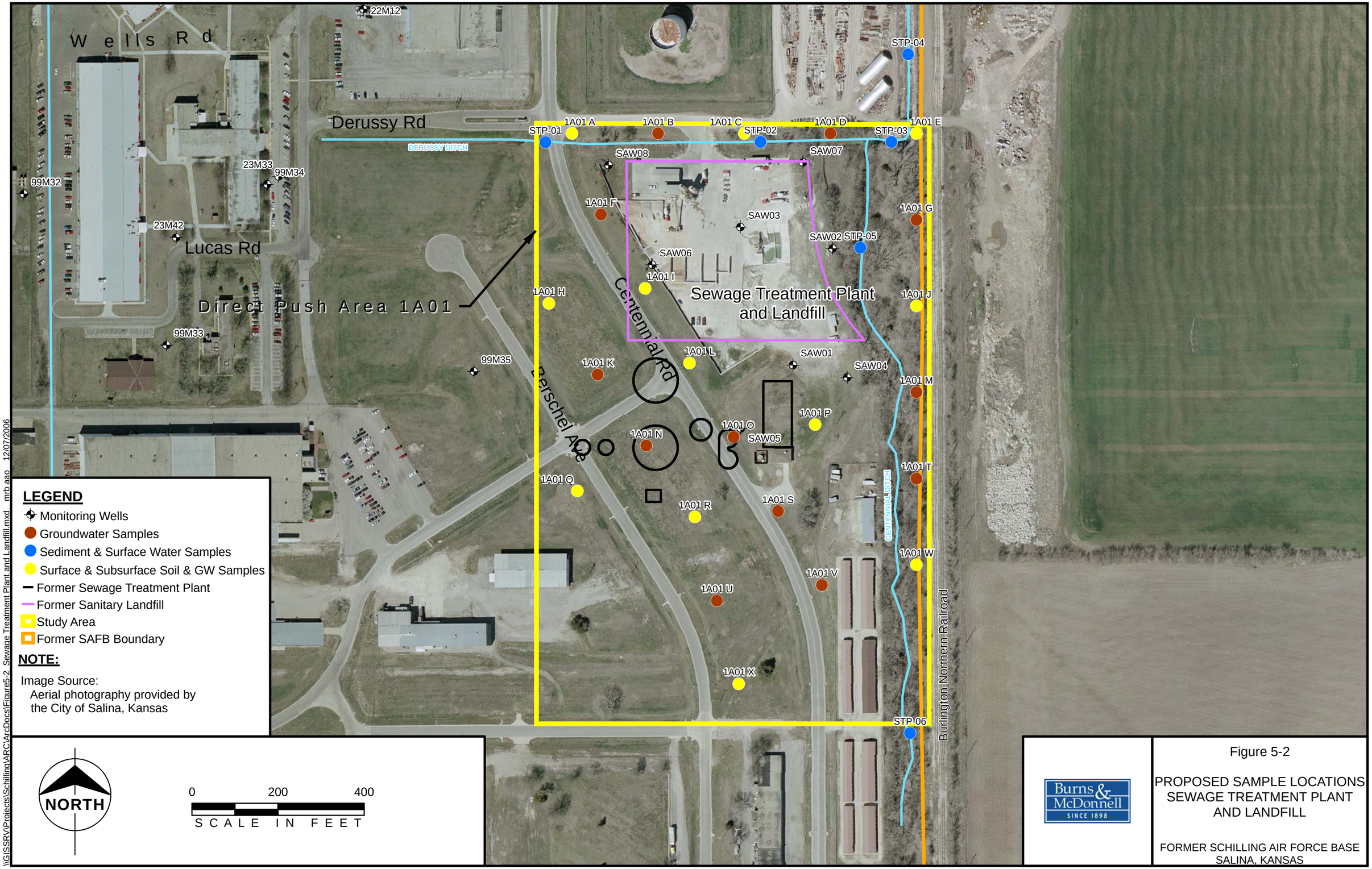


Figure 5-2

PROPOSED SAMPLE LOCATIONS
SEWAGE TREATMENT PLANT
AND LANDFILL

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

\\GISSRV\Projects\Schilling\ARC\ArcDocs\Figure5-2_Sewage Treatment Plant and Landfill.mxd mrb aao 12/07/2006

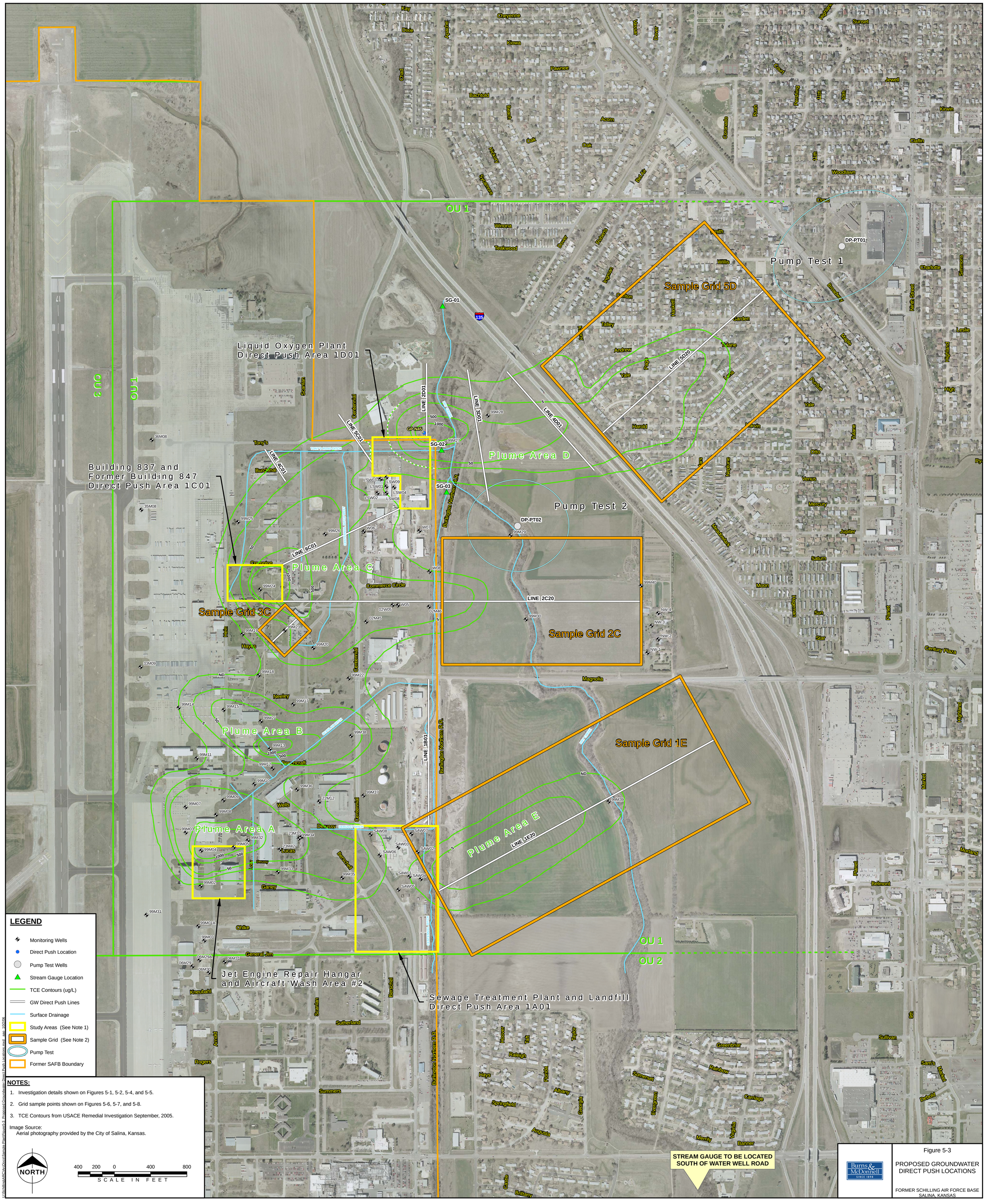


Figure 5-3

PROPOSED GROUNDWATER DIRECT PUSH LOCATIONS

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

U:\Schilling\ARC\ArcDocs\Sample Plan\Figure5-3_Proposed Groundwater Direct Push Locations.mxd aap 10/2/06

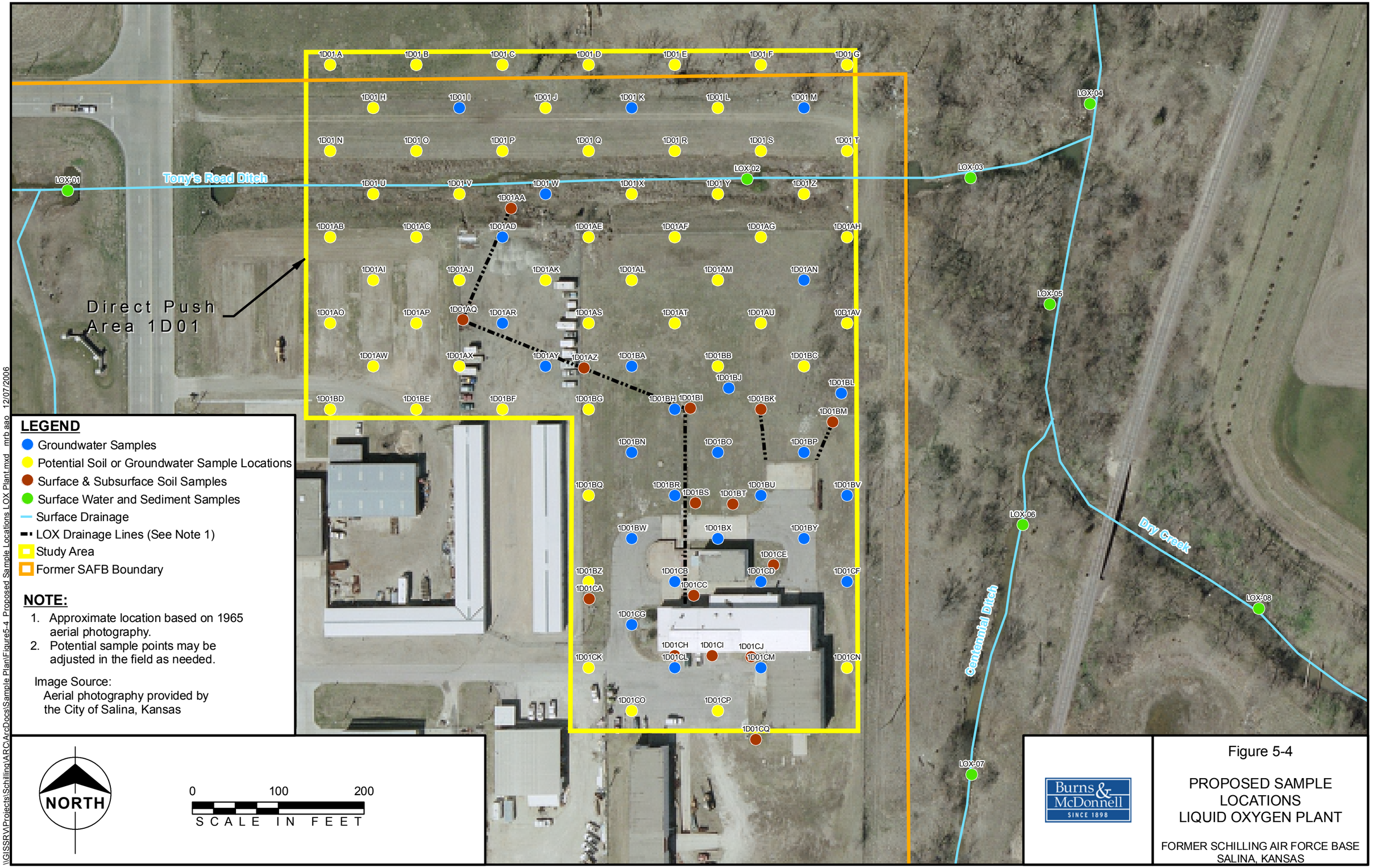


Figure 5-4

PROPOSED SAMPLE LOCATIONS
LIQUID OXYGEN PLANT

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

\\GISSRV\Projects\Schilling\ARC\ArcDocs\Sample Plan\Figure5-4_Proposed Sample Locations LOX Plant.mxd mrb aao 12/07/2006

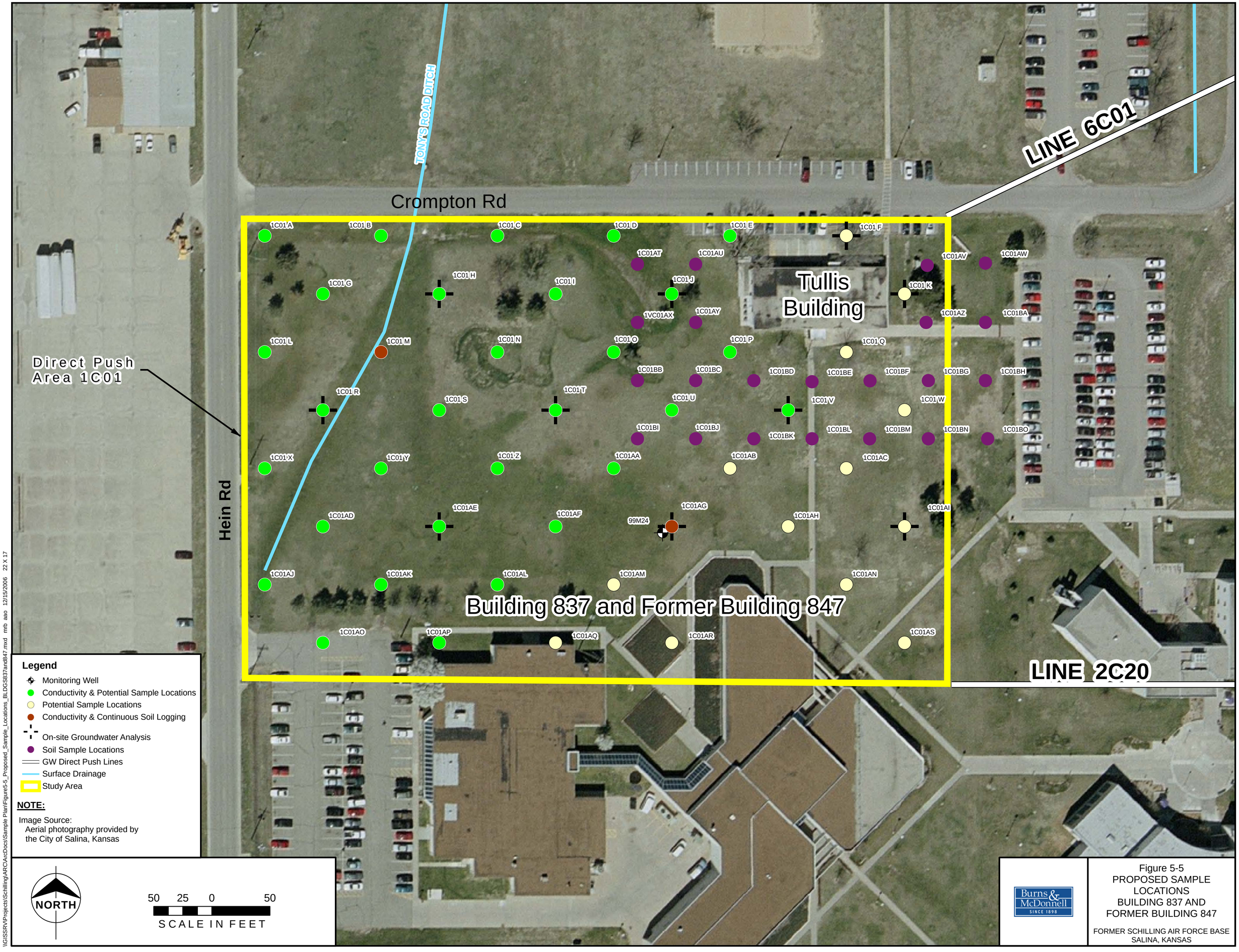


Figure 5-5
PROPOSED SAMPLE LOCATIONS
BUILDING 837 AND FORMER BUILDING 847

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

\\GISSRV\Projects\Schilling\ARC\ArcDocs\Sample Plan\Figure5-5_Proposed_Sample_Locations_BLDGS837and847.mxd mrb aao 12/15/2006 22 X 17

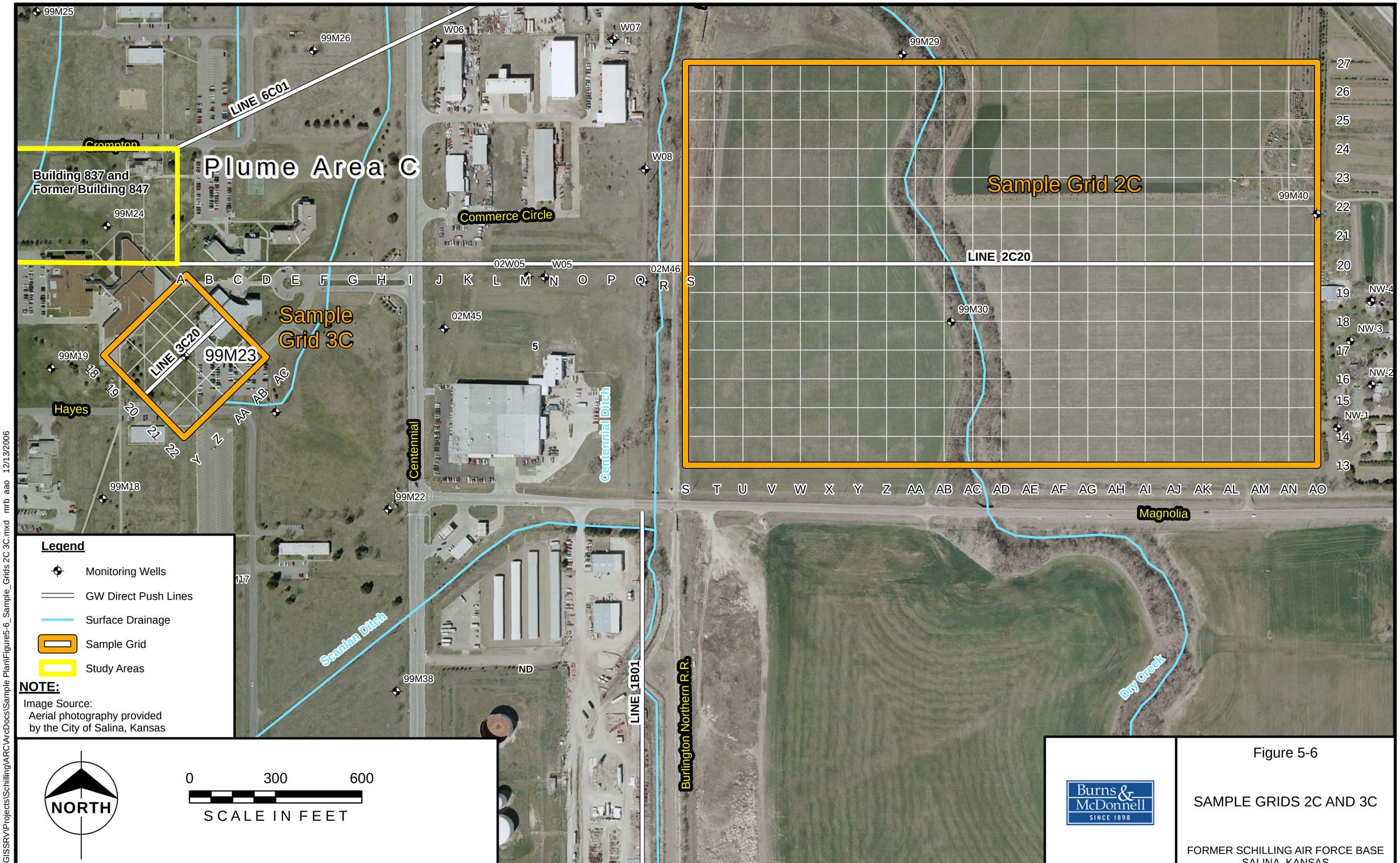


Figure 5-6

SAMPLE GRIDS 2C AND 3C

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

\\GISSRV\Projects\Schilling\ARC\ArcDocs\Sample Plan\Figure5-6_Sample_Grids 2C 3C.mxd mrb aao 12/13/2006

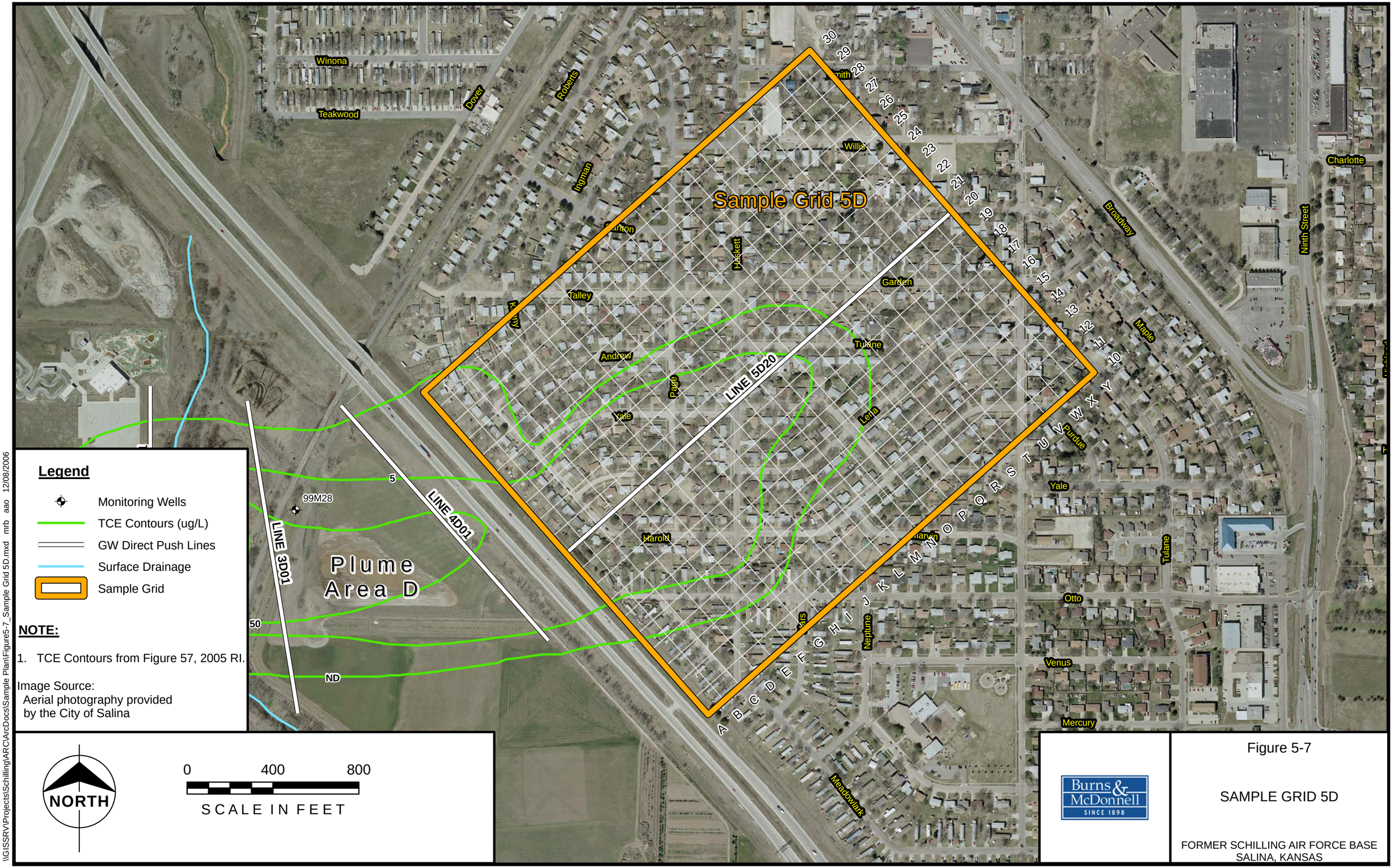


Figure 5-7

SAMPLE GRID 5D

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

\\GISSRV\Projects\Schilling\ARC\ArcDocs\Sample Plan\Figure5-7_Sample Grid 5D.mxd mrb aao 12/08/2006

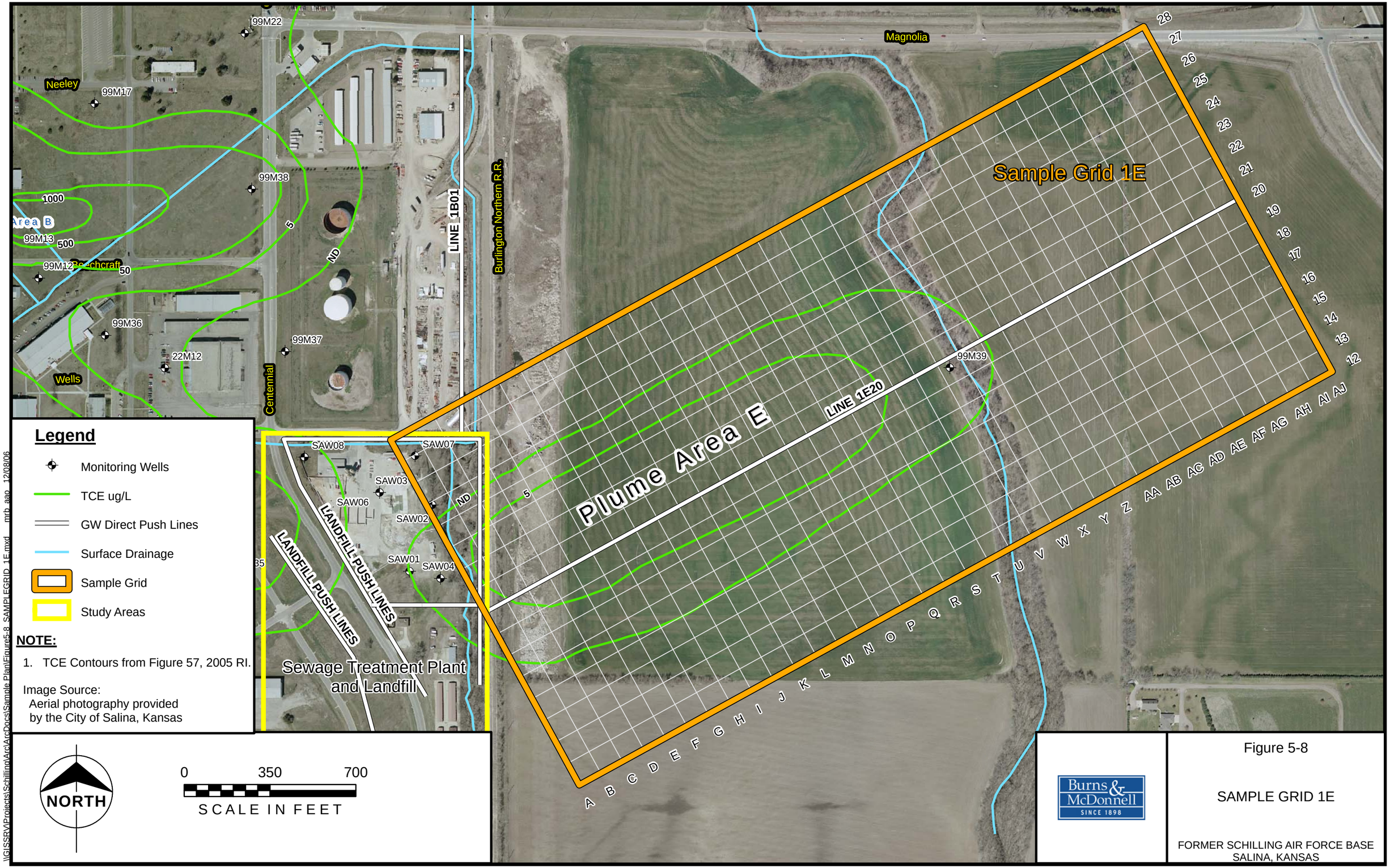
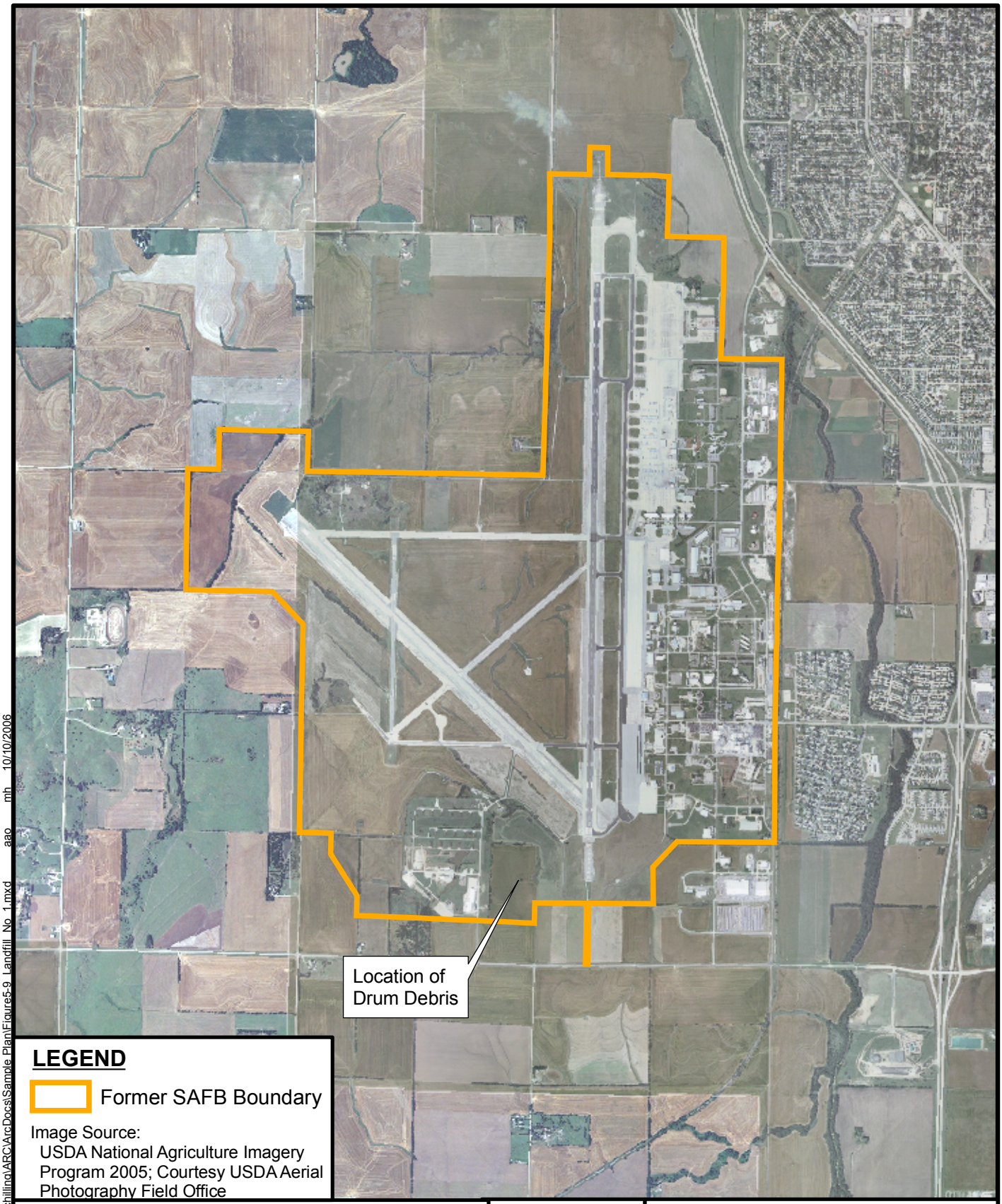


Figure 5-8

SAMPLE GRID 1E

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

\\GISSRV\Projects\Schilling\Arc\ArcDocs\Sample Plan\Figure5-8_SAMPLEGRID_1E.mxd mrb aao 12/08/06



LEGEND

Former SAFB Boundary

Image Source:
USDA National Agriculture Imagery Program 2005; Courtesy USDA Aerial Photography Field Office

NORTH

3,000 1,500 0 3,000 6,000

SCALE IN FEET

Burns & McDonnell
SINCE 1898

Figure 5-9

Landfill No. 1 Area

FORMER SCHILLING AIR FORCE BASE
SALINA, KANSAS

U:\Schilling\ARC\ArcDocs\U:\Schilling\ARC\ArcDocs\Sample Plan\Figure5-9_Landfill_No_1.mxd aao mh 10/10/2006

APPENDICES

APPENDIX A

Monitoring Well Installation Plan

Final
Sampling and Analysis Plan
Volume I – Field Sampling Plan

Appendix A
Monitoring Well Installation Plan

OU 1 Remedial Investigation Addendum/ Feasibility Study

Former Schilling Air Force Base
Salina, Kansas

January 12, 2007

Prepared for

U.S. Army Corps of Engineers
Kansas City District

Prepared by

MALCOLM PIRNIE

Burns & McDonnell
SINCE 1898

Contract Number: W912DQ-06-D-0006
Project Number: 42244

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Monitoring Well Installation Diagram
Well Development Record

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2	Generalized Schematic for Pump Test

LIST OF ACRONYMS AND ABBREVIATIONS

APP	Accident Prevention Plan
ASTM	American Society for Testing and Materials
BMcD	Burns & McDonnell Engineering Company, Inc.
bgs	Below Ground Surface
CENWK	United States Army Engineer District – Kansas City
cm	Centimeter
DNAPL	Dense Non-Aqueous Phase Liquid
ft	Feet/Foot
HSAs	Hollow-Stem Augers
K	Hydraulic Conductivity
KAR	Kansas Administrative Regulations
KDHE	Kansas Department of Health and Environment
LDNAPL	Light Non-Aqueous Phase Liquid
M	Saturated Thickness of the Aquifer
MP	Malcolm Pirnie
MWIP	Monitoring Well Installation Plan
NAD	North American Datum
NSF	National Sanitation Foundation
NTU	Nephelometric Turbidity Unit
PM	Project Manager
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
ROI	Radius of Influence
s	Second
S	Storativity
SAFB	Schilling Air Force Base
SAP	Sampling and Analysis Plan
T	Transmissivity
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
U_c	Uniformity Coefficient
UTM	Universal Transverse Mercator
WP	Work Plan
Yr	Year

1.0 INTRODUCTION

1.1 BACKGROUND

Field investigations are planned for certain areas identified in the *Work Plan, OU 1 Remedial Investigation/Feasibility Addendum, Former Schilling Air Force Base, Salina, Kansas* (WP) (United States Army Corps of Engineers [USACE], 2007a). The scope of these investigations includes advancing borings to collect soil samples for chemical or geologic analyses and installing monitoring wells and piezometers. Investigations may also include collecting groundwater screening samples without installing monitoring wells. This Monitoring Well Installation Plan (MWIP) is designed to support the *Sampling and Analysis Plan, Volume I – Field Sampling Plan, OU 1 Remedial Investigation/Feasibility Study Addendum, Former Schilling Air Force Base, Salina, Kansas* (SAP) (USACE, 2007b). It should be used in conjunction with the *Accident Prevention Plan, OU 1 Remedial Investigation/Feasibility Study Addendum, Former Schilling Air Force Base, Salina, Kansas* (APP) (USACE, 2007c).

1.2 OBJECTIVES

The MWIP sets forth general procedures for site drilling, aquifer testing, and installing and developing monitoring wells and piezometers.

1.3 SCOPE

The MWIP describes drilling procedures appropriate for the anticipated subsurface conditions in the Former Schilling Air Force Base (SAFB) area. Construction procedures and drilling methods are described for typical monitoring well and piezometer installation. In addition, general methods are presented for bedrock coring and pump test well installation. In the event modifications to methods are required, BMcD will propose an alternative method to the United States Army Engineering District - Kansas City (CENWK) project manager (PM) for review on a case-by-case basis.

* * * * *

2.0 DRILLING METHODS

Boreholes will be advanced for monitoring well/piezometer installation and/or subsurface sample collection using one or more different drilling methods. Based on information obtained during previous field investigations, geologic and hydrogeologic conditions vary throughout the subsurface environment at SAFB. Generally, two hydrogeologic environments are present beneath SAFB: the bedrock uplands and the alluvial valley floor and terraces of the Smokey Hill River. The soils on the site have a silty or clayey subsoil. Shallow bedrock is typically encountered at 1 to 15 feet (ft) below ground surface (bgs) in the uplands, which are primarily located in the southern and western portions of SAFB including some of the inter-runway areas. Bedrock is usually present at depths greater than 20 ft bgs on the alluvial floor and terraces, which are primarily located in the northern and eastern portions of the SAFB. On the northeast portion of the SAFB, the depth to bedrock increased to approximately 70 ft bgs. The boundary between the two regimes is gradational and cannot be discerned from the surface features (USACE, 1999)

Anticipated drilling methods include hollow-stem augers (HSAs), direct rotary wash, cable tool, rotosonic, and rock coring. Direct air rotary may also be used. Other drilling methods will be presented to the CENWK for review on a case-by-case basis if unexpected drilling conditions occur. Wells and piezometers completions will be either above-grade or flush-mount surface completions using procedures described in Section 3.1 of this MWIP.

2.1 HOLLOW-STEM AUGER

The hollow-stem, continuous-flight augering method is expected to be used for sampling and well installation in relatively shallow, unconsolidated material. The augers are constructed by welding flights onto a hollow pipe. The lead auger in the drill string is mounted with a cutting head (bit) to advance it through the subsurface material.

Soil samples can be collected during drilling using a continuous split-barrel sampling device that is advanced ahead of the lead auger. This approach provides a mechanism to collect subsurface soil samples for geologic definition and/or chemical analysis.

When the desired drilling depth is attained, the well screen, casing, gravel pack, and other well materials can be installed through the HSAs as they are withdrawn from the subsurface. By using the HSAs as a temporary casing, a well can be installed without the use of drilling fluid to maintain borehole integrity.

The HSA drilling method will be used to install shallow monitoring wells and will also be used to advance the boring through unconsolidated material prior to setting a surface casing for the bedrock (cored) borings.

2.2 DIRECT AIR ROTARY

The direct air rotary method is primarily used for well installation in consolidated material. Air rotary can also be used in combination with a temporary casing driving mechanism in unconsolidated material. Air rotary drilling forces air down the center of the drill pipe, through the bit, and back up the bore to remove the drill cuttings. Tri-coned roller bits and winged drag bits are commonly used. Generally, tri-coned bits are used for advancing through hard rock and drag bits are used in softer material. Small quantities of water can be added to the air to reduce dust and aid in removal of cuttings from the borehole. It is important to filter the compressed air prior to use downhole as compressor oil could escape into the borehole.

2.3 DIRECT ROTARY WASH

The direct rotary wash drilling method was developed to increase drilling speeds and to reach greater depths in most formations. The borehole is drilled by rotating a bit, and cuttings are removed by continuous circulation of a drilling fluid as the bit penetrates the formation. The bit is attached to the lower end of a string of drill pipe, which transmits the rotating action from the rig to the bit. In the direct rotary wash system, drilling fluid is pumped down through the drill pipe and out through the ports or jets in the bit; the fluid then flows upward in the annular space between the hole and drill pipe, carrying the cuttings in suspension to the surface. At the surface, the fluid is channeled into a settling pit or pits, where most of the cuttings drop out. Clean fluid is then picked up by the pump at the far end of the pit and is recirculated down the hole. The direct rotary wash drilling method will be used to install the wells and piezometers for the two pump tests.

2.4 CABLE TOOL

The cable-tool method of drilling advances a borehole using entirely mechanical procedures. The borehole is advanced by lifting and dropping a heavy string of drill tools repeatedly in the borehole. As a result of this repetitive action, the subsurface material within the borehole is reduced to mud and chips that can be pumped or bailed to the surface. Above the water table, it may be necessary to add water to the boring to facilitate the removal of cuttings. An alternative means of advancing a borehole is to continuously use a drive sampling device (drive barrel) in unconsolidated material. Use of a drive barrel

enables the recovery of a soil core. Under conditions expected at SAFB, it should not be necessary to add water to the borehole to enhance drilling effectiveness when using a drive barrel. This method of drilling has minimal impact on subsurface conditions.

When used in unconsolidated material and unstable borehole conditions, steel casing may be driven in conjunction with the drilling action to maintain an open borehole. Soil samples are collected and material is removed from the casing by use of the drive barrel sampler.

Using the cable-tool drilling method, well installation in unconsolidated material when the borehole is unstable is similar to the HSA method (see Section 2.1). The steel casing driven in conjunction with the drilling activity is used as a temporary casing to maintain an open borehole. The well is constructed within the casing, which is gradually removed as well construction progresses to the ground surface. In stable conditions, the well is installed through the open borehole.

2.5 ROTOSONIC

Rotosonic drilling combines high frequency vibrations, downward pressure, and relatively slow rotations to advance a dual string of drill pipe. This combination of forces advances the drill pipe through soil and rock without the use of drilling fluids.

A dual string of drill pipe is used to sample and advance the hole and consists of an inner core barrel sampler and an outer pipe casing. The core barrel is driven ahead of the outer casing and is used to collect a representative continuous core sample. Once the core barrel is driven to the required depth, the drill head (attached to the drill rig) is disconnected from the core barrel and reconnected to the outer casing. The outer casing is then driven down over the core barrel. The casing prevents the hole from collapsing when the core barrel is extracted for sample retrieval. Drilling can be completed without the use of drill fluids, but water is commonly used during driving of the outer casing to flush material from the annular space between the core barrel and pipe casing. Attached to the tip of both the core barrel sampler and the outer drill casing are hardened steel casing shoe-type bits. The drill bits have several carbide buttons around the tip and outer edge that cut through the soil and rock as the drill string is vibrated and rotated.

2.6 ROCK CORING

Diamond or tungsten carbide bit coring is used to collect high-quality, nearly undisturbed rock samples for geologic and laboratory analysis using direct air rotary or direct rotary wash methods. Due to cost considerations, this method is not normally used for monitoring well construction because of the large diameter borehole needed to adequately install a well. It is useful, however, to drill pilot holes to obtain geologic or laboratory information prior to reaming the well borehole to a larger size using another method.

Using this drilling method, a tubular bit is rotated, cutting the rock, and obtaining a cylindrical piece of rock (core) within the core barrel. Either non-chlorinated potable water or air is pumped across the bit for cooling and to facilitate the removal of rock cuttings. As the bit advances into the rock, the core barrel slides over the rock core. At the end of the core run, the core barrel is retrieved, breaking the core near the bit. After the sample core is retrieved, it can be examined for geologic definition or analysis and logged.

* * * * *

3.0 MONITORING WELL AND PIEZOMETER CONSTRUCTION

Monitoring wells and piezometers will be constructed to minimize the potential for borehole collapse and cross-contamination between aquifers. Construction requirements common to all monitoring wells and piezometers are provided below in Section 3.1. Construction details for each specific type of well or piezometer is provided in Sections 3.2 through 3.4.

During borehole drilling, information including soil profile and bedrock description, soil sampling information, and evidence of contamination will be recorded by the on-site geologist on HTW drilling log forms MRK-55 and MRK-55-2 (see attachments for diagrams) in accordance with USACE requirements. The geologist who supervises the monitoring well or piezometer construction will complete the appropriate Monitoring Well Installation Diagram (see attachments for diagrams) for each well or piezometer. Copies of drilling logs and installation diagrams will be submitted to CENWK upon completion of the monitoring wells and piezometers. Additionally, the drilling subcontractor will complete and submit Kansas Department of Health and Environment (KDHE) form WWC-5.

3.1 GENERAL MONITORING WELL CONSTRUCTION REQUIREMENTS

Each monitoring well installed during field investigations at SAFB will be constructed according to the requirements set forth in the USACE guidance document entitled *Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites*, EM 1110-1-4000 (USACE, 1994) and KDHE regulations (Article 30) (KDHE, 1987). Additional guidance may be provided by the CENWK. The on-site geologist will have a copy of the guidance documents for reference. The following installation and construction requirements will be used:

1. Monitoring wells will be constructed with National Sanitation Foundation (NSF) potable water grade, flush-threaded PVC riser and screen that conforms to American Society of Testing and Materials (ASTM)-D 1785 standards. Riser and screen will be packaged in containers that bear the manufacturer's markings. Deviation from the use of PVC for well installation will be presented in the SAP for review and approval by the CENWK.

2. PVC monitoring well screen and riser pipe will be flush-threaded. The joints will be constructed so as to form a watertight seal. Screen bottoms will be sealed with a flush-

threaded PVC cap or slip-on cap secured with three, stainless steel, self-tapping screws. No glues or solvents shall be used in the construction of PVC monitoring wells.

3. PVC well screen shall be factory slotted and sized to be compatible with filter pack and aquifer materials. Field slotted or cut screens will not be used.

4. A minimum annulus of 2 inches will be maintained between the outside of the well casing and the borehole wall.

5. Centralizers will be used to maintain concentricity and alignment of the well in the borehole. Centralizers will not be installed in the filter pack or bentonite seal. Centralizers will not be used on wells installed through HSAs or in wells less than 30 ft deep.

6. The filter pack will consist of clean, inert, non-carbonate, uniform sand. The filter pack will be installed from the bottom of the borehole to approximately 3 to 5 ft above the top of the well screen to allow for settlement. The on-site geologist will confirm that the filter pack is uniform and continuous (has not bridged) by making frequent measurements during installation using a weighted tape measure.

7. Bentonite pellets or chips will be used as the primary well seal material above the filter pack. The bentonite will not be tremied into place within the borehole, but will be poured from the ground surface into the annulus and continually checked with a weighted tape to verify that no bridging has occurred. When installed above the water table, the bentonite pellets or chips will be hydrated in one-ft lifts using non-chlorinated potable water. The bentonite seal will be 3 to 5 ft thick.

8. The bentonite pellets and chips will be allowed to hydrate a minimum of 4 hours.

9. A high-solids bentonite grout slurry, mixed to manufacturer's specifications, will be used to fill the annulus above the bentonite seal to within 2 ft of the ground surface. The grout slurry will be emplaced using a tremie pipe with a side discharge. The grout may be poured in from the surface if the depth to the bentonite seal is less than 15 ft and the top of the bentonite seal is above the water table. The grout will be allowed to cure for a

minimum of 24 hours before well development. If the top of the primary seal is above the watertable, bentonite chips or pellets, hydrated in one-ft lifts, may be used instead of grout.

10. When the grout has cured to a depth of 3 ft bgs, a square or round concrete pad will be installed around the monitoring well. The borehole will be enlarged so that the concrete pad will extend away from the well casing at the surface and taper down to the size of the borehole within 2 to 3 ft. The top of the concrete pad will slope gently away from the protective cover, but be constructed nearly flush with the surrounding surface. A permanent survey monument will be placed in the concrete pad, with the well number stamped on the monument.

11. Depending on the location, the monitoring well will be completed either as an above-grade or a flush with grade well. In either case, the well will be completed in such a way so that there is enough room at the top of the well riser to the bottom of the protective cover to install a locking, protective cap (i.e., J-plug) on the riser.

12. Depending on the location, three 3-inch diameter steel posts could be placed around the concrete pad. These posts will be positioned one ft outside the pad and equally spaced. They will extend one foot above the protective casing and 2 ft bgs. The protective casing and posts will be painted orange in remote areas and brown in populated areas.

13. At locations where a well/piezometer is needed but groundwater is not apparent during drilling in the unconsolidated overburden, the borehole may be left open to determine if groundwater is seeping into the borehole. The borehole will be bermed and covered during this period to reduce the potential for entry of surface water runoff or contamination. After 24 hours (unless specified otherwise in the SAP), the on-site geologist will consult with the CENWK PM to determine if the borehole should be advanced further. Procedures for bedrock monitoring well construction are presented in Section 3.3.

14. Before groundwater sampling, each well will be developed according to specifications outlined in Section 4.0 of this document.

3.1.1 Screen Size and Filter Pack

Based on previous construction practice at this Site, monitoring wells will be completed with 0.010-inch slot size. The filter pack installed with these wells will consist of either 10-20 or 20-40 silica sand. Screen lengths for intermediate and deep overburden monitoring wells will be 10 ft. Shallow monitoring wells might require 15 ft of screen, depending on local conditions. Screen length for bedrock monitoring wells will be 5 ft.

The pumped wells and piezometers for the aquifer tests will be designed based on data collected from pilot borings. Screen size, length, and filter pack will be determined as part of this process, and are described in more detail in Section 3.5.2.

3.2 OVERBURDEN MONITORING WELL CONSTRUCTION

Monitoring wells will be constructed in overburden deposits consisting of unconsolidated residual, alluvial, and colluvial material to monitor groundwater quality. This general discussion describes certain types of wells and the reasons for their installation. Site-specific details for construction of these wells will be included in the SAP.

3.2.1 Water Table Monitoring Wells

When monitoring groundwater for certain volatile and semivolatile organic compounds, it is necessary to monitor at the water table because some of these compounds are lighter than water (specific gravity less than 1.0) (light non-aqueous phase liquids [LNAPLs]) and tend to accumulate there. Wells installed to monitor these compounds will be screened across the top of the water table, anticipating seasonal groundwater fluctuation. For these wells, the borehole will be advanced to the necessary depth below the top of the water table, drilling refusal, or bedrock, whichever occurs first. Construction requirements described in Section 3.1 will be used to install the wells/piezometers. The well screen will be set across the water table surface.

3.2.2 Monitoring Wells with Submerged Screens

When monitoring groundwater for compounds that are heavier than water (specific gravity greater than (dense non-aqueous phase liquids [DNAPLs], it is necessary to monitor in the deeper level of the aquifer because these compounds tend to migrate vertically downward and accumulate on surfaces of lesser permeability. Prior to drilling, the depth of the overburden will be estimated using readily available information such as geophysical survey interpretations, adjacent borehole data, and published literature.

For monitoring wells requiring a submerged screen, the borehole will be advanced to a target depth or slightly below the top of the overburden/bedrock interface (unit of less permeability) or refusal, whichever occurs first. Construction requirements described in Section 3.1 will be used to install the wells; the bottom of the screen will be set at, or just below, the overburden/bedrock (or less permeable) interface or at a predetermined depth. The top of the well screen will not necessarily extend above the top of the water table, depending on the saturated thickness of the aquifer.

3.3 BEDROCK MONITORING WELL CONSTRUCTION

Bedrock monitoring wells may be constructed when groundwater in the bedrock has been targeted for investigation. The monitoring well construction requirements include the following in addition to the list in Section 3.1:

- Prior to drilling, the depth of the overburden/bedrock interface will be estimated using readily available information such as geophysical survey interpretations, adjacent borehole data, and published literature.

- The borehole will be advanced five feet into competent bedrock.

- A 6-inch surface casing will be installed through the unconsolidated overburden to maintain the integrity of the borehole and isolate the bedrock zone from groundwater within the overburden while drilling into underlying bedrock. The surface casing will be set at least 5 ft into competent bedrock and cemented into place.

- Ten feet of bedrock core will be obtained, then the borehole reamed to a nominal 6-inch diameter and to the total depth of the corehole.

- Five feet of 0.010-inch will be installed at the bottom of the borehole.

- Filter pack will be installed to 3 feet above the top of the screen.

3.4 GEOTECHNICAL TESTING

Site-specific geotechnical testing will be conducted during borehole drilling activities at selected locations. These tests are discussed in following sections.

3.4.1 Geotechnical Sample Testing

During drilling, the on-site geologist may collect soil samples for geotechnical analysis. These samples, selected to best represent the physical characteristics of the zones of interest, will be collected and placed in appropriate containers and shipped to a geotechnical laboratory. Where undisturbed soil samples are required, samples will be collected by use of a Shelby tube. Geotechnical sampling will not be conducted on every sample location and will vary based on the type of material. Geotechnical sample testing may include any of the following tests:

- Grain size distribution (ASTM D421 and 422)
- Atterberg limits (ASTM 4318)
- Hydraulic conductivity (includes dry bulk density and moisture content) (ASTM D5084)
- Specific gravity (ASTM D854)
- Total organic carbon (Walkley-Black Method)

Gradation or grain-size distribution can be used to estimate permeability. Gradation data are also important in the design of cut-off trenches and sand/filter packs for extraction wells for remedial systems. Atterberg limits tests are useful in site characterization. The plasticity of fine-grained soils is indicative of soil type, and when considered in conjunction with moisture content, can be useful in evaluating options for handling and remediating contaminated soil.

Hydraulic conductivity of the soil is necessary for flow and transport calculations which are required for groundwater modeling. The hydraulic conductivity analysis requires undisturbed sample, which will be collected using a Shelby tube.

Moisture content is an important consideration when evaluating remedial options such as thermal treatment, chemical fixation, and biological applications.

The density of a material is the mass of the substance per unit volume. If the material is oven-dried, the measure represents the dry bulk density; if the material is in its natural moisture-bearing condition, the measure represents the wet density. Bulk density data is used for contaminant fate and transport modeling.

Specific gravity is also known as relative density and is needed to calculate certain physical properties such as porosity, saturation, void ratio, and unit weight.

3.5 AQUIFER TESTING

3.5.1 Slug Testing

In-situ permeability or slug testing may be conducted in wells to determine the hydraulic conductivity of the water-bearing media immediately surrounding the well. Slug testing will be conducted only on wells that have been developed. To conduct a test on a well recently purged for groundwater sampling, the measured water level must be allowed to return to static level prior to testing.

The procedures for conducting a rising head (slug-out) slug test are described below.

1. Decontaminate transducer and cable.

2. Record pertinent information (e.g., well diameter, reference level, etc.) into the electronic data logger before beginning the slug test.

3. Determine the static groundwater level in the well by measuring the depth to water approximately 4 times over 30 minutes before beginning the test.

4. Cover sharp edges of well casing or cover to protect the transducer cables.

5. Install the transducer and cable in the well to a depth below the target drawdown estimated for the test, but a minimum of 2 ft above the bottom of the well. Check that the depth of submergence is within the design range stamped on the transducer.

6. Tape the transducer cable to the well to maintain a constant depth.

7. Connect the transducer cable to the electronic data logger.

8. Enter the initial groundwater level and transducer design range into the recording device according to the manufacturer's instructions.

9. 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.

10. 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.

11. 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 semi-logarithmic plot of time versus depth.

12. 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.

13. Stop the logging sequence.

14. Review the field forms for completeness.

During the slug test, water will not be added to the well. All equipment used will be decontaminated prior to the slug test and between wells to avoid cross-contamination.

If the slug test is conducted using an electronic data-logger and pressure transducer, all data will be stored internally on computer diskettes or tape. The information will be directly transferred to a computer and analyzed. A printout of the raw data will be kept in the project files for documentation.

The data measured during the slug test can be interpreted by one of several different methods. It is important when selecting a method for data analysis that 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).

Pre-analysis will be performed prior to processing aquifer response data collected during the slug test. It is recommended that the following general guidelines be used for data pre-analysis.

- The response data should be transformed into the normalized deviation from the static water level.
- Normalized data should be utilized in the analysis if a transducer was used to collect the response data.
- The translation method (Pandit and Miner, 1986 and Butler, 1998) should be used in cases of noninstantaneous slug introduction.
- Consideration should be given for the potential occurrence of well skin effect.
- Aquifer parameters (e.g. saturated thickness, aquifer conditions, porosity, etc.) should be verified.
- Verification of well construction (screen length, well diameter, water position in screened interval, and stratigraphy relative to screen and water bearing unit (s)) will be needed.

After pre-analysis of data, care should be taken in selection of appropriate solution method(s) relative to the screen position, water level and aquifer conditions. This coupled with careful analysis of the actual test data in reference to the data plot and solution values should receive critical review prior to finalization. The usage of computer software (i.e. AQTESOLV©) can be useful since multiple solutions can be evaluated with a single data set and greater accuracy can be obtained.

3.5.2 Pumping Tests

Aquifer pumping tests are performed to enhance the hydrogeologic understanding of the site. An aquifer pumping test also provides actual drawdown data resulting from the diversion of groundwater from a well or wells in the aquifer. Unlike slug tests, an aquifer pumping test provides estimates of aquifer parameters over a larger area of the aquifer under actual pumping conditions, thereby providing a more representative value for the aquifer in the area.

Aquifer pumping tests will determine the hydrogeologic parameters such as transmissivity (T), hydraulic conductivity (K), and storativity (S) (storage coefficient), specific capacity, well efficiency, and radius of influence (ROI) of the pumping wells.

Transmissivity is defined as the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is a function of the properties of the liquid, the porous media, and the thickness

of the porous media. The K of the aquifer can be determined by dividing the transmissivity by the saturated thickness (m) of the aquifer (T=Km).

Storativity is defined as the volume of water and aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. It is equal to the product of specific storage and aquifer thickness. The range for an unconfined aquifer is 0.01 to 0.3 (unitless), and on the order of 0.005 or less for a confined aquifer. For an unconfined aquifer, storativity is equivalent to specific yield.

ROI is the horizontal distance from the center of the pumping well to the limit of the cone of depression. In effect, it is the maximum horizontal distance from the pumping well at which groundwater levels are influenced by pumping.

3.5.2.1 Pumping Well and Piezometer Installation

Two pumping wells will be installed as part of this investigation. A generalized pump test layout is shown on Figure 1. One well (DPDT-1) will be installed in the general vicinity of 9th Street and Cloud Street and another well (DPPT-2) will be completed south and west of Interstate 135 (see Figure 5-3 in the FSP). A pilot hole will be drilled and continuously sampled to top of bedrock at each pumping well location. Geotechnical samples for grain size distribution will be collected for well screen design using split-barrel samplers and Shelby tubes. During borehole drilling, information including soil profile and bedrock description, soil sampling information, and evidence of contamination will be recorded by the on-site geologist on HTW drilling log forms MRK-55 and MRK-55-2 in accordance with USACE requirements.

The pumping wells will be drilled and installed at the top of competent bedrock. Each well will be drilled using rotary wash drilling equipment. An excavated or portable mud pit will be used to handle water circulation and cuttings during the drilling of the two pumping wells. The pumping wells will be constructed of 6-inch diameter Schedule 80 PVC casing with flush threaded connections. Well screens will also be 6-inch diameter Schedule 80 PVC with factory slotting. Wells will be constructed with NSF potable water grade, flush-threaded PVC riser and screen that conforms to ASTM-D 1785 standards. Specifics of screen openings and screen length will be determined after collection and testing of geotechnical samples for grain size analysis (refer to Section 3.6.1). A technical memorandum will be prepared and presented to USACE presenting the geotechnical results and well design prior to well installation.

Following installation, the pumping wells will be developed by the drilling subcontractor to remove fines from the filter pack. The wells will be developed until the turbidity is less than 10 nephelometric turbidity units (NTUs) and contains not more than 2 part per million of sand by weight after one-half hour of pumping. Development water will be piped to a designated manhole for discharge into the storm sewer. The City of Salina Water and Sewer Department Superior will be contact prior to discharging fluids into the sewer.

Each of the pumping wells will have four piezometers installed at distances of 10, 20, 50, and 100 feet from each pumping well. The four piezometers at each pumping well location will be constructed in accordance with procedures described Section 3.4. Screen slot size, length, and piezometer depth will be determined after completion of grain size analysis. The piezometers will be installed using HSA drilling equipment. This information will be included as part of the technical memorandum. Piezometers will be developed by using a combination of pumping, surging, and swabbing. Development of the piezometers will be completed when the turbidity is no greater than 50 NTUs. Procedures for piezometer development are provided in Chapter 4.0.

Development fluids from both the pumping wells and piezometers will be piped to a designated manhole for discharge into the storm sewer.

3.5.2.2 Step-Rate Drawdown Test

Following installation and development of the production well, a step-rate drawdown test will be conducted on the pumping wells. The primary purpose of a step-rate test is to determine the specific capacity (discharge/drawdown) of the pumping well and the optimum pumping rate to be used during the 72-hour constant-rate test.

The pump, temporary piping, flow meter, valves, and metering devices used during the step tests will be the same as those used during the constant-rate test (Figure 2). Discharge water from the pumping well will be piped from the wells to a storm sewer manhole.

The following procedures will be used when conducting the step-rate drawdown test:

1. The flow rate and water level will be monitored at the pumping well while only water levels will be observed in the piezometers.

2. Prior to commencing the step-rate drawdown test for the pumping well, static water levels will be observed in the pumping well and the nearby observation wells for a minimum of 8 hours. The step-rate drawdown test will not begin until all water levels have equilibrated to static levels after installing the pump and logging equipment.

3. The pumping rate will be adjusted to rates of approximately 25, 50, 75, and 100 gpm. Based on measurements in the field, these rates may be adjusted to represent 25, 50, 75, and 100 percent of full discharge.

4. Each step will last for approximately 60 minutes, provided the pumping rate is properly adjusted in the first 5 minutes of the test. Tests in which the pumping rate is not properly adjusted in the first 5 minutes will be discontinued and will commence again after the water level in the pumping well has stabilized. If, during the test, the water level drops below the level of the pump, the test will be halted and the well will be allowed to recover to 90 percent of its original static water level. At this time, the test will then be restarted at the next lower pumping rate increment.

5. At the end of each 60-minute pumping period, the pump will be adjusted to the next pumping rate before shutdown. Following shutdown, the well will be allowed to recover to a minimum of 90 percent of its original static condition.

6. During each step-rate drawdown test, the water level in the pumping well and the observation wells will be recorded. Measurements for the pumping well will be recorded based on a set schedule as indicated below. Measurements collected for the observation wells will be set on 5 minute intervals for the first 30 minutes and 10 minute intervals for the remainder of the step-rate drawdown test.

Pumping Well Measurement Schedule

Time	Reading Time
Every 15 seconds	5 minutes
Every 30 seconds	5 minutes
Every 1 minute	10 minutes
Every 2 minutes	10 minutes
Every 5 minutes	30 minutes

Aquifer recovery will be monitored in the pumping well following cessation of the last step-rate drawdown test. These water level measurements will also be recorded based on the preceding

measurement schedule. At this time, measurements will not be collected from the four observation wells.

7. Based on the step-rate drawdown test data, the specific capacity of the test well will be calculated for each step and plotted on a graph showing pumping rate verses specific capacity. The optimal pumping rate, based on the well's specific capacity, will be used to conduct the constant-rate pump test. It is estimated that the maximum rate of 100 gpm will be used.

3.5.2.3 Constant Rate Aquifer Pumping Test

A constant-rate pumping test will be performed on the extraction well following recovery of the well from the step-rate drawdown test. The purpose of the constant-rate pumping test is to determine the T, K, and S of the aquifer and if any aquifer hydraulic boundaries are located within the pumping well ROI. If boundaries are detected, an additional goal will be to determine the distance and direction of the boundaries. To achieve this purpose, consideration has been given to the distance and direction (with respect to the pumping well) to the observation well locations.

The constant-rate pumping test will be conducted over a period of up to 80 hours, of which the first 72 hours will consist of continuous pumping and the remaining time will be allowed for well drawdown recovery. Recovery will be for a maximum of 6 hours or until the pumping well recovers to within 90 percent of original static water level, whichever comes first. During the constant-rate test, the flow rate will be monitored and water level measurements will be collected at the pumping well and the newly installed observation wells. However, the number of wells and frequency of water level collection may change based on data collected in the field during the constant-rate test. Using the water level observations and time data acquired during the test, semi-log graphs of the drawdown versus time will be plotted in the field for the pumping well and observation wells.

The pump, temporary piping, flow meter, valves, and metering devices used during the constant-rate pump test will be the same as those used during the step-rate drawdown tests. Discharge water from the pumping well will be piped from the well to a storm sewer.

The following procedures will be used to conduct the constant-rate pumping test: Prior to commencing the constant-rate pumping test, the static water levels will be measured and collected from the extraction well and the observation wells.

1. A data logger will measure and record the water level changes in the temporary observation wells. The data logger will consist of an in-situ Hermit 3000® equipped with four, 20 pounds per square inch (psi) pressure transducers. The data logger will be programmed to obtain water level measurements according to a logarithmic schedule for the first 16 hours (approximately) of the pumping and recovery periods and at 15-minute intervals for the remainder of each period. The Hermit 3000® logarithmic schedule is given below:

Log Cycle	Elapsed Time	Sample Interval
1	0-5 seconds	0.5 second
2	5-20 seconds	1 second
3	20-120 seconds	5 seconds
4	2-10 minutes	0.5 minute
5	10-100 minutes	2 minutes
6	100-1000 minutes	10 minutes

Manual water level measurements will be measured at the extraction well during normal working hours according to the following approximate schedule:

Minutes	Readings
0-5	Once every 15 seconds
5-10	Once every 1 minute
10-20	Once every 2 minutes
20-60	Once every 5 minutes
60-120	Once every 10 minutes
120-300	Once every 30 minutes
300-End of Test	Once every 60 minutes

The number of wells and frequency of water level collection may change based on data collected during the constant-rate pumping test.

2. After pumping is stopped, water levels at the pumping and observation wells will be measured and recorded during the well recovery period. During the 8 hours (480 minutes) of water level recovery, measurements will be based as follows:

- **Pumping Well (Manual)**

Minutes	Readings
0-5	Once every 15 seconds

5-10	Once every 1 minute
10-20	Once every 2 minutes
20-60	Once every 5 minutes
60-120	Once every 10 minutes
120-360	Once every 30 minutes

- **The Observation Wells (Data Logger).**

Log Cycle	Elapsed Time	Sample Interval
1	0-5 seconds	0.5 second
2	5-20 seconds	1 second
3	20-120 seconds	5 seconds
4	2-10 minutes	0.5 minute
5	10-100 minutes	2 minutes
6	100-1000 minutes	10 minutes

After completion of the aquifer pumping tests, the data will be evaluated using several solution models such as Cooper-Jacobs time and distance plots, Theis, or Neuman. The results of the aquifer models will predict a T, K, S, specific capacity, and ROI for each test location.

3.6 Decontamination Procedures

All tools used for aquifer testing will be decontaminated before use. The following decontamination procedure will be used for sampling and testing equipment:

1. Collect water from the designated City of Salina potable water hydrant or other source of potable water.

2. Fill a washtub/bucket to a depth of about 6 inches with potable water. Add approximately one tablespoon of Liquinox for each gallon of water.

3. Using the Liquinox solution scrub all equipment using a stiff, long bristled brush until it is visibly clean. Rinse with distilled water. (Note: periodically inspect wash tub and decontamination water, and refresh when necessary, as the decontamination water becomes dirty.)

4. After rinsing, place each piece of equipment on a clean sheet of plastic and allowed to dry.

Decontamination water will be handled as described in Section 9.0 of the FSP.

* * * * *

4.0 DEVELOPMENT OF MONITORING WELLS/PIEZOMETERS

Monitoring wells and piezometers will be developed to remove fine particles and sediment from the screen and filter pack. The method will consist of swabbing with a surge block or similar apparatus, followed by pumping and/or bailing. Swabbing consists of raising and lowering a surge block within the casing and screened interval. Caution should be exercised when swabbing within the screened interval so as not to damage the screen. Sediment and volume of water removed will be monitored and recorded regularly until development is complete. The development of a monitoring well should be initiated not sooner than 48 hours, nor longer than seven days after the final grouting of the monitoring well (USACE, 1994).

The initial static water level and depth will be measured and recorded on the Well Development Record (see attachments). The volume of standing water will also be calculated.

The pH, conductivity, temperature, and turbidity of the water will be recorded before beginning development. After several volumes of water have been removed, these water quality parameters will be reevaluated. The data will be recorded on the Well Development Record. Development will continue until the well or piezometer is properly developed based on attainment of the specified standard for turbidity units and stabilization of the pH, conductivity, and temperature. The required parameter standard criteria will be discussed in the SAP.

The development sequence is as follows:

1. Collect water sample and measure pH, conductivity, temperature, and turbidity.

2. Record water level and total depth of the well.

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

4. Remeasure and record the depth of the well.

5. Bail and/or pump the well to remove any sediment in the well.

6. Repeat Steps 3-5 until the water bailed or pumped meets the required turbidity standard (30 Nephelometric Turbidity Units [NTUs] for monitoring wells, 10 NTUs for the pump test wells, and 50 NTUs for observation wells) 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 or piezometers that purge dry during development will be purged dry three times and considered developed).

7. If stabilization of the monitored groundwater parameters (pH, temperature, conductivity, and turbidity) cannot be achieved as specified in the SAP, the on-site geologist will discuss the matter with the USACE technical manager and end development after a reasonable effort has been made. It is noted that it is usually possible to reach the criterion during development, but various conditions may cause an ongoing turbidity problem.

* * * * *

5.0 MONITORING WELL ABANDONMENT

The abandonment of monitoring wells/piezometers will be conducted in accordance with KDHE regulations Article 30 (KDHE, 1987). Prior to abandonment, approval will be obtained from the CENWK PM. The following information will be provided to the PM:

- Designation of monitoring well/piezometer
- Borehole information, including total depth, stratigraphy, and water level
- Reason for abandonment
- Abandonment procedures

Monitoring wells/piezometers will be abandoned according to the following procedure:

1. For above ground installations, destroy and remove the protective casing and concrete pad.

2. Remove well materials to a depth of 3 ft bgs.

3. Backfill the casing with bentonite/cement slurry from the bottom of the casing to within 3 ft of the ground surface. Emplace the slurry, from the bottom upward, using a tremie pipe. Slowly raise the tremie pipe as the slurry is emplaced, while keeping the end of the tremie pipe submerged below the surface of the slurry.

4. After 24 hours, the abandoned borehole should be checked for bentonite/cement slurry settlement. Additional bentonite/cement slurry should be emplaced into the borehole if the top of the slurry is greater than 3 ft from the ground surface. If less than 15 lineal ft exists between the ground surface and the upper surface of the slurry, a tremie pipe is not required for emplacement of additional slurry.

5. Backfill the remainder with clean, native soil from 3 ft bgs to the ground surface.

6. Repair the site as much as possible to match the original surrounding conditions.

For each abandoned boring/well, the on-site geologist will prepare a record for the USACE Project Manager. It will include the following, as applicable:

- Project and boring/well designation
- Location with respect to the replacement boring or well (if any); e.g., 20 ft north and 20 ft west of Boring XX
- Open depth of well/annulus/boring prior to grouting
- Casing or items left in hole by depth, description, composition, and size
- Copy of construction diagram for abandoned well
- Reason for abandonment
- Description and total quantity of grout used initially
- Description and daily quantities of grout used to compensate for settlement
- Dates of grouting
- Disposition of materials removed/displaced from decommissioned boring/well (e.g., objects, soil, and groundwater)
- Water or mud level (specify) prior to grouting and date measured
- Report all depths/heights from ground surface
- Report to KDHE

* * * * *

6.0 DECONTAMINATION OF EQUIPMENT

All sampling and investigation equipment will be decontaminated prior to beginning investigation activities, between borings, between locations, and upon completion of investigation activities.

6.1 Equipment

Typical decontamination equipment includes the following items:

- Deionized water
- Non-chlorinated potable water
- Isopropanol, pesticide-grade
- Wash bottles
- Buckets
- Scrub brushes
- Non-phosphate laboratory grade detergent
- Plastic sheeting
- Garbage bags

6.2 Decontamination of Sample-Contacting Equipment

Non-disposable and other non-dedicated equipment which contacts the sample will be decontaminated prior to the collection of each sample. This equipment includes, but is not limited to, sampling knives and spoons, split-barrel samplers, direct push shoes and subs, and containers.

Sampling equipment will be decontaminated according to the following procedure:

1. Fill a nonmetallic wash tub or bucket to a depth of about 6 inches with deionized water. Mix a detergent solution in the tub. The solution shall consist of approximately 1 tablespoon of non-phosphate laboratory-grade detergent (e.g. Liquinox®) per gallon of water.

2. Scrub all sampling equipment with a stiff-bristled brush and detergent solution.

3. Transfer the equipment to another wash tub partially filled with deionized water and rinse.

4. Rinse the sampling equipment with fresh deionized water.

5. If sampling for organics, rinse the equipment with pesticide-grade isopropanol and perform a final rinse with deionized water.

6. Place the equipment on clean plastic and allow it to air dry.

7. Store the equipment covered with plastic or aluminum foil upon the completion of decontamination. (If phthalates or aluminum are contaminants of concern, this step will be replaced as described in the SAP.)

8. Retain decontamination fluids for disposal as described in Section 9.0 of the FSP.

6.3 Decontamination of Non-Sample-Contacting Equipment

Down-hole sampling tools such as drill string, augers, and direct push rods, as well as drill rigs and direct push trucks/vans will be decontaminated between each borehole according to the following procedure:

1. Construct a three-sided decontamination pad using planks as a frame and plastic sheeting as the bottom. The pad should be constructed on a slight slope with the open side facing uphill.

2. Back the drill rig or direct push rig into the decontamination pad or place equipment in a rack off the ground inside the pad.

3. Use hot, pressurized, non-chlorinated water to completely remove all visible soil and contamination from all surfaces. Include the inside of all drill string, augers, and direct push rods. If necessary, use a stiff-bristled brush to remove soil and contamination.

4. Place the equipment on clean plastic and allow to air dry.

5. Store equipment and cover with plastic after decontamination.

6. Retain all decontamination fluids for disposal as described in Section 9.0 of the FSP.

* * * * *

7.0 WELL LOCATION SURVEYS

After all wells are installed well elevations will be surveyed at the top of the riser at the point at which water levels are collected (represented by a notch on the well casing or the northern-most point) and on the concrete pad at the survey monument. Horizontal locations will be determined to the nearest 0.1 foot and elevations to the nearest 0.01 foot. Permanent site features shall be used to locate the wells, and these locations will be plotted on an appropriately scaled map. A copy of all maps and survey data will be provided to CENWK. Ideally, the survey should be completed before the first groundwater sampling occurs.

Coordinates will be established for each borehole location. The northing and easting coordinates will be to the nearest 0.1 foot and referenced to the UTM. Elevations of ground surface (from the survey monument) and top of casing will be determined to the nearest 0.01 foot using NAD 88 datum. The location, identification, coordinates, and elevations of the wells will be plotted on maps with a scale large enough to show their locations. A tabulated list of the borehole locations, copies of all field logbooks, and all computation sheets will be prepared and submitted to CENWK. The tabulation, consisting of the designated number of the borehole, the X and Y coordinates, and all required elevations, will be supplied in electronic format.

* * * * *

8.0 BOREHOLE LOGGING

All soil borings drilled during any environmental investigation at SAFB will be logged by an experienced on-site geologist according to the requirements in EM 1110-1-4000 (USACE, 1994). The procedures and requirements listed below will be followed while in the field:

1. Borings will be logged at the drill rig as the holes are drilled. The boring logs will be prepared directly on MRK Forms 55 and 55-2. The field drilling logs will represent actual observations, not expectations based on previous field studies.

2. The MRK forms must be filled out as completely as possible where appropriate and applicable data are available. "NA" will be written on the forms for all entries that are not applicable (e.g., "NA" is written in the Depth to Bedrock Section if bedrock is not encountered in the borehole).

3. Stratigraphic or lithologic changes encountered within the boring will be shown in Column c as a solid line. Gradational changes in stratigraphy and lithology will be shown as a dashed line in Column c. The scale of the log shall be one inch equals one ft.

4. The bottom of the borehole will be represented on the form as a solid double line with the notation "Bottom of Hole."

5. Results of headspace air monitoring will be reported in Column d. Any evidence of contamination will be noted in the remarks section under Column h, including color, odor, or staining.

6. During the course of drilling, water levels and time of measurement should be taken as often as possible and noted in Column h. The absence of water following drilling of the borehole, shall also be indicated in Column h. The depth to water will be recorded in Column h and Box 15 at the time when the first water zone is encountered. Depth to water measurements will be recorded after the completion of drilling and again after additional time has elapsed and groundwater has returned to static conditions in Column h and Boxes 16 and 17.

7. The depth to the top and bottom of each run (core or soil sample) will be measured with a weighted tape to the nearest 0.1 ft and recorded in Column h. Borehole depths and time of measurement should be taken as often as possible and recorded on the MRK form. Significant times to record include the beginning and end of each day, the time prior to equipment placement in the borehole, and when any equipment is removed from the borehole. The weighted tape will be constructed of materials that will not introduce contaminants into the borehole.

8. Intervals of lost bedrock core or soil sample (noting both intact and lost intervals) will be recorded in Column e. The length of the core or soil sample (recovery) will be measured with a tape measure to the nearest 0.1 ft and recorded in Column h.

9. The size and type of sampler or coring bit and barrel will be noted and recorded in the remarks section of Column h and Box 7. Logs will show borehole and sample diameters and depths at which sampling methods or equipment change in Column h.

10. The source of the water used for coring or monitoring well installation will be recorded in Column h.

11. Drill fluid volume, loss or gain, brand, and product name will be recorded in the remarks section in Column h.

12. If compressed air is used during the drilling process, the type of air filter will be recorded in Column h.

13. The depth and type of any temporary casing used during the well installation procedure will be recorded in Column h.

14. Depth intervals of hole instability that are encountered during drilling will be recorded in Column h.

15. Difficulties during drilling (e.g., changes in drilling speed, rates, or downhole torque) and any special sampling problems also will be noted in Column h, including descriptions of problem resolutions.

16. The depth interval over which samples are collected for lithologic analysis will be noted and recorded in Column e. The depth interval over which samples are collected for chemical analysis will be noted and recorded in Column f.

17. Each boring log will be legibly signed by the preparer after proofreading the log for completeness. Copies will be submitted to USACE as borings are completed.

8.1 SOILS (UNCONSOLIDATED MATERIAL)

Unconsolidated material will be logged using the Unified Soil Classification System (USCS). All items in this section are noted in Column c of the MRK form.

1. The moisture content, in relative terms (i.e., dry, moist, wet/saturated), will be noted. If the sample is saturated (i.e., encountered groundwater), the groundwater level will be recorded to the nearest 0.1 ft as noted above.

2. The standardized color of the unconsolidated material will be logged using the Munsell Soil Color Chart.

3. 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.

4. 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.

5. Bedding characteristics, evidence of bioturbation, root holes, and fractures will be noted and logged.

6. The depositional type (i.e., alluvium, till, loess) will be noted.

8.2 ROCK (CONSOLIDATED MATERIAL)

All items from this section are noted in Column c of the MRK forms.

1. The formation name, if known, will be logged.

2. The rock type (i.e., limestone, sandstone, shale) will be noted and logged.

3. The relative hardness of the consolidated material will be measured and logged.

4. The texture and grain angularity of the consolidated material will be examined with a hand lens, and the results of the field analysis will be logged.

5. The standardized color of the consolidated material will be logged using a Munsell Rock Color Chart.

6. The consolidated material will be inspected for apparent weathering. The results of this inspection will be logged.

7. The moisture content, in relative terms (i.e., dry, moist, wet/saturated), will be noted. If the sample is saturated (i.e., encountered groundwater), the groundwater level will be recorded to the nearest 0.1 ft as noted above.

8. Evidence of bedding, bedding planes, fractures, and joints will be noted and logged. The approximate angle of the dip of bedding, fracture, and joint planes will be noted.

9. Other significant features (e.g., fossils, crystals, pits, solution cavities) will be noted.

10. The reaction of the consolidated material to hydrochloric acid, if any, will be recorded.

11. Bedrock coring information shall be recorded in consecutively numbered runs in Column h and shall include the start and stop time of each run, depth to the top and bottom of each run, length of recovery, and size and type of coring bit and barrel.

* * * * *

9.0 RECORD KEEPING

Records will be kept for well drilling, installation, and development. The on-site geologist or scientist/engineer is primarily responsible for collecting this data; however, these records will be checked daily by the field site manager.

9.1 FIELD LOGBOOKS

The logbook is a record of all activities that transpire in the field during a project. Review of the field logbook should provide enough information to reconstruct daily activities.

Information regarding drilling and well installation not included on the boring logs will be recorded in the field logbook. Additional information to be recorded in the field logbook includes (but is not limited to):

- Daily weather and site conditions
- Notes that the geologist or scientist/engineer may make concerning drilling procedures or rig operations
- Details about the geological or hydrogeological observation or analysis in the context of the expected geological sequence
- Safety equipment calibration
- Safety monitoring data (breathing zone air monitoring readings)
- Administrative notes relevant for cost accounting
- Discussion of delays or problems
- Drilling rig downtime
- Notes concerning conversations with client, site personnel, and/or other entities using this area

- Logic and background behind significant field decisions

Entries will be made in waterproof ink in the bound logbook and dated. Copies of the field logbooks and boring logs shall be submitted to CENWK. Additional details regarding field logbook entries are described in the SAP.

9.2 PHOTOGRAPHS

Photographs will be taken as appropriate to record the drilling and well installation process. Photographs of cores, samples, and local outcrops (if present) will be obtained. Photographs will be taken to assist in locating the well. Photographs will be noted in the field logbook and described therein. Photographs will be labeled with project name, project number, photographer, date, time, and subject.

* * * * *

10.0 REFERENCES

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USACE, 2007a, *Work Plan for OU 1 Remedial Investigation/Feasibility Study Addendum, Former Schilling Air Force Base, Salina, Kansas,* prepared by Malcolm Pirnie and Burns & McDonnell.

USACE, 2007b, *Sampling and Analysis Plan, Volume I – Field Sampling Plan, OU 1 Remedial Investigation/Feasibility Study Addendum, Former Schilling Air Force Base, Salina, Kansas,* prepared by Malcolm Pirnie and Burns & McDonnell.

USACE, 2007c, *Accident Prevention Plan, OU 1 Remedial Investigation/Feasibility Study Addendum, Former Schilling Air Force Base, Salina, Kansas,* prepared by Malcolm Pirnie and Burns & McDonnell.

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* * * * *

ATTACHMENTS

Forms MRK-55 and MRK-55-2
Monitoring Well Installation Diagram
Well Development Record

HTW DRILLING LOG

HOLE NO	
1 COMPANY NAME	2 DRILLING SUBCONTRACTOR
SHEET 1 OF SHEETS	
3 PROJECT	4 LOCATION
5 NAME OF DRILLER	6 MANUFACTURER'S DESIGNATION OF DRILL
7 SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8 HOLE LOCATION
	9 SURFACE ELEVATION
	10 DATE STARTED / 11 DATE COMPLETED
12 OVERBURDEN THICKNESS	15 DEPTH GROUNDWATER ENCOUNTERED
13 DEPTH DRILLED INTO ROCK	16 DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED
14 TOTAL DEPTH OF HOLE	17 OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18 GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19 TOTAL NUMBER OF CORE BOXES

20 SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21 TOTAL CORE RECOVERY %

22 DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23 SIGNATURE OF INSPECTOR

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO e	ANALYTICAL SAMPLE NO f	BLOW COUNTS g	REMARKS h

HTW DRILLING LOG

HOLE NO

PROJECT	INSPECTOR	SHEET 1 OF SHEETS

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO e	ANALYTICAL SAMPLE NO f	BLOW COUNTS g	REMARKS h

PROJECT	HOLE NO

051601
Form MRK-55-2

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

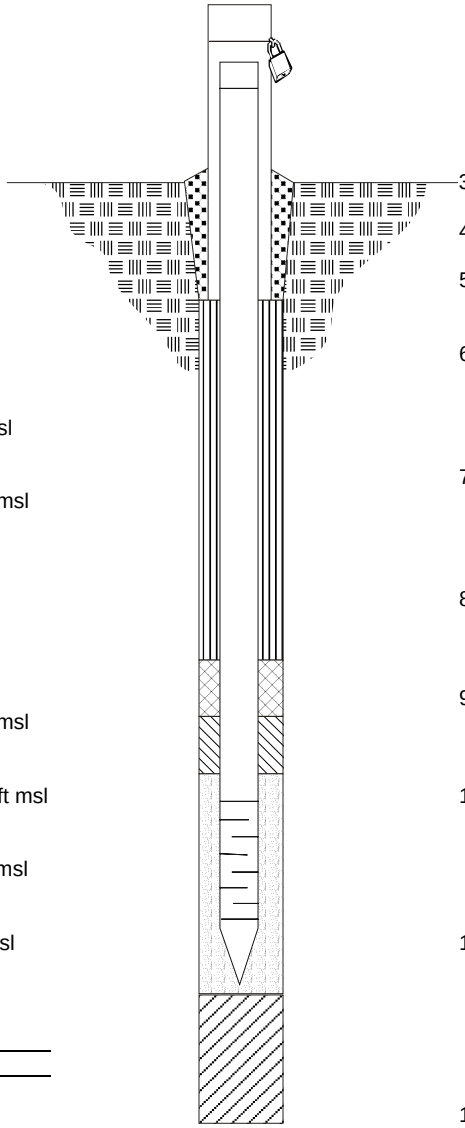
Well casing, top elevation _____ft. msl

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	
Facility Name:	
Location: N	E

Elevation of Well
Ground Surface Elevation (GS):
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

Well Development Form (continuation)

Project Number:	Well Number:

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-6-2

FIGURES

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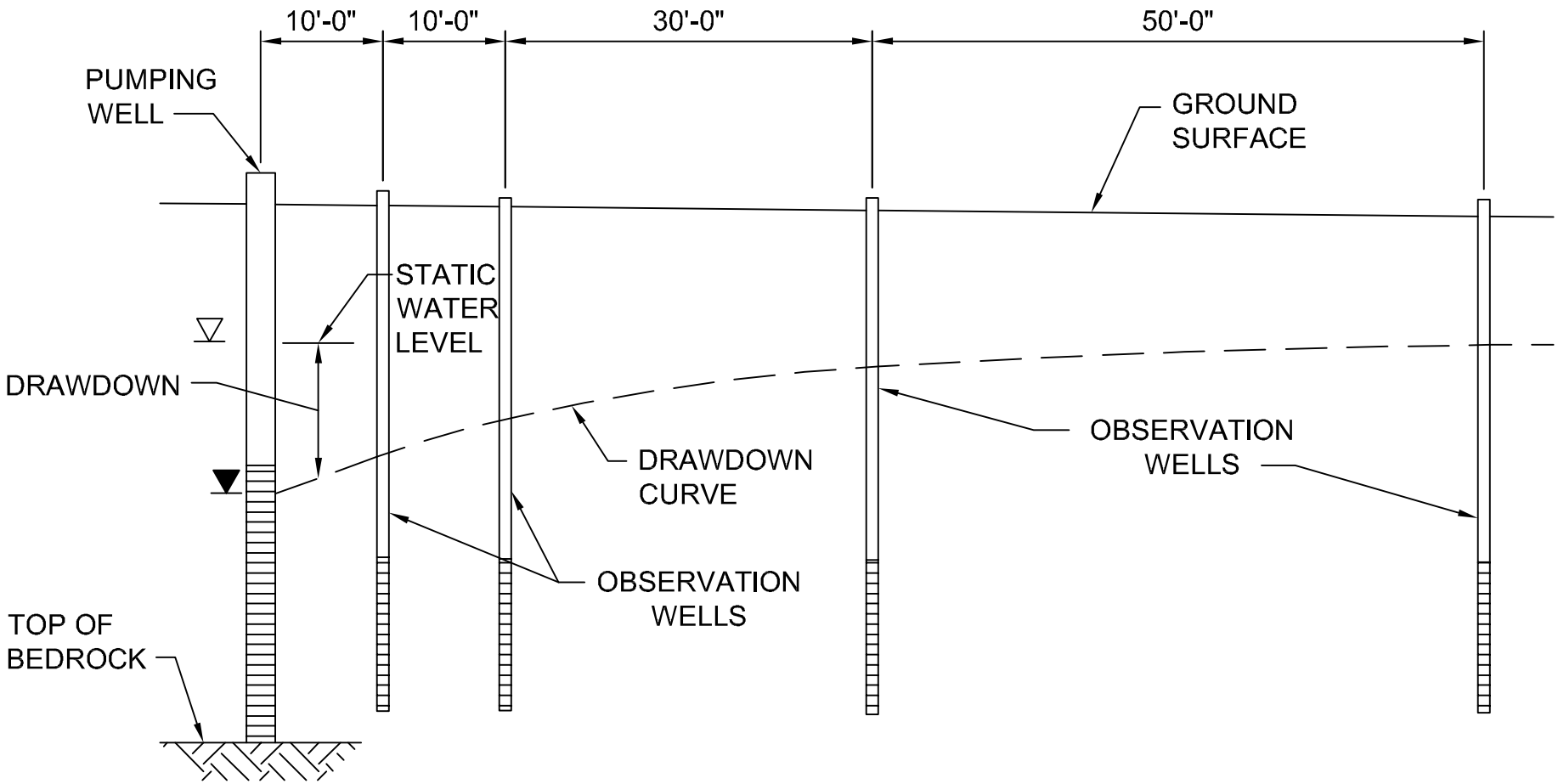
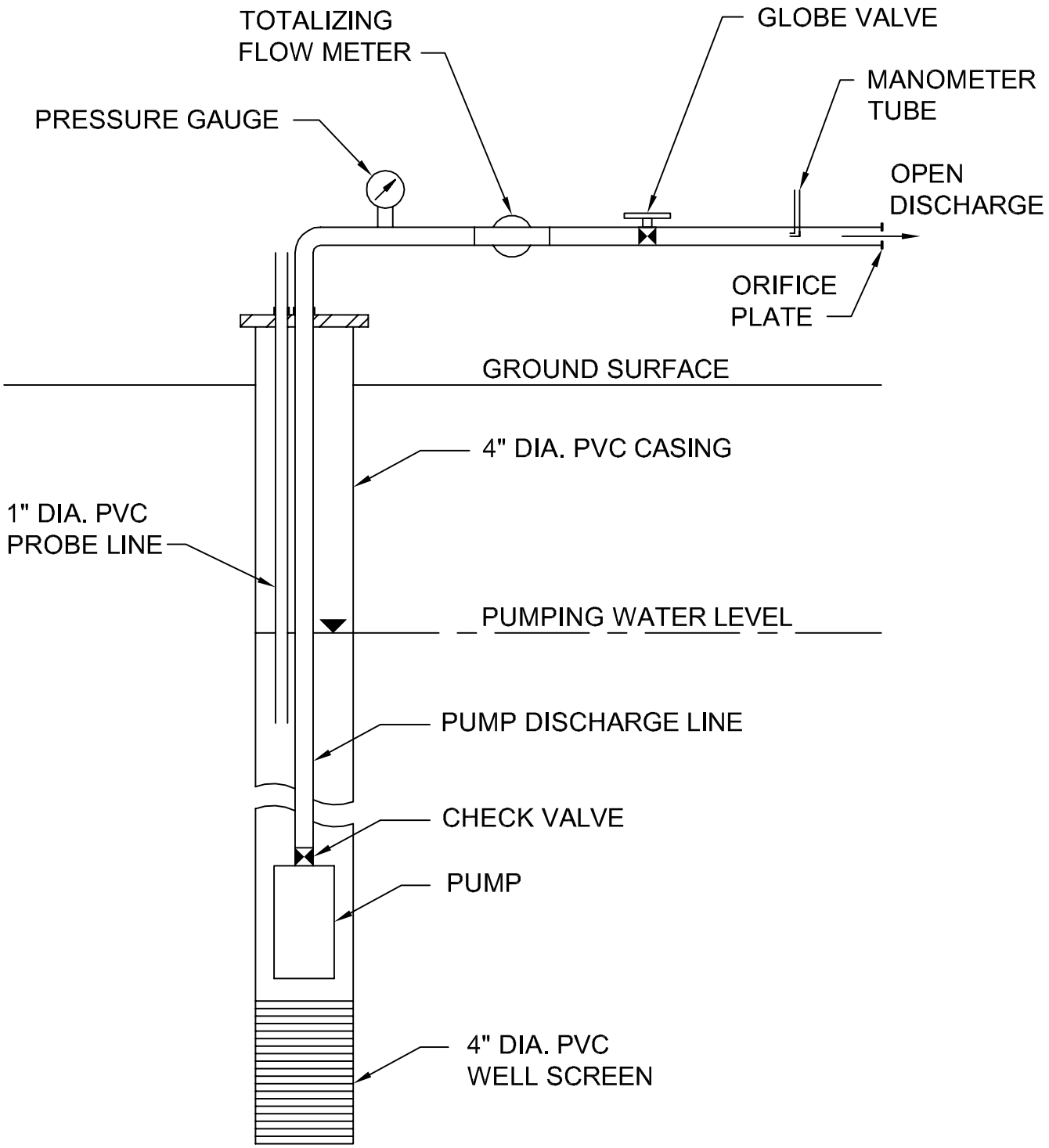


NOT TO SCALE

Burns & McDonnell SINCE 1898

Figure 1

GENERALIZED PUMP TEST LAYOUT



NOT TO SCALE

Burns & McDonnell
SINCE 1898

Figure 2

GENERALIZED SCHEMATIC
FOR PUMP TEST

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APPENDIX B

Standard Field Forms

APPENDIX B – Standard Field Forms

Sample Label

Custody Seal

Chain-of-Custody Form (COC)

Drilling Log

Daily Calibration Log

Daily Quality Control Report

Field Groundwater Sampling Report

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

Sample Group: _____

Sample Point: _____

Sample Designator: _____

Sample Round: _____ Year: _____

Sample Depth From: _____ To: _____

Date Sampled: _____

Time Sampled: _____

Preservation: _____

_____

090705 Form WCD-97N

Sample Label

WCI-101

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

Custody Seal

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:

Client Name:

Sample Number			Sample Event		Sample Depth (in feet)		Sample Collected		Sample Type			Number of Containers	Analysis						Remarks
									Matrix										
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:

HTW DRILLING LOG

		HOLE NO
1 COMPANY NAME	2 DRILLING SUBCONTRACTOR	SHEET 1 OF SHEETS
3 PROJECT	4 LOCATION	
5 NAME OF DRILLER	6 MANUFACTURER'S DESIGNATION OF DRILL	
7 SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8 HOLE LOCATION	
	9 SURFACE ELEVATION	
	10 DATE STARTED	11 DATE COMPLETED
12 OVERBURDEN THICKNESS	15 DEPTH GOUNDWATER ENCOUNTERED	
13 DEPTH DRILLED INTO ROCK	16 DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14 DEPTH OF HOLE	17 OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18 GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19 TOTAL NUMBER OF CORE BOXES				
20 SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21 TOTAL CORE RECOVERY %	
22 DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23 SIGNATURE OF INSPECTOR			

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO e	ANALYTICAL SAMPLE NO f	BLOW COUNTS g	REMARKS h

HTW DRILLING LOG

ROJECT	INSPECTOR	HOLE NO
		SHEET OF SHEETS

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO e	ANALYTICAL SAMPLE NO f	BLOW COUNTS g	REMARKS h

Daily Calibration Log

Project Number: _____
Project Name: _____
Field Site Manager: _____

Date	Time	DO %	DO mg/L	pH	Conductivity mmhos/cm	PID ppm	Turbidity NTU	Iron mg/L	ORP mV	Temp ^{0}C	Notes
Standards:		100	10	4/7/10	4.49	100	0.0	1.0	200-275		

ORP=Oxidation Reduction Potential
NTU= Nephelometric Units

DO=Dissolved oxygen
%=Percent
Temp=ambient air temperature at time of calibration

Photoionization Detector
ppm=Parts per million

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			

Subcontractors and Equipment on Site: _____

Health and Safety Levels: (circle)

D	Mod. D.	C	B	A

Summary of Health and Safety Activities: _____

Instrument Used: (circle)
Calibrated: (check)

PID	LEL	pH	Cond.	Therm.	Turbidity	DO	ORP

For actual calibration results see field calibration forms

Summary of Work Performed: _____

All Samples Were Collected According to Procedures Outlined in the Work Plan?
Yes _____ No _____

Problems Encountered/Corrective Action Taken: _____

Time Project Manager Contacted: _____

Tomorrow's Expectations: _____

Name: _____ Signature: _____

FIELD GROUND-WATER SAMPLING REPORT

DATE: _____ SITE: _____ PID READING at WELL HEAD (ppm): _____

ROJECT NUMBER: _____ WEATHER: _____

WELL NUMBER

DEPTH TO WATER (ft): _____

TOTAL DEPTH (ft): _____ WELL DIAMETER (inches): _____

PURGING **A + B = C**

A [(Borehole Diameter)^2 – (Well Diameter)^2 X (0 0408) X (TD-Depth to top of saturated filter pack) X 0 30 (porosity)] +

B [Total Depth – Water Level X 0 163] X 3 = **C** Total purge volume for well

A [(64 – 4) X 0 0408 X _____X 0 3] + **B** [(TD_____) – (WL_____) X 0 163] X 3 = _____ gallons

Equipment Used: Dedicated Bladder Pump Non-dedicated Bladder Pump Bailer Other _____

Time (24 hr)	Amount Purged (gals)	Flow Rate (ml/min)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D O (mg/L)	Depth to Water (ft TOC)
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
		*					*	*	*
Continued on back (circle one) yes / no									

SAMPLING Equipment Used: Same as above Other _____

Sample Time (24 hr)	Total Purged (gals)	pH	Temp (C)	Conductivity (mmhos/cm)	Turbidity (NTUs)	ORP (mV)	D O (mg/L)	Depth to Water (ft TOC)	Obs
						*	*		

* = Reading not applicable for this site

FINAL DEPTH TO WATER (ft TOC): _____ TIME FINAL DEPTH TAKEN: _____

SAMPLE ID: _____ SAMPLE ID FOR QC: _____

PARAMETERS REQUESTED FOR ANALYSIS: _____

OC pH: _____ IDW TOTAL: _____ Comment _____

	NAME	SIGNATURE	DATE
PREPARED:			
REVIEWED:			

APPENDIX C

KDHE SOP for Characterization and Disposal of IDW (BER-08)

BUREAU OF ENVIRONMENTAL REMEDIATION

STANDARD OPERATING PROCEDURE BER-08

CHARACTERIZATION AND DISPOSAL OF INVESTIGATIVE DERIVED WASTE

Revisor: Randolph L. Brown Date of Revision: November 6, 2000

Remedial Section Chief: _____ Date: _____

Tank Section Chief: _____ Date: _____

ARS Section Chief: _____ Date: _____

Bureau QA Representative: _____ Date: _____

Bureau Manager: _____ Date: _____

Revisor: _____ Date of Revision: _____

Remedial Section Chief: _____ Date: _____

Tank Section Chief: _____ Date: _____

ARS Section Chief: _____ Date: _____

Bureau QA Representative: _____ Date: _____

Bureau Manager: _____ Date: _____

Revisor: _____ Date of Revision: _____

Remedial Section Chief: _____ Date: _____

Tank Section Chief: _____ Date: _____

ARS Section Chief: _____ Date: _____

Bureau QA Representative: _____ Date: _____

Bureau Manager: _____ Date: _____

TABLE OF CONTENTS

1. INTRODUCTION 3

2. METHOD SUMMARY 3

3. PROCEDURE 3

4. GENERAL CONSIDERATIONS 4

5. SPECIAL CONSIDERATIONS 4

1. INTRODUCTION

This guidance provides general options for management of investigation-derived wastes (IDW) generated during the investigation of potential or actual contaminated sites. These wastes include soil cuttings, drilling muds, and other materials. The general process for characterization and disposal of IDW is outlined on the attached flow chart. Individual project managers and/or programs may have additional requirements.

2. METHOD SUMMARY

In the process of collecting environmental samples during investigations, field staff may generate many different types of potentially contaminated IDW. This SOP is to be used to assist project managers and field staff in their decision making. Project managers should use EPA Guidance Document EPA/540/G-91/009, "Management of Investigation-Derived Wastes" for additional information concerning disposal of IDW.

3. PROCEDURE

Analysis of IDW should be conducted using KDHE-approved methodologies and technologies. Laboratory analysis should be performed according to EPA SW-846 8000 Series (solids or liquids) or 600 series (waste water). Type and frequency of laboratory analysis should be approved on a site-specific basis by the KDHE Project Manager. Use of field analytical technology is encouraged and should be chosen on a site-specific basis considering the constituents of concern and analytical equipment limitations. Use of field analytical equipment, type and frequency of confirmatory laboratory analysis should be approved on a site-specific basis by the KDHE Project Manager. The appropriate BER SOP should be consulted for sampling methods for actual or potentially contaminated media generated as IDW.

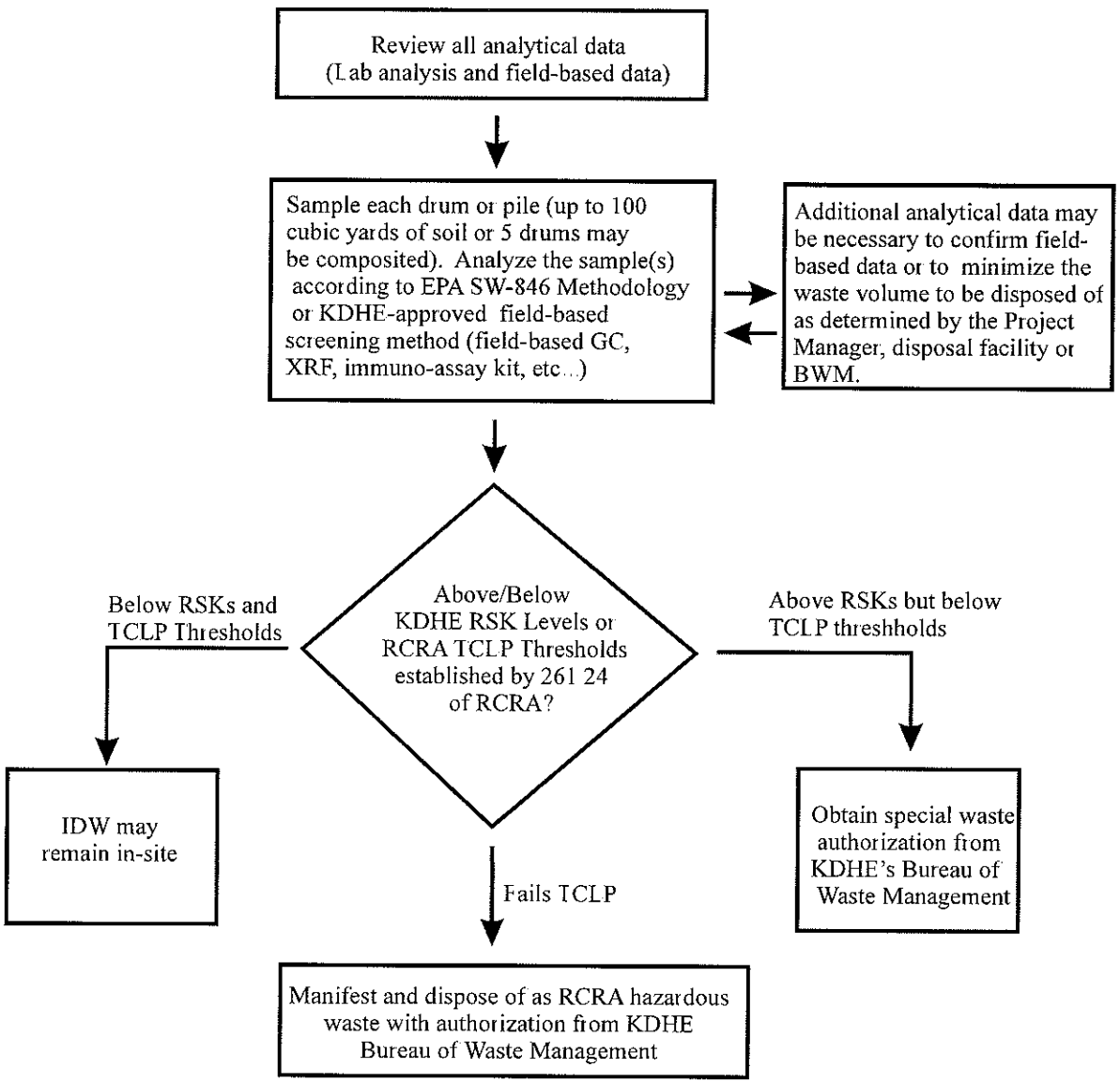
4. GENERAL CONSIDERATIONS

- Leave the site in no worse condition than existed prior to the investigation;
- Remove wastes that pose an immediate threat to human health or the environment;
- Spread evenly on-site IDW that does not require off-site disposal or above-ground containerization;
- Minimize the quantity of IDW to the extent practicable; and
- Comply with applicable clean-up and disposal standards to the extent practicable and as approved by the KDHE Project Manager.

5. SPECIAL CONSIDERATIONS

Disposal of solids must have concurrence of the KDHE's Bureau of Waste Management (BWM). Responsibility of providing necessary BWM documentation and information is upon the party disposing of the IDW. Waste characterization and disposal must be in accordance with applicable State, Federal, and local waste management regulations and standards.

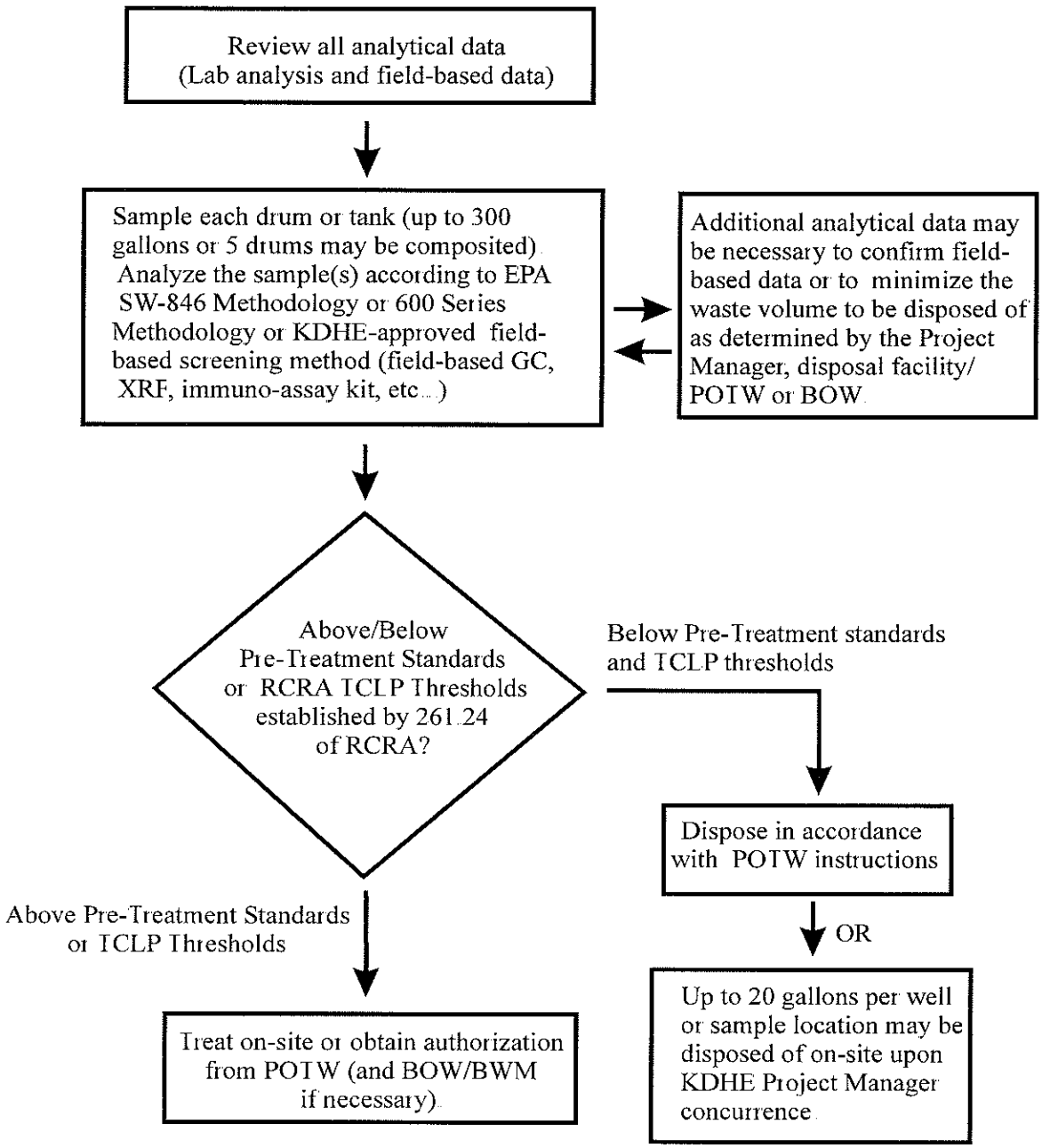
Attachment A
General Solid IDW Disposal Process Flowchart



**NOTE: All site-specific IDW procedures must be approved by the KDHE Project Manager prior to implementation

All off-site disposal of IDW must have concurrence/approval of KDHE/ Bureau of Waste Management

Attachment B
General IDW Water Disposal Process Flowchart



**NOTE: All site-specific IDW procedures must be approved by the KDHE Project Manager prior to implementation.

All off-site disposal of IDW must have concurrence/approval of KDHE/ Bureau of Waste Management or Bureau of Water