ENTERED

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 49TH WING (ACC)
HOLLOMAN AIR FORCE BASE, NEW MEXICO

APR 27 2015

NMED
Hazardous Waste

23 April 2015

DeAnna Rothhaupt
Chief, Holloman AFB Environmental
550 Tabosa Avenue
Holloman AFB NM 88330-8458

Mr. John E. Kieling
Chief, Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East Bldg. 1
Santa Fe NM 87505-6063

SUBJECT: Transmittal of the *Final SS-018 – Resource Conservation and Recovery Act Facility Investigation Work Plan* and the *Final Groundwater Monitoring Plan, SS-018 – Chromic Acid Spill Site*

Dear Mr. Kieling,

Attached are the *Final SS-018 – Resource Conservation and Recovery Act Facility Investigation Work Plan* and the *Final Groundwater Monitoring Plan, SS-018 – Chromic Acid Spill Site*. The documents incorporate resolutions to comments provided in the New Mexico Environment Department (NMED) reviews documented in the "Disapproval, Final SS-018 – Resource Conservation and Recovery Act Facility Investigation Work Plan, September 2014, Holloman Air Force Base, EPA ID #NM6572124422, HWB-HAFB-14-015" (NMED, 2015a) and "Disapproval, Groundwater Monitoring Plan, SS-018 – Chromic Acid Spill Site, September 2014, Holloman Air Force Base, EPA ID #NM6572124422, HWB-HAFB-14-016' (NMED, 2015b), respectively, both dated March 2, 2015. Also included with this submittal is the Response to Comment forms documenting the comment resolutions, hardcopies of the reports, and CDs that contain native and PDF files of the subject documents.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions regarding this submittal, please contact me at (575) 572-3931.

Sincerely,

DEANNA ROTHHAUPT, GS-12, DAFC

2 Attachments:

1. *Final SS-018 – Resource Conservation and Recovery Act Facility Investigation Work Plan.* Hard copy and CD.

2. *Final Groundwater Monitoring Plan, SS-018 – Chromic Acid Spill Site.* Hard copy and CD.

cc: Mr. David Strasser, NMED HWB (Hard copy and CD)
Mr. Will Moats, NMED HWB (letter only)
C. Hendrickson, EPA, Region 6 (letter and CD)

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CERTIFIED MAIL - RETURN RECEIPT REQUESTED

March 2, 2015

Ms. DeAnna Rothhaupt
Chief, Holloman AFB Environmental
49 CES/CEIE
550 Tabosa Avenue
Holloman AFB, NM 88330-8261

RE: DISAPPROVAL
FINAL SS-018 – RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION WORK PLAN, SEPTEMBER 2014
HOLLOMAN AIR FORCE BASE, EPA ID # NM6572124422
HWB-HAFB-14-015

Dear Ms. Rothhaupt:

The New Mexico Environment Department (NMED) has reviewed the Holloman Air Force Base (Permittee) *Final SS-18* (AOC-H) - *Resource Conservation and Recovery Act Facility Investigation Work Plan* dated September 2014 (hereafter the Work Plan) and received on September 30, 2014. NMED hereby issues this Disapproval for the reasons discussed below.

Comment 1

Section 1.1 of the Work Plan states that vapor intrusion is a concern and will be evaluated during the investigation. However, the Work Plan does not indicate how the vapor intrusion evaluation will be conducted. The Permittee shall amend the Work Plan to describe how the proposed vapor intrusion evaluation will be accomplished.

Comment 2

Section 3.5 of the Work Plan proposes the use of a Membrane Interface Probe (MIP) to detect both chlorinated and non-chlorinated volatile organic compound (VOC) contaminants in the subsurface. Due to the geologic conditions at the site, it has been determined that using the MIP for detecting and logging VOCs in the boreholes is not a viable alternative for subsurface characterization. Therefore, the Permittee shall collect soil samples and analyze them as proposed in the Work Plan at three (3) depths within each 15-foot deep borehole from the intervals based on field screening (e.g., visual, olfactory) including those with the highest photoionization detector (PID) readings. In the absence of elevated PID readings or other field screening evidence of the presence of contamination, samples shall be collected from the surface, at five feet below the surface, and from immediately above the water table at each borehole. The Permittee shall amend the Work Plan to include the changes discussed in this comment.

Comment 3

The Work Plan was originally submitted without a figure depicting the locations of the proposed boreholes and monitoring wells. At NMED's request, on December 9, 2014 the Permittee provided supplemental figures depicting the proposed borehole and monitoring well locations. The Permittee shall include these supplemental figures in the amended Work Plan. NMED also requests that for all future submittals, the figures and tables be combined into separate tabs/attachments at the end of the document text (main body) instead of being placed in different locations throughout the text and that every table page include the appropriate descriptive header.

The Permittee must submit an amended work plan by no later than **May 27, 2015**. The submittal (including figures and tables) must be in the form of a paper copy in a three-ring binder and one electronic copy (in MS Word/Excel™ format).

If you have any questions regarding this matter, please contact Mr. David Strasser of my staff at (505) 222-9526.

Sincerely,

John E. Kieling
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
W. Moats, NMED HWB
C. Amindyas, NMED HWB
D. Strasser, NMED HWB
D. Rizzuto, HAFB
C. Hendrickson, EPA-Region 6 (6PD-N)
L. King, EPA-Region 6 (6PD-N)

File: HAFB 2015 and Reading
HAFB-14-015

Common Comment and Response Worksheet (Version 3)

Date	Reviewer	Document Title (version)	Contract/TO Number
2-Mar-15	NMED	Final SS-018 - Resource Conservation and Recovery Act Facility Investigaiton Work Plan	23446541.0040AA

Item	Source	Section	Page	Para	Line	Class	ADEQ Comment	FPN/URS Response
							Final Work Plan (text)	
1	NMED	1.1					Section 1.1 of the Work Plan states that vapor intrusion is a concern and will be evaluated during the investigation. However, the Work Plan does not indicate how the vapor intrusion evaluation will be conducted. The Permittee shall amend the Work Plan to describe how the proposed vapor intrusion evaluation will be accomplished.	Section 3.6, Vapor Intrusion Evaluation, has been added to the text describing the approach that will be taken to assess vapor intrusion based on the NMED *Risk Assessment Guidance for Site Investigation and Remediation.*
2	NMED	3.5					Section 3.5 of the Work Plan proposes the use of a Membrane Interface Probe (MIP) to detect oth chlroinated and non-chlorinated volatile organic compound (VOC) contaminants in the subsurface. Due to the geologic conditions at the site, it has been determined that using the MIP for detecting and logging VOCs in the boreholes is not a viable alternative for subsurface characterization. Therefore, the Permittee shall collect soil samples and analyze them as proposed in the Work Plan at three (3) depths within each 15-foot deep borehole from the intervals based on field screening (e.g., visual, olfactory), including those with the highest photoionization detector (PID) readings. In the absence of elevated PID readings or other field screening evidence of the presence of contamination, samples shall be collected from the surface, at five feet below the surface, and from immediately above the water table at each borehole. The Permittee shall amend the Work Plan to include the changes discussed in this comment.	Section 3.5 has been revised to reflect the proposed sampling approach.
2	NMED						The Work Plan was originally submitted without a figure depicting the locations of the proposed boreholes and monitoring wells. At NMED's request, on December 9, 2014, the Permittee provided supplemental figures depicting the proposed borehole and monitoring well lcoations. The Permittee shall include these supplemental figures in the amended Work Plan. NMED also requests that for all future submittals, the figures and tables be combined into separate tabs/attachments at the end of the document text (main body) instead of being placed in different locations throughout the text and that every table page include the appropriate descriptive header.	Figures 3-1 and 3-2 have been added to the document depicting the proposed locations of the new groundwater monitoring wells and boreholes, respectively. To note, the figures and tables have been moved to the end of the document as requested.

NOTE: Sections and page numbers may be inferred if they were not specifically called out in the reviewer's comments.

Column A:	Comment Identifier Number
Column B:	Source (Commenter/Authority)
Column C:	Section Number of Comment
Column D:	Page Number of Comment (first page associated with
Column E:	Paragraph number, on page, of Comment
Column F:	Line Number (within Paragraph above) of Comment
Column G:	Comment Classification
Column H:	Comment
Column I:	Response
Notes:	Comments must be actionable ("add the following text:…", "delete…", "change text to:")
	Place only one comment per row.
	Classify comment as C, M, S, or A.

Comment Classifications

(C) Critical: Critical comments will result in a critical issue. Provide convincing support.
(M) Major: Major comments are significant concerns that may result in a major issue. This category may be used with a general statement of concern followed by a detailed
(S) Substantive: An entry in the document that appears to be or is potentially unnecessary, misleading, incorrect, or confusing.
(A) Administrative: Administrative comments correct inconsistencies between different sections, typographical and grammatical errors.

HOLLOMAN AIR FORCE BASE
NEW MEXICO

FINAL SS-018 – RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION WORK PLAN

March 2015

49 CES/CEI
550 Tabosa Avenue
Holloman AFB, New Mexico 88330-8458

HOLLOMAN AIR FORCE BASE, NEW MEXICO

SS-018 – CHROMIC ACID SPILL SITE

RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION WORK PLAN

March 2015

Prepared for

Department of the Air Force, 772nd ESS/PKB
3515 S. General McMullen Dr., Suite 155
Joint Base San Antonio Lackland, Texas 78226-2018

Contract FA8903-13-C-0008

Submitted by

URS Group, Inc.
7720 North 16th Street, Suite 100
Phoenix, Arizona 85020

In Association with

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NOTICE

This Resource Conservation and Recovery Act Facility Investigation Work Plan was prepared for the Air Force Civil Engineer Center by URS Group, Inc in association with FPM Remediations, Inc. to aid in the implementation of a final remedial action plan under the Installation Restoration Program. As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the Installation Restoration Program, along with the evolving knowledge of Site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate.

Government agencies and their contractors registered with the Defense Technical Information Center should direct requests for copies of this report to: Defense Technical Information Center, Cameron Station, Alexandria, Virginia 22304-6145.

Non-government agencies may purchase copies of this document from: National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

REPORT DOCUMENTATION PAGE

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AFCEC

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12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This Resource Conservation and Recovery Act Facility Investigation Work Plan specifies the activities that will be performed in support of the site investigation activities to be conducted at Site SS-018, Holloman Air Force Base, New Mexico. The purpose of this plan is to provide guidance for additional characterization activities to be performed at the site to more fully evaluate the nature and extent of contamination. The additional data gathered as a result of this investigation are required to support refinement of the nature and extent of groundwater contamination underlying the site.

15. SUBJECT TERMS
Site SS-018, groundwater monitoring, soil sampling, volatile organic compounds, metals, total dissolved solids

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Richard Wells
					19b. TELEPHONE NUMBER *(Include area code)* 602-861-7409

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PREFACE

This Resource Conservation and Recovery Act Facility Investigation Work Plan addresses the activities that will be performed in support of investigation of the extent of contamination associated with the groundwater underlying the SS-018 Chromic Acid Spill Site at Holloman Air Force Base, New Mexico. The primary activities that will be performed include installation of new groundwater monitoring wells and collection of sediment samples and initial groundwater samples. In addition, further evaluation of vadose zone will be performed to evaluate and identify existing or historic sources of contamination. Groundwater monitoring will continue to be performed on an annual basis in accordance with a separate plan prepared for this project.

This work will be performed under the authority of the requirements of the Air Force Civil Engineer Center Contract No. FA8903-13-C-0008. This program is conducted under the Holloman AFB Installation Restoration Section Chief, Ms. DeAnna Rothhaupt. URS Group, Inc., as a subcontractor to FPM Remediations, Inc., has prepared this Resource Conservation and Recovery Act Facility Investigation Work Plan as defined in the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland Air Force Bases located in New Mexico, and Luke Air Force Base located in Arizona. Mr. Steven Geiger is the URS Group, Inc. Installation Manager for Installation Restoration Project Sites at Holloman Air Force Base.

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TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
bgs	below ground surface
CFR	Code of Federal Regulations
1,1-DCE	1,1-dichloroethene
DOT	U.S. Department of Transportation
DRO	diesel-range organics
EPA	U.S. Environmental Protection Agency
FPM	FPM Remediations, Inc.
GRO	gasoline-range organics
HASP	health and safety plan
HSA	hollow-stem auger
HWA	Hazardous Waste Act
HWB	Hazardous Waste Bureau
IDW	investigation-derived waste
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
mg/L	milligram per liter
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSA	New Mexico State Rules Act
NMWQCC	New Mexico Water Quality Control Commission
NTU	nephelometric turbidity unit
ORO	oil-range organics
PCE	tetrachloroethene
PID	photoionization detector
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RSL	regional screening level
SOP	standard operating procedure
SSL	soil screening level
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
URS	URS Group, Inc.
USAF	U.S. Air Force
USGS	U.S. Geological Survey
VOC	volatile organic compound
µg/L	microgram per liter
°F	degrees Fahrenheit

1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan addresses the activities that will be performed in support of the refinement of the nature and extent of contamination at the SS-018 Chromic Acid Spill Site at Holloman Air Force Base (AFB), New Mexico, hereinafter referred to as the Site. The Site location is shown in Figure 1-1. This plan was prepared in accordance with the requirements of the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008. URS Group, Inc. (URS), as a subcontractor to FPM Remediations, Inc. (FPM), has prepared this Work Plan in accordance with the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland AFBs located in New Mexico, and Luke AFB located in Arizona. Monitoring requirements are further delineated in the *Final Groundwater Monitoring Plan, SS-018 – Chromic Acid Spill Site* (United States Air Force [USAF], 2014a) and the *Final Uniform Federal Policy Quality Assurance Project Plan, SS-018 – Chromic Acid Spill Site* (USAF, 2014b), which serve as companion documents to this Work Plan. The quality assurance project plan (QAPP) also delineates sampling and analysis requirements necessary to support the activities defined within this Work Plan.

As outlined in the *Final Accelerated Corrective Measures Work Plan Multiple Sites, Holloman Air Force Base, New Mexico* (Bhate, 2007), the Site was originally identified as being potentially contaminated with chromium as a result of chrome plating operations conducted at Building 281, which is located immediately adjacent to the Site. The *Final Accelerated Corrective Measures Completion Report Sites OU-03 and OU-45, Holloman Air Force Base, New Mexico* (Bhate, 2008) documents that the investigation demonstrated that chromium did not pose an unacceptable risk to receptors at the site. However, subsequent to the investigation of the Site with regard to chromium, 1,1-dichloroethene (1,1-DCE) was identified in groundwater underlying the Site as being present at concentrations above the New Mexico Water Quality Control Commission (NMWQCC) standard of 5 micrograms per liter (μg/L). The exact source of contamination is unknown, but it is believed to have originated in an area southwest of Building 281 and slightly northwest of Building 279. A secondary source of 1,1-DCE was identified as originating between Buildings 282 and 283. Since the original evaluation of the groundwater contamination at the Site, additional chlorinated volatile organic compounds (VOCs) have been identified that exceed the applicable regulatory levels including tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and 1,1-dichloroethane (1,1-DCA).

1.1 Purpose and Scope

The purpose of this investigation is to refine the understanding of the nature and extent of 1,1-DCE contamination in groundwater underlying the Site. New monitoring wells are to be installed at the Site. In addition, soil sampling will be conducted to assess whether historic Site activities have had an adverse impact to soils and to vertically and horizontally delineate the potential primary source of 1,1-DCE. Soil samples will be collected from the top of the groundwater table (approximately 15 feet below ground surface [bgs]) during the installation of the new monitoring wells. The groundwater monitoring well network located at Sites SS-018 and OT-045 will be gauged and monitored to assess the extent of impact in groundwater underlying the Site in accordance with the aforementioned monitoring plan and QAPP. Previous subsurface investigations and groundwater monitoring events will be evaluated and used to develop background concentrations for 1,1-DCE, the primary constituent of interest in groundwater at the Site. Given the proximity of the groundwater contamination to buildings in the area, vapor intrusion is a concern and will be evaluated during the investigation. The goal of this project is to bring the Site to corrective action complete status without controls.

1.2 Regulatory Setting

Pursuant to the RCRA permit, Installation Restoration Program (IRP) activities conducted at Holloman AFB are performed under the New Mexico Hazardous Waste Act (HWA), the New Mexico Hazardous Waste Management Regulations, and RCRA. The New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) has regulatory enforcement authority for the State of New Mexico.

The media of concern for the Site includes subsurface soil and groundwater underlying the Site. Pursuant to the RCRA permit and with guidance provided by NMED, cleanup levels for impacted groundwater will be in accordance with the latest revision of NMED and U.S. Environmental Protection Agency (EPA) regulations at the time of Work Plan approval and/or execution of the fieldwork. Currently, these levels include the residential soil screening levels (SSLs) presented in the following:

- New Mexico Environment Department Risk Assessment Guidance for Site Investigations and Remediation. NMED soil screening levels for residential soil.
- EPA Regional Screening Levels for Residential Soil available online at http://www.epa.gov/region6/6pd/rcra_c/pd-n/screen.htm.

For groundwater, the applicable action levels are available in the following:

- New Mexico Water Quality Commission Regulations (New Mexico Administrative Code [NMAC] 20.6.2).
- Applicable federal standards include EPA maximum contaminant levels (MCLs) as found in 40 CFR 141 and 40 CFR 142.
- New Mexico Ground Water Quality Bureau (GWQB) Voluntary Remediation Program limits for tapwater as found in the *Technical Background Document for Development of Soil Screening Levels* (NMED, 2006)
- EPA Regional Screening Levels for Tapwater available online at http://www.epa.gov/reg3hwmd/risk/human/

Additionally, the RCRA permit requires groundwater cleanup levels to be set at the more conservative of those specified by either the NMWQCC as protective of human health or by EPA's MCLs.

For vapor intrusion, vapor concentrations will be evaluated in accordance with the "OWSER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)" (EPA, 2002) and the *Risk Assessment Guidance for Site Investigation and Remediation* (NMED, 2014) and compared to the action levels provided in the following:

- EPA Regional Screening Levels for Industrial Air available online at http://www.epa.gov/region6/6pd/rcra_c/pd-n/screen.htm.
- NMED Vapor Intrusion Screening Levels available online at http://www.nmenv.state.nm.us/HWB/documents/RA_Guidance_for_SI_and_Remediation_12-24-2014.pdf.

1.3 Work Plan Organization

This Work Plan is divided into six sections including:

- Section 1 – Introduction, purpose, objectives, and regulatory setting
- Section 2 – Background and history
- Section 3 – Technical approach for conducting the field activities at the Site
- Section 4 – Brief discussion of the reporting requirements
- Section 5 – An estimated project schedule for implementation and reporting
- Section 6 – References.

2.0 BACKGROUND AND HISTORY

The following background and history information is per reference documents *Final Accelerated Corrective Measures Work Plan Addendum* (NationView, 2009) and *Final Release Assessment Report* (NationView, 2011). SS-018 is located on the south side of Building 281 within the main base area of Holloman AFB and is approximately 0.35 acres. Building 281 operated as a chrome plating shop until the late 1970s. When operations at Building 281 were discontinued, the full chromic acid vats were temporarily stored along the south wall of the building. An estimated 500 gallons of chromic acid were spilled on the ground within the storage area in the late 1970s. A surface drainage ditch is located to the west of the storage area and a portion of the spill was suspected to have infiltrated the subsurface through this ditch. The area of the spill was approximately 30 feet by 30 feet.

Due to the release of chromic acid, several subsurface investigations were performed to evaluate potential chromium contamination within the subsurface. During an investigation by Bhate Environmental Associates, Inc. in June and October 2007 conducted in accordance with the *Final Accelerated Corrective Measures Work Plan Multiple Sites, Holloman Air Force Base, New Mexico* (Bhate, 2007), soil concentrations indicated chromium concentrations were below the NMED residential SSL; furthermore, groundwater samples were collected and the results identified 1,1-DCE as a contaminant of concern with concentrations exceeding the NMWQCC standard of 5 µg/L. Seven monitoring wells were installed to assist in the delineation of the groundwater plume in June through October 2007. Results of this investigation are documented in the *Final Accelerated Corrective Measures Completion Report Sites OT-03 and OT-45 Holloman Air Force Base, New Mexico* (Bhate, 2008).

The 1,1-DCE is a breakdown compound of TCE. TCE was widely used at Holloman AFB as a cleaning solution for approximately 40 years prior to the phase-out of the chemical in the early 1980s; therefore, groundwater contamination is suspected to have originated upgradient (to the north) of SS-018 (Building 281). The 2007 investigation evaluated the surrounding buildings and identified three historical Solid Waste Management Units (SWMUs) associated with Buildings 282 and 283. Results from this investigation did not find any conclusive evidence of a 1,1-DCE source.

Between August and October 2009, a Phase II investigation was performed to define the nature and extent of the VOC impacts that were identified during the Bhate 2007 investigation. The 2009 Phase II performed in accordance with the *Final Accelerated Corrective Measures Work Plan Addendum, Site SS-18 VOC Source Area Delineation, Holloman Air Force Base, New Mexico* (NationView, 2009) advanced 17 soil borings in the vicinity of the SWMUs associated with Buildings 282 and 283. In addition, 14 groundwater monitoring wells were installed. Groundwater data identified the main source area of 1,1-DCE (as well as TCE, PCE, and 1,1-DCA) originating in an area southwest of Building 281. A secondary source of 1,1-DCE was identified as originating from between Buildings 282 and 283. Based on available data, the 1,1-DCE plume appears to have migrated downgradient of Building 282. Results of this evaluation are documented in the *Final Release Assessment Report Site SS-18 Holloman Air Force Base, New Mexico* (NationView, 2011).

As a result of the extent of the VOC groundwater contamination identified during the 2009 fieldwork, a supplemental investigation was performed in 2012 as documented in the *Site S-18 Accelerated Corrective Measures Completion Report – Holloman Air Force Base, New Mexico* (NationView, 2013). Twenty-three soil borings were advanced to 15 ft bgs with a single soil sample collected per borehole from the saturated zone (defined as that point where soil comes in contact with groundwater just below the water table and relatively all pores and fractures are saturated with water) for chemical analysis. Eight of the boreholes were converted into permanent monitoring wells to further delineate the boundaries of the groundwater plumes. Figure 2-1 shows the locations of the buildings and the existing monitoring wells in the vicinity of the Site.

2.1 Groundwater Contamination

During the 2012 investigation, all monitoring wells associated with SS018 along with five wells associated with SS-051 were sampled and analyzed. To supplement the analytical data, results for three wells associated with UST-508 sampled during this same timeframe have been included for evaluation. Groundwater contamination comprised of chlorinated VOCs, including 1,1-DCE, TCE, PCE, 1,1-DCA, and cis-1,2-DCE was identified with analytical results provided in Table 2-1. As a constituent of interest, trans-1,2-dichloroethene (trans-1,2-DCE) is included for completeness. Figures 2-2 through 2.7 provide isoconcentration maps for the six chlorinated VOCs of interest.

As discussed in the *Site S-18 Accelerated Corrective Measures Completion Report – Holloman Air Force Base, New Mexico* (NationView, 2013), five chlorinated VOCs are of primary interest, including 1,1-DCA, 1,1-DCE, cis-1,2-DCE, PCE, and TCE. Included in the report is a risk evaluation which determined that the groundwater concentrations do not pose an unacceptable risk based on the current commercial/industrial worker, future resident, and future construction worker scenarios. However, the groundwater has been impacted by the five chlorinated VOCs at concentrations above applicable action levels of 25 µg/L, 5 µg/L, 70 µg/L, 5 µg/L, and 5 µg/L, respectively. For trans-1,2-DCE, the applicable action level is 100 µg/L, which was not exceeded for any of the samples collected in 2012. Based on the groundwater data collected during 2007, 2009, and 2012, it appears that biodegradtion is occurring, but it is unclear if there is a potential for complete biodegradation.

To investigate the potential for biodegradation, a compound specific isotope analysis was conducted for chlorinated VOC contamination. Compound specific isotope analysis is an analytical method that measures the ratios of naturally occurring stable isotopes in groundwater samples and can be used to determine potential contaminant sources and the extent of degradation. In order to evaluate the potential for biodegradation, groundwater samples were collected along two transects parallel to the direction of groundwater flow extending from the suspected origin of the contamination to the distal edge of the VOC plumes.

The compound specific isotope analysis study provided evidence regarding the slow biodegradation of 1,1,1-trichloroethane, PCE, and TCE. The active mechanism appears to be a mix of reductive dechlorination and biological oxidation. A review of the historical VOC concentrations showed little change over a five year period from 2007 to 2012. In addition, the isotopic results suggested that there is not a single course for the observed groundwater contamination, but rather multiple small sources. Furthermore, the subsurface soil data collected in 2007, 2009, and 2012 have not determined a source area in the vicinity of the impacted groundwater, further supporting the determination of the compound specific isotope study.

As can be seen by examination of the isoconcentration maps, the chlorinated VOCs have migrated downgradient of the suspected source locations. The highest concentrations appear to be northeast of Building 281 and southwest of Building 279. The plumes have reached the furthest downgradient wells of SS18-MW29 and SS18-MW30, with TCE concentrations of 9.5 µg/L and 3.7 µg/L, respectively.

2.2 Soil Contamination

Table 2-2 summarizes the borehole soil results from 2007, 2009, and 2012. Samples were collected from various depths as shown in Table 2-2 ranging from 3 to 12 feet bgs. The majority of the analytical results with the exception of samples collected from boreholes SS18-DP06, SS18-DP17, SS18-DP20, SS18-DP27, SS18-DP28, SS18-DP29, SS18-DP30, DD18-DP31, and SS18-DP32. The boreholes S18-DP-17 and SS18-DP20 are located just south of Building 283 as shown in Figure 2-8. The other boreholes are located off the southern corner of Building 281. The elevated concentrations represented by the soil samples collected from these boreholes support the assertion that the groundwater contamination may be attributed to multiple historic releases with at least two originating from locations adjacent to these two buildings.

2.3 Conceptual Site Model

Holloman AFB is situated in south central New Mexico, in the northwest central part of Otero County, approximately 75 miles north–northeast of El Paso, Texas (USAF, 2013). Holloman AFB has a population of 3,054 (U.S. Census, 2010) and occupies 59,639 acres. The White Sands Missile Range testing facilities occupy additional land extending northward from the Base. Privately and publicly owned lands border the remainder of Holloman AFB. The major highway servicing Holloman AFB is Highway 70, which runs southwest from the town of Alamogordo, New Mexico, and separates Holloman AFB from publicly owned lands to the south. Alamogordo, which has a population of 30,401 (U.S. Census, 2010), is located approximately 7 miles east of the Base.

Holloman AFB was first established in 1942 as Alamogordo Army Air Field. From 1942 through 1945, Alamogordo Army Air Field served as the training grounds for over 20 different flight groups, flying primarily B-17s, B-24s, and B-29s. After World War II, most operations had ceased at the Base. In 1947, Air Material Command announced that the air field would be its primary site for the testing and development of unmanned aircraft, guided missiles, and other research programs (USAF, 2013). On 13 January 1948, the Alamogordo installation was renamed in honor of the late Colonel George V. Holloman, a pioneer in guided missile research. In 1968, the 49th Tactical Fighter Wing arrived at Holloman AFB and has remained since. Today, Holloman AFB also serves as the training center for the German Air Force’s Tactical Training Center.

2.3.1 Physiography and Topography

Holloman AFB is located within the Basin and Range physiographic province in the Sacramento Section on the western edge of the Sacramento Mountains at a mean elevation of 4,093 feet above mean sea level (New Mexico Bureau of Geology and Mineral Resources, 2003). The region is characterized by high tablelands with rolling summit plains, cuesta-formed mountains dipping eastward, and west-facing escarpments with the wide bracketed basin forming the basin and range complex. Holloman AFB is within the Tularosa Basin, which is part of the Central Closed Basins (NMED, 2004). The bordering mountains rise abruptly to altitudes of 7,000 to 12,000 feet above mean sea level. The basin is bound by the San Andres Mountains approximately 30 miles to the west and the Sacramento Mountains approximately 10 miles to the east. At its widest, the basin is approximately 60 miles east to west and stretches approximately 150 miles north to south.

2.3.2 Climate

As a whole, New Mexico has a mild, arid to semiarid continental climate characterized by light precipitation totals, abundant sunshine, relatively low humidity, and relatively large annual and diurnal temperature ranges (Western Regional Climate Center, 2013). The climate of the Central Closed Basins varies with elevation. The Base is located in the lower elevation areas, characterized by warm temperatures and dry air. Daytime temperatures often exceed 100 degrees Fahrenheit (°F) in the summer months and are in the middle 50-degree range in the winter. A preponderance of clear skies and relatively low humidity permits rapid cooling resulting in average diurnal temperature ranges of 25° to 35°F.

Potential evapotranspiration, at 73 inches per year, significantly exceeds annual precipitation, usually less than 10 inches. Arid conditions resulting from very low rainfall amounts, coupled with topographically induced wind patterns and combined with sparse vegetation, tend to cause localized “dust devils.” The annual rainfall for Alamogordo is 12 inches per year. Much of the precipitation falls during the mid-summer monsoonal period (July and August) from brief, yet frequent, intense thunderstorms culminating in 30 to 40 percent of the total annual rainfall (Western Regional Climate Center, 2013).

2.3.3 Regional Geology

The sedimentary rocks, which make up the adjacent mountain ranges, are between 500 and 250 million years old (Weir, Jr., 1965). During the period when the area was submerged beneath the shallow intracontinental sea, the layers of limestone, shale, gypsum, and sandstone were deposited. In time, these layers were pushed upward through various tectonic forces, forming a large bulge on the surface. Approximately 10 million years ago, the center began to subside, resulting in a vertical drop of thousands of feet leaving the edges still standing (the present-day Sacramento and San Andres mountain ranges). In the millions of years following, rainfall, snowmelt, and wind eroded the mountain sediments, depositing them in the valley (i.e., Tularosa Basin). Water carrying eroded limestone, dolomite, gravel, and other materials continued to flow into the basin.

As the Tularosa Basin is a bolson-type basin, which is a basin with no surface drainage outlet, sediments carried by surface water into a closed basin are bolson deposits. The overlying alluvium generally consists of unconsolidated gravels, sands, and clays. Soils in the basin are derived from the adjacent ranges as erosional deposits of limestone, dolomite, and gypsum. A fining sequence from the ranges towards the basin's center characterizes the area with the near surface soils being alluvial, eolian, and lacustrine deposits. The alluvial fan deposits are laterally discontinuous units of interbedded sand, silt, and clay, while the eolian deposits consist primarily of gypsum sands. The eolian and alluvial deposits are usually indistinguishable due to the reworking of the alluvial sediment by eolian processes. The playa, or lacustrine deposits, consist of clay containing gypsum and are contiguous with the alluvial fan and eolian deposits throughout the Base. Stiff caliche layers, varying in thickness, have been identified at different areas of the Base.

2.3.4 Site-Specific Geology

Site specific geologic information was obtained from the compilation of lithologic data from the soil borings drilled during the investigations conducted in 2007, 2009, and 2012. The subsurface profile underlying SS-18 consists primarily of interbedded silty sands containing varying degrees of moisture. From grade to approximately 4 ft bgs, soils are predominantly reddish brown, moist, silty snds. Saturated soils are generally encountered between 4 and 5 ft bgs in light reddish brown to pink, silty sand. A reddish brown, silty sand layer with find grained gypsum crystal inclusions was present in more boreholes from approximately 8 to 13 ft bgs. A cemented silt/silty sand caliche layer was present throughout the majority of the site from approximately 13 to 15 ft bgs. The groundwater table occurs at approximately 5 to 8 ft bgs.

2.3.5 Soils

The United States Department of Agriculture, Natural Resources Conservation Service (formerly Soil Conservation Service) has identified two soil associations in the vicinity of Holloman AFB—the Holloman-Gypsum Land-Yesum Complex and the Mead silty clay loam (Derr, 1981). The hydraulic conductivity of these horizons ranges from 4×10^{-4} to 1×10^{-3} centimeters per second.

The Holloman-Gypsum Land-Yesum Complex (0 to 5 percent slopes) consists of larger areas of shallow and deep, well-drained soils and areas of exposed gypsum. The Holloman soil makes up about 35 percent of the complex. Typically, the surface layer is light brown, very fine sandy loam approximately 3 inches thick. The upper 13 inches of the substratum is pink, very fine sandy loam that is very high in gypsum.

Below that, the substratum is white gypsum to a depth of more than 60 inches. This soil is calcareous and mildly alkaline to moderately alkaline throughout. Permeability is moderate, and available water capacity is very low.

Gypsum Land makes up approximately 30 percent of the Holloman-Gypsum Land-Yesum Complex (0 to 5 percent slopes). Typically less than 1 inch of very fine sandy loam overlies soft to hard, white gypsum. The deeper Yesum horizon consists of very fine sandy loam that makes up approximately 20 percent of the complex. Typically, the surface layer is light brown, very fine sandy loam approximately 3 inches thick. The upper 9 inches of the substratum is light brown, fine sandy loam that is very high in gypsum. Below that, the substratum is pink, very fine sandy loam to a depth of more than 60 inches. The soil is calcareous throughout and is mildly alkaline. Permeability is moderate, and available water capacity is moderate. Many fine gypsum crystals are found throughout the profile.

The soil type found across the main drainage area for the Base is Mead silty clay loam (0 to 1 percent slopes). This deep, poorly drained, nearly level soil occurs on outer fringes of alluvial fans. This soil formed in fine-textured alluvium over lacustrine lake sediment. It is very high in salt content because of periodic flooding and poor drainage. Slopes are smooth and concave. Typically, the surface layer is reddish-brown, silty clay loam and clay loam approximately 5 inches thick. The substratum, to a depth of 48 inches, is light reddish-brown clay that has a high salt content. Below that, the substratum is lacustrine material of variable texture and color to a depth of more than 60 inches. Included within this soil are areas of Holloman soils and Gypsum Land along the margins of the unit of steep, short gully sides and knolls.

These inclusions make up approximately 15 percent of the map unit for this soil type. Individual areas are generally smaller than 10 acres. This soil is moderately calcareous throughout and is moderately to strongly alkaline. It has a layer of salt that is more soluble than gypsum. Permeability is very low, and available water capacity is low (URS, 2009).

2.3.6 Regional Hydrogeology

Groundwater occurs as an unconfined aquifer in the unconsolidated deposits of the central basin, with the primary source of recharge as rainfall percolation and minor amounts of stream runoff along the western edge of the Sacramento Mountains (Basabilvazo et al, 1994). Surface water/rainfall migrates downward into the alluvial sediments at the edge of the shallow aquifer near the ranges and flows downgradient through progressively finer-grained sediments towards the central basin. Because the Tularosa Basin is a closed system, water that enters the area leaves either through evaporation or percolation. This elevated amount of percolation results in a fairly high water table.

Beneath Holloman AFB, groundwater ranges from 5 to 50 feet bgs. Flow for the Base is generally towards the southwest with localized influences from variations in topography. In the northern and western portions of the Base, groundwater flows more to the west towards the Ritas Draw, Malone Draw, and Lost River drainages. Groundwater flow is affected by local topography in areas immediately adjacent to arroyos, where groundwater flows directly toward the drainages regardless of the regional flow pattern.

Groundwater in the Tularosa Basin is of potable quality at the recharge areas in close proximity to the Sacramento Mountains and becomes increasingly mineralized toward the central portion of the basin and discharge areas. The majority (over 70 percent) of the IRP sites located across Holloman AFB have groundwater monitoring wells containing water with an average total dissolved solids (TDS) concentration greater than 10,000 milligrams per liter (mg/L) (Basabilvazo et al, 1994). These TDS data support the hypothesis that TDS concentrations below 10,000 mg/L at Holloman AFB are caused by dilution of natural groundwater quality from leaking water lines and surface irrigation from the domestic water supply. TDS concentrations greater than 10,000 mg/L exceed the NMWQCC limit for potable water, and therefore, the groundwater beneath Holloman AFB has been designated as unfit for human consumption. Likewise, the EPA guidelines have identified the groundwater as a Class IIIB water source, characterized by TDS concentrations exceeding 10,000 mg/L and a low degree of interconnection with adjacent surface water or groundwater of a higher class. Groundwater at Holloman AFB does not discharge or connect to any adjacent aquifers because the Tularosa Basin is a closed basin. Adjacent surface waters include Lost River and Lake Holloman, which also have high concentrations of TDS and are not considered potential drinking water sources.

2.3.7 Site Specific Hydrogeology

To determine the groundwater flow direction and horizontal hydraulic gradient, groundwater elevations were measured at 34 monitoring wells located throughout the SS-18 monitoring well network on August 29, 2012. Groundwater onsite occurs within a silty-sand in a shallow, unconfined aquifer approximately 3.5 to 7.7 ft bgs. Static water elevations at SS-018 ranged from 4,073.617 ft amsl at SS18-MW24 to 4,063.875 ft amsl at SS18-MW30.

The SS-018 groundwater flow direction is generally toward the south-southwest and generally mimics the south-southwest basewide flow direction at Holloman AFB. The horizontal hydraulic gradient was calculated along the groundwater flow lines within the SS-018 monitoring well network. The horizontal gradient for SS-018 is approximately 0.006 as calculated using water levels obtained from monitoring wells SS18-MW24 (upgradient) and SS18-MW30 (downgradient). Based on data from slug tests conducted at Sites SD-08 and OT-14 located within the Main Base Area in proximity to SS-018, the groundwater velocity at SS-018 is estimated to be approximately 19 feet per year.

2.3.8 Surface Water Hydrology

The Tularosa Basin contains all of the surface flow in its boundaries (NMWQCC, 2006). The nearest inflow of surface waters to the Base comes from the Lost River, located in the north central region of the Base. The upper reaches of the Three Rivers and Sacramento River are perennial in the basin. Holloman AFB is dissected by several southwest-trending arroyos that control surface drainage. Hay Draw arroyo is located in the far north. Malone and Ritas draws, which drain into the Lost River and Dillard Draw arroyos, are located along the eastern perimeter of the Base. Indications are that the climate was much wetter approximately 10,000 years ago.

The present-day Lake Otero formerly encompassed a much larger area, possibly upwards of several hundred square miles. Its remains include the Alkali Flat and Lake Lucero. Lake Lucero is a temporary feature merely a few inches deep during the rainy season. Ancient lakes and streams deposited water-bearing deposits over older bedrock basement materials. Fractures, cracks, and fissures in the Permian and Pennsylvanian bedrock yield small quantities of relatively good quality water in the deeper periphery. Potable water is only found in wells near the edges of the basin with more saline water found towards the center. Two of the principal sources of potable water are a long narrow area on the upslope sides of Tularosa and Alamogordo and another area in the far southwestern part of the basin. A portion of the city of Alamogordo’s water, as well as the Holloman AFB’s water, was formerly supplied from Bonito Lake (which is in the Pecos River Basin) prior to the Little Bear Fire, in 2012.

2.3.9 Fate and Transport and Potential Receptors

The land surrounding Holloman AFB consists of residential areas to the east and northeast (City of Alamogordo), rangeland to the south, White Sands National Monument to the west, and areas where military activities are conducted to the north. The desert terrain immediately surrounding Holloman AFB has limited development; Mesa Verde Ranch operates along the eastern border, and there are no residential communities or large industrial operations located adjacent to the Base. Holloman AFB is an active military installation and is expected to remain active for the foreseeable future. No transfer of military property to the public is anticipated, and public access to the Base is restricted (Foster Wheeler, 2002). Future land use is not expected to differ significantly from current land use practices (Foster Wheeler, 2002).

Currently, there are no potable supplies of groundwater or surface water located on the Base (Foster Wheeler, 2002). Holloman AFB obtains its water supply from the city of Alamogordo and Holloman AFB wells in the Boles, San Andres, and Douglas well fields at the base of the Sacramento Mountains. No water supply wells are located on or near the Base because of poor groundwater quality with TDS concentrations greater than 10,000 mg/L. There are no potable or irrigation wells near or immediately downgradient of the Base.

Given the proximity to buildings in the immediate vicinity of SS-018, vapor intrusion is a concern and will be evaluated as part of this overall investigation. The potential exists for chlorinated VOCs to migrate from the shallow groundwater that comprises the aquifer underlying the site into buildings having a negative impact on workers.

3.0 PROCEDURES FOR IMPLEMENTATION

This section includes general procedures for implementing the RFI activities to be undertaken. Several supporting project-related plans have also been prepared as described in the following sections, including a Site-specific QAPP, a health and safety plan (HASP), and a groundwater monitoring plan.

The following specific tasks will be applied to the Site subject to investigation under this Work Plan:

- Pre-mobilization activities
- Mobilization/Site setup
- Monitoring well installation
- Surveying
- Monitoring well development
- Groundwater monitoring
- Borehole installation

3.1 Applicable Regulations and Standards

Federal and state regulations and standards that may be applicable to these activities include the following:

- Holloman AFB RCRA Permit No. NM6572124422, February 2004 (NMED, 2004).
- RCRA Permit No. NM6572124422 Modification, October 2009 (NMED, 2009).
- NMED residential SSLs
- EPA residential RSLs
- NMWQCC groundwater cleanup levels protective of human health (20.6.2.3103 New Mexico Administrative Code [NMAC]).
- EPA MCLs
- New Mexico HWA (New Mexico State Rules Act [NMSA] 1978, §74-4-1).
- New Mexico Hazardous Waste Management Regulations, (20.4.1.100 NMAC).
- RCRA, 40 Code of Federal Regulations (CFR) 260-268, Management of Hazardous Waste. In the event that investigation derived waste (IDW) sampling and analysis indicate the presence of constituents of potential concern at concentrations rendering them hazardous, storage and disposal protocols will be followed in accordance with RCRA hazardous waste regulations, as adopted by NMED.
- United States Department of Transportation (DOT) 49 CFR 172, 173, and 178: Applies to packaging IDW for removal off Site and addresses hazard-class diamond labeling.

The latest revision of NMED and EPA documents at the time of Work Plan approval and/or execution of the field work will be used.

3.2 Pre-Mobilization Activities

Prior to mobilization of equipment, subcontracted services (e.g., drilling subcontractor, licensed surveyor, analytical laboratory) will be procured. All necessary permits (e.g., digging permits) will be initiated. All Site activities will be coordinated with appropriate Holloman AFB personnel.

Prior to initiating intrusive activities, a completed and approved Air Force Form 332 will be obtained for authorization of construction work at Holloman AFB. A request for locating underground utilities in the area will be submitted to the local one-call utility notification center, as applicable. Additionally, Air Force Form 103 will be submitted to request that the location of underground utilities be marked at the specified areas. Drilling locations will be identified with paint, flags, or stakes, as appropriate to the surface material. Utility clearance approvals will be completed by the appropriate Holloman AFB utility office (e.g., telephone, sewer, water, natural gas, etc.).

3.3 Mobilization Setup

Personnel, equipment, and resources necessary to implement this RFI Work Plan will be mobilized to the Site. Site setup will occur at the SS-018 Site. Warning signs and safety fencing may be used, where necessary, to indicate the danger of entering a work zone and to keep the work area clear of obstructions such as facility worker vehicles. Setup will also include establishing a location for material storage and other equipment staging areas.

3.4 Monitoring Wells

Two new groundwater monitoring wells will be installed in the vicinity of the Site to further delineate the nature and extent of contamination in the groundwater. One well will be drilled to the southwest of existing wells SS18-MW29 and SS18-MW30 as shown in Figure 3-1 to provide a downgradient monitoring point given that TCE is encroaching on these two wells. A second well will be drilled midway between wells SS18-MW18 and S51-MW3 (see Figure 3-1) to help refine the groundwater contours. The groundwater flow is predominantly in a southwesterly direction. One soil sample will be collected from the saturated zone from each new monitoring well borehole from the interval with the highest photoionization detector (PID) reading and analyzed by an off-Site laboratory for VOCs and total petroleum hydrocarbons (TPHs) – gasoline-range organics (GRO), diesel-range organics (DRO), and oil-range organics (ORO). After allowing a sufficient time for the well to equilibrate following installation, the water level will be measured for each new well and groundwater samples will be collected. The groundwater samples will be analyzed for VOCs, TPH-GRO/DRO/ORO, metals (total and filtered), and TDS. The new wells will continue to be monitored on an on-going basis in accordance with the *Final Groundwater Monitoring Plan, SS-018 – Chromic Acid Spill Site* (USAF, 2014a).

3.4.1 Monitoring Well Installation

Well drilling activities will be performed by an individual with a current and valid well driller license issued by the State of New Mexico. The monitoring wells will be installed using the hollow-stem auger (HSA) drilling technique in accordance with NMED Ground Water Quality Bureau Monitoring Well Construction and Abandonment Guidelines (NMED, 2011). The boreholes will be advanced into the water table using an HSA such that the borehole diameter will be at least 4 inches larger than the outside diameter of the well casing to allow for proper placement of the filter pack and sealant. Care will be taken to ensure that the completed monitoring wells are sufficiently straight and plumb to allow passage of measuring and sampling devices.

During drilling, a URS Geologist or Engineer will document the following information for each boring:

- Boring or well identification (this identification will be unique, and ensure it has not been used previously at the Base)
- Purpose of the boring (e.g., soil sampling, monitoring well)
- Location in relation to an easily identifiable landmark
- Names of drilling subcontractor and logger
- Start and finish dates and times
- Drilling method
- Diameters of surface casing, casing type, and methods of installation
- Descriptions and quantities of materials placed in the annular space of the boring.
- Depth at which saturated conditions were first encountered
- Lithologic descriptions and depths of lithologic boundaries
- Sampling-interval depths
- Other pertinent field observations.

Field forms, including soil boring logs for documentation of field activities, will be completed. Well installation equipment will be decontaminated in accordance with the standard operating procedure (SOP) 3 provided in the QAPP.

The soil sample from the saturated zone will be collected using a split-spoon sampling device during the advancement of the well boring. As indicated previously, the interval with the highest PID reading will be targeted. Should an interval not be encountered with elevated PID readings, the interval immediately above groundwater will be sampled. Soil samples will be analyzed for the parameters outlined above. All samples will be collected in accordance with the protocols outlined in the QAPP.

Well borings will be advanced approximately 8 feet into the water table and completed such that the well screen intersects the water table. The wells will be constructed of 2-inch diameter Schedule 40 polyvinyl chloride (PVC) riser and screen. The screened section of the wells will consist of 10 feet of 0.010-inch slotted screen (or other field-determined slot size). A silica sand filter pack will be placed around the screen to approximately 2 feet above the top of the screen. A 2-foot thick bentonite seal will be placed above the filter pack. The remaining annular space will be grouted with neat cement.

Monitoring wells will be completed as “flush-mounted” and constructed with water-tight well vaults that are rated to withstand traffic loads and fitted with locking, expandable well plugs. Concrete pads (2-foot minimum radius, 4-inch minimum thickness) will be poured around the well vaults. Vault covers will be secured with bolts. Additionally, the vault cover will indicate that the wellhead of a monitoring well is contained within the vault. The concrete and surrounding soil must be sloped to direct rainfall and runoff away from the well vault.

To document specific details of the monitoring well installations, the URS Geologist or Engineer will prepare drilling logs and as-built well construction diagrams in the field as the activity is taking place. Specific procedures for installing monitoring wells are provided in SOP-7 – “Installation of Groundwater Monitoring Wells” provided in the QAPP. The monitoring wells will be constructed in accordance with NMED requirements.

3.4.2 Surveying

Surveying of the new monitoring well locations will be conducted by a State of New Mexico licensed surveyor. Elevation data for monitoring wells will include the ground surface elevation of the well locations, as well as the elevation of the measuring point on the inner casing. Surveying data will be provided in a spreadsheet format for import into the geographic information system, and the data will be incorporated into the RFI report figures.

Horizontal coordinates will be referenced to the New Mexico Central State Plane Coordinate System and surveyed to an accuracy of ±1.0 foot. Vertical elevations will be reference to North American Datum 1983 coordinate system to an accuracy of ±0.01 foot.

Geospatial information will also be submitted as a separated deliverable to the USAF. All applicable federal, U.S. Department of Defense, and USAF geospatial data standards will be followed. Spatial data will be compliant with The Spatial Data Standards for Facilities, Infrastructure, and Environment which can be accessed at http://www.sdsfieonline.org/.

Each geospatial data set will be accompanied by metadata that conforms to the Spatial Data Facilities, Infrastructure, and Environment standards. The horizontal accuracy of any geospatial data created will be tested and reported in accordance with the National Standard for Spatial Data Accuracy, and the results will be recorded in the metadata.

3.4.3 Monitoring Well Development

The newly installed monitoring wells will be developed in accordance with SOP-10 – “Monitoring Well Development” provided in the QAPP to create an effective filter pack around the well screen, remove fine particles from the formation near the borehole, and assist in restoring the natural water quality of the aquifer in the vicinity of the well. All newly installed monitoring wells will be developed no sooner than 48 hours after installation to allow for grout curing. Monitoring wells will be developed using surge blocks, bailers, or pumps to achieve effective well development.

During well development, documentation of the activity will take place and will include recording of water level and depth to bottom measurements, water quality parameters, discharge water color, water volume, and time period. Well development will continue until the following criteria are met:

- Water that has been removed from the well is visually clear, and the turbidity measures less than or equal to 10 nephelometric turbidity units (NTUs).
- The pH, temperature, and specific conductance parameters have stabilized (less than 10 percent variation for three successive readings).

In the event that fine-grained deposits are present in the subsurface, it may be difficult to achieve a turbidity of 10 NTUs during well development. This is primarily a concern when a well has been screened in a formation that contains a high level of fine material (silt and clay). Silt and clay can occasionally travel through filter packs on properly constructed wells, resulting in turbid water. While selection of proper filter pack and screen materials minimizes turbidity, fine-grained particles may still flow through. Proper well construction and development procedures will be followed to reduce measured turbidity in monitoring wells. If turbidity remains greater than 10 NTUs after 4 hours of continuous well development, well development will cease. If the well is pumped dry, it will be allowed to recharge and be re-pumped as much as practical within the 4-hour time limit.

3.4.4 Groundwater Monitoring

Groundwater sampling will occur no sooner than two days following monitoring well development at any monitoring well. Groundwater samples will be collected from Site monitoring wells in accordance with the procedures provided SOP-11 – "Monitoring Well Purging and Groundwater Sampling" contained in the QAPP. If groundwater at the Site exceeds NMED water quality standards, the TDS levels from nearby monitoring wells will be used to develop a TDS survey to determine if the present-day groundwater in the immediate vicinity of the Site is above the NMED 10,000 mg/L TDS potable water threshold. The Ground Water Quality Bureau does not regulate groundwater that has a TDS over this threshold. Regardless, if contaminant concentrations exceed regulatory thresholds, it will be necessary to assess potential risks associated with vapor intrusion and/or ecological receptors.

Groundwater monitoring wells will be sampled using low-flow sampling techniques. Field parameters (e.g., temperature, conductivity, pH, and turbidity) will be measured. Groundwater samples will be collected when the field parameters stabilize with minor fluctuations between consecutive readings. Groundwater samples will be analyzed for the parameters discussed above. Quality assurance/quality control samples will be collected in accordance with the requirements set forth in the QAPP.

3.5 Subsurface Evaluation

As discussed in Section 2.2, available borehole data indicate that the likely source of VOCs appears to originate near the southern corner of Building 283 with a second source near the corner of Building 281. Five boreholes will be drilled in the vicinity of each of these two locations for a total of 10 boreholes at the locations shown in Figure 3-2. Boreholes will be installed using either direct-push technology or an HSA drill rig depending on conditions encountered in the field. Surveying of the borehole locations will be performed in accordance with the requirements described in Section 3.2.

Boreholes will be installed to a maximum depth of 15 feet bgs. Soil samples will be collected from three depths within each 15-foot deep borehole. The intervals may be adjusted based on field screening (e.g., visual, olfactory) including collecting sample(s) for the interval(s) based on elevated PID readings or other field screening evidence of the presence of contamination. In the absence of elevated PID readings or other evidence of contamination, samples shall be collected from the surface, at five feet below the surface, and from immediately above the water table at each borehole. Soil samples will be analyzed by an off-site laboratory for VOCs and TPH-GRO/-DRO/-ORO.

3.6 Vapor Intrusion Evaluation

As indicated in Section 1.2, the vapor intrusion pathway will be evaluated in accordance with the "OWSER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)" (EPA, 2002) and Section 2.5.2 of the *Risk Assessment Guidance for Site Investigation and Remediation* (NMED, 2014) and compared to the action levels provided in the following:

- EPA Regional Screening Levels for Industrial Air available online at http://www.epa.gov/region6/6pd/rcra_c/pd-n/screen.htm.
- NMED Vapor Intrusion Screening Levels available online at http://www.nmenv.state.nm.us/HWB/documents/RA_Guidance_for_SI_and_Remediation_12-24-2014.pdf.

The NMED Vapor Intrusion Screening Levels are provided in Table A-3 of the risk assessment guidance.

The vapor intrusion evaluation will be performed following completion of any site remediation activities determined to be necessary. Evaluation will consist of comparison of groundwater analytical data to the Residential Groundwater screening levels specified in the table. Should concentrations exceed the screening levels, further evaluation of indoor air and soil gas will be performed by collection of indoor air samples and soil gas samples. Should such sampling be required, an addendum to this work plan will be prepared and submitted for review and approval by AFCEC and the NMED.

3.7 Quality Assurance Project Plan

The objective of this investigation is to provide sample analytical data of sufficient quality and quantity to characterize and refine the understanding of the nature and extent of contamination underlying the Site. The *Final Uniform Federal Policy Quality Assurance Project Plan, SS-018 – Chromic Acid Spill Site* (USAF, 2014b) outlined sampling and analytical requirements necessary to ensure that the functional activities, organization, and quality assurance/quality control protocols are achieved in accordance with the project's data quality objectives.

The *Final Uniform Federal Policy Quality Assurance Project Plan, SS-018 – Chromic Acid Spill Site* (USAF, 2014b) provides the direction necessary for the collection of data required for assessment of the sediments and groundwater underlying the SS-018 Site at Holloman AFB. The plan was written in accordance with the QAPP requirements and elements set forth in the Intergovernmental Data Quality Task Force Uniform Policy for QAPPs by the EPA (EPA, 2005), dated March 2005, which was adopted by the AFCEC. QAPPs written in the Uniform Federal Policy format integrate the technical and quality aspects of a project, including planning, implementation, and assessment, and include elements of a sampling and analysis plan.

As outlined in the QAPP, quality assurance objectives are specified to ensure that data produced are of a known and sufficient quality for determining whether a risk to human health or the environment exists. Minimum precision, accuracy, and completeness measurements and minimum detection limits are quantitative objectives specified in the QAPP. Representativeness and comparability are qualitative objectives. During the sampling discussed in the QAPP, field quality control samples will be collected and analyzed to evaluate the achievement of the precision and accuracy objectives specified in the QAPP. Overall, both field and laboratory precision will be evaluated through the results of duplicate groundwater samples, equipment rinsates, and field blanks. The duplicate samples, equipment rinsates, and field blanks will be analyzed for the same suite of analytes as the primary samples. Trip blanks to be analyzed for VOCs will be included in each cooler containing VOC samples shipped to the laboratory.

Environmental analyses are critical, because decision-making based on inaccurate measurements or data of unknown quality can have significant economic and health consequences. Data verification and validation will be performed as specified in the QAPP to ensure data meet the project requirements. Method data validation is the process whereby analytical data are reviewed against set criteria to ensure that the results conform to the requirements of the analytical method and any other specified requirements. All laboratory-generated data will be validated in accordance with the requirements of the QAPP. The field-generated data will not be validated, but the quality of the field-generated data will be ensured through adherence to established operating procedures and use of equipment calibration and standardization, as appropriate.

3.8 Health and Safety Plan

The *Health and Safety Plan – Selected Sites Under the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008 (SS-017;SS-018; DP-030/SD-033; SS-039; OT-037/OT-038; SS-065; SS-069; SD-027)* (USAF, 2014c) has been prepared and addresses the tasks and conditions to be encountered during this project. The HASP presents the health and safety requirements and guidelines for field operations addressed under the IRP at Holloman AFB, specifically for the 10 sites being administered by URS New Mexico and Phoenix offices under terms of the AFCEC Contract No. FA8903-13-C-0008. The purpose of the HASP is to identify and educate personnel of the potential hazards associated with field activities at Holloman AFB. Subcontractors working for URS at task sites will be responsible to provide their own HASPs and provide documentation to URS that describes their plan for addressing applicable health and safety requirements for activities that are unique to their scope of services. The HASP is a living document and may be updated as conditions dictate. The HASP covers the following items:

- Project team organization and responsibilities
- Training and medical monitoring requirements
- Site hazard analysis
- Emergency response plan
- Personal protective equipment and medical screening
- Frequencies and types of air monitoring
- Site control measures and safe work practices
- Decontamination procedures
- Site inspections
- Recordkeeping

The Health and Safety Plan – Selected Sites Under the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008 (SS-017;SS-018; DP-030/SD-033; SS-039; OT-037/OT-038; SS-065; SS-069; SD-027) (USAF, 2014c) is augmented by the URS Health and Safety Program's relevant Safety Management Standards that were developed under the company's Health and Safety Management System and are required to be available on-Site during all activities.

3.9 Investigation-Derived Waste

The IDW generated during the groundwater monitoring, soil boring, and well installation will include spent and unused sample material, personal protective equipment, miscellaneous sampling supplies, decontamination water, and purge water. The IDW will be managed in accordance with SOP 49, "IDW Management" provided in Appendix A of the QAPP (USAF, 2014b). Prior to performing sampling, the field team leader will discuss with the field sampling personnel waste reduction methods. Practices to be instituted to support waste minimization include, but are not limited to, the following:

- Restriction of materials (especially hazardous materials) to those needed for performance of work
- Substitution of recyclable materials for disposable items
- Reuse of items, when practical
- Segregation of contaminated from uncontaminated waste
- Segregation of reusable items (such as personal protective equipment and tools)
- Waste characterization will be evaluated based on the comparison of analytical results with applicable regulatory levels.

Wastewater from pre-sampling well purging and equipment decontamination will be stored in tanks pending the receipt of the groundwater analytical results. A sign posted on each tank will identify the contents and convey a warning that no material should be added or removed. Waste characterization will be performed by reviewing the groundwater sample analytical results from the wells. The detected constituent concentrations will be compared to the NMWQCC Regulations, Part 2, 3103, A, B, and C groundwater quality standards (20 NMAC 6.2).

A Notice of Intent to discharge development, purge, and decontamination water will be prepared and submitted to NMED Ground Water Quality Bureau for approval prior to discharging any groundwater to surface. Results from laboratory analyses will be summarized and concentrations evaluated for individual containers based on the volume added from the wells from which the purge water and decontamination water originated. The maximum concentrations will be used to determine whether purge water meets the discharge requirements. After NMED provides their approval, the water will be discharged to the ground surface at the Site. If the results indicate that the water cannot be released to the ground surface, it will be disposed at an appropriate facility.

All personal protective equipment and disposable equipment will be placed in double plastic bags and sealed for disposal in dumpsters at the Base.

As part of the contract with the subcontracted laboratories, all laboratory and sample waste is managed in accordance with the subcontract. Analytical waste streams may include unused/unaltered sample material, analytical residues, and sample containers. Unused/unaltered sample material will be generated from the sampling activities in the form of groundwater not required for analysis. Generally, the laboratory will be responsible for disposal of the unused/unaltered sample material. In those cases where samples must be returned from the laboratory, this excess material will be documented and disposed in accordance with the requirements for disposal of purge and decontamination water. Analytical residues will be generated from the sample analytical activities conducted by the subcontracted laboratories. Although the laboratories are required to dispose of analytical residues under terms of the subcontract, the potential does exist for return of analytical residues. If analytical residues are returned, this will be documented and the waste disposed at an appropriate facility.

Sample containers will become a waste stream following analyses. The laboratories are required to dispose of the sample containers in accordance with established waste management procedures. Sample containers will only be returned to the project should unused/unaltered sample material need to be returned as discussed above.

4.0 REPORTING

Reporting will be comprised of an RFI report, well completion reports, and annual groundwater monitoring reports.

4.1 Resource Conservation and Recovery Act Facility Investigation Report

Documentation of the project will include field notes and forms, photographs, and analytical data. The RFI report will be prepared following completion of the activities described herein documenting the results of the drilling, sampling, and analyses. The report will be submitted for USAF and NMED review. The RFI report will include, at a minimum, the following elements:

- A description of the field activities completed
    - Groundwater monitoring well installation
    - Borehole installation
- Summaries of analytical results
- Summaries of problems encountered and deviations from the planned work scope
- Summaries of accomplishments and evaluation of the results
- Recommendations for future disposition of the Site.

4.2 Well Completion Reports

Well completion reports for each installed groundwater monitoring well will be prepared and submitted by the licensed driller in accordance with NMED requirements.

4.3 Groundwater Monitoring Reports

Annual groundwater monitoring reports will be prepared to document the results of the groundwater sampling and well gauging activities completed during the fiscal year. The annual monitoring reports will provide evaluation of the data and associated trends and provide recommendations as to future monitoring requirements and optimization actions. Concentration versus time trend analysis for key constituents will be performed using appropriate statistical analysis software such as the Monitoring and Remediation Optimization System, which was developed by GSI Environmental Inc. of Houston, Texas and the University of Houston for the Air Force Center for Environmental Excellence in accordance with the organization’s Long-Term Monitoring Optimization guide. Other appropriate statistical methods may be employed with approval of the USAF.

In addition to the above reports, analytical data will be exported for upload to AFCEC’s Environmental Restoration Program Information Management System database within 90 days of sample collection.

5.0 PROJECT SCHEDULE

An integrated master schedule (see Table 5-1) has been prepared for the overall anticipated sequence of activities to be performed in support of the investigation at the Site. The schedule is dependent on many factors including, but not limited to, USAF and NMED review and comment, subcontractor availability, weather, and Site conditions. The USAF and NMED will be notified 30 days prior to the implementation of field activities. Additionally, during implementation of the field activities, weekly status reports will be submitted to Holloman AFB IRP personnel by electronic mail. These reports will summarize the previous week's activities, the planned activities for the following week, and any other pertinent information.

The RFI schedule will allow for evaluation of screening level data during field work to allow for timely response to changing conditions. Groundwater monitoring will be continued on an annual basis to:

- Monitor impacts of contaminants.
- Measure the effectiveness of the future interim measures implemented.
- Augment the implemented interim measures with additional actions if determined to be necessary in order to achieve the project objectives. Changes to groundwater monitoring or interim measures based on monitoring results will be documented in the annual monitoring report or interim measures report, as appropriate. Any reduction in scope or change in interim measures employed will be communicated in writing either prior to implementation or within one week of implementation if the change is immediately necessary because of potential impacts to safety or the environment.
- Demonstrate that the interim measures have successfully addressed contamination at the Site based on mitigation of contaminant impacts on groundwater underlying the Site

Ultimately, these activities will support a corrective action completion without controls determination.

The RFI report will be submitted for review and approval by USAF and NMED personnel.

6.0 REFERENCES

Basabilvazo, G.T., Myers, R.G., and Nickerson, E.L. 1994. *Geohydrology of the High Energy Laser System Test Facility Site, White Sands Missile Range, Tularosa Basin, South- Central New Mexico*: U.S. Geological Survey Water-Resources Investigations Report 93-4192, 59 p.

Bhate. 2007. *Final Accelerated Corrective Measures Work Plan Multiple Sites, Holloman Air Force Base, New Mexico*. Bhate Environmental Associates, Inc. May.

_____. 2009. *Final Accelerated Corrective Measures Completion Report Sites OT-03 and OT-45 Holloman Air Force Base, New Mexico.* Bhate Environmental Associates, Inc. November.

Derr, Phillip S. 1981. *Soil Survey of Otero Area, New Mexico, Parts of Otero, Eddy, and Chaves Counties*. Soil Conservation and Forest Service in Cooperation with the New Mexico State University Agricultural Experiment Station, 1981.

EPA. 2002. "OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)." Office of Solid Waste and Emergency Response. Washington, DC. EPA 530-D-02-004. November. Available online at www.epa.gov/osw/hazard/correctiveaction/eis/vapor.complete.pdf.

_____. 2005." Uniform Federal Policy for Implementing Environmental Quality Systems." Final Version 2. EPA-505-F-03-001. DTIC ADA 395303. DOE/EH-0667. In conjunction with the Department of Defense and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March.

_____. 2013. USEPA Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table. November. Accessed online at: http://www.epa.gov/region9/superfund/prg/.

Foster Wheeler. 2002. *Draft Report for the Remedial Investigation of DP-63—Disposal Pit 63*, Holloman Air Force Base, New Mexico. December.

NationView. 2009. *Final Accelerated Corrective Measures Work Plan Addendum, Site SS-18 VOC Source Area Delineation, Holloman Air Force Base, New Mexico*. NationView, LLC. July.

_____. 2011. *Final Release Assessment Report, Site SS-18, Holloman Air Force Base, New Mexico*. NationView, LLC. February.

_____. 2013. *Final Site SS-18 Accelerated Corrective Measures Completion Report Holloman Air Force Base, New Mexico*. NationView, LLC. June.

New Mexico Bureau of Geology and Mineral Resources. 2003. Geologic Map of New Mexico.

NMAC. 2013a. Title 20 Environmental Protection. Chapter 6. Water Quality. Part 2. Ground and Surface Water Protection. 20.6.2. Standards for Ground Water of 10,000 mg/l TDS Concentration or Less.

_____. 2013b. Title 20 Environmental Protection. Chapter 4. Hazardous Waste. Part 1. Hazardous Waste Management Regulations. 20.4.1. Adoption of 40 CFR Part 260.

NMED. 2004. Holloman Air Force Base RCRA Permit No. NM6572124422. February.

_____. 2006. *Technical Background Document for Development of Soil Screening Levels*. Revision 4. New Mexico Environment Department. Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program. July.

_____. 2009. Holloman Air Force Base RCRA Permit No. NM6572124422 Modification. October.

_____. 2011. Monitoring Well Construction and Abandonment Guidelines, New Mexico Environment Department. Ground Water Quality Bureau. March.

_____. 2014. *Risk Assessment Guidance for Site Investigations and Remediation.* New Mexico Environment Department. December.

NMSA.1978. Chapter 74 Environmental Improvement. Article 4. Hazardous Wastes. 74-4-1. Hazardous Waste Act.

NMWQCC. 2006. 2004-2006 State of New Mexico Integrated Clean Water Act §303(D)/§305(B) Report.

USAF. 2013. Holloman Air Force Base official website. http://www.holloman.af.mil/. Accessed 12/3/2013.

_____. 2014a. *Final Groundwater Monitoring Plan, SS-018 – Chromic Acid Spill Site*. U.S. Air Force, Holloman AFB, New Mexico. September.

_____. 2014b. *Final Uniform Federal Policy Quality Assurance Project Plan, SS-018 – Chromic Acid Spill Site*. U.S. Air Force. Holloman AFB, New Mexico. September.

_____. 2014c. *Health and Safety Plan – Selected Sites Under the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008 (SS-017; SS-018; DP-030/SD-033; SS-039; OT-037/OT-038; SS-065; SS-069; SD-027)*. U.S. Air Force, Holloman AFB, New Mexico. July

U.S. Census. 2010. Census 2010 using American FactFinder. http://factfinder2.census.gov. Accessed 12/3/2013.

URS. 2009. *Volume II, Final Evaluation Report, Holloman Air Force Base, Identification and Evaluation of Defense Environmental Restoration Account Eligibility*. Contract No. W912QR-04-D-0025, Task Order DS03. September.

Weir, Jr., James E. 1965. *Geology and Availability of Ground Water in the Northern Part of the White Sands Missile Range and Vicinity New Mexico*. U.S Geological Survey and U.S. Department of Interior, 1965.

Western Regional Climate Center. 2013. Desert Research Institute State Narrative Web Page, http://www.wsmr.army.mil/paopage/Pages/WU%2360.htm. Accessed 12/3/2013.

TABLES

Table 2-1. Fiscal Year 2012 Groundwater Monitoring Data

Well	Sample Date	1,1-DCE (µg/L)	TCE (µg/L)	1,1-DCA (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)	PCE (µg/L)
S51-MW1	9/12/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
S51-MW3	9/12/2012	4.9	**83.2**	14.3	**103**	5.4	**26.8**
S51-MW4	9/12/2012	< 0.23	1.3	0.44	< 0.26	< 0.35	3.8
S51-MW5	9/12/2012	< 0.23	0.6	< 0.25	< 0.26	< 0.35	2
S51-MW7	9/12/2012	< 0.23	0.46	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW02	9/13/2012	4.3	< 0.26	2.9	< 0.26	< 0.35	< 0.25
SS18-MW03	9/14/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW04	9/14/2012	**35.9**	< 0.26	**25.2**	< 0.26	< 0.35	0.32
SS18-MW05	9/12/2012	**54.4**	0.26	**170**	< 0.26	< 0.35	< 0.25
SS18-MW06	9/12/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW07	9/10/2012	< 0.23	< 0.26	0.29	< 0.26	< 0.35	< 0.25
SS18-MW08	9/10/2012	**95.5**	**6.5**	**27.2**	0.36	< 0.35	**28.2**
SS18-MW09	9/11/2012	1.2	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW10	9/11/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW11	9/11/2012	0.27	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW12	9/11/2012	0.7	< 0.26	9	< 0.26	< 0.35	< 0.25
SS18-MW13	9/12/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW14	9/10/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW15	9/10/2012	1	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW16	9/13/2012	2	**12.9**	1.2	**199**	5.5	0.83
SS18-MW17	9/12/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW18	9/13/2012	2.8	**111**	8.5	**102**	6.2	**16.4**
SS18-MW19	9/13/2012	**53.8**	**40.2**	**497**	8.2	1.8	**150**
SS18-MW20	9/14/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW21	9/13/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW22	9/11/2012	4.5	< 0.26	0.42	< 0.26	< 0.35	< 0.25
SS18-MW23	9/10/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	0.54

Well	Sample Date	1,1-DCE (µg/L)	TCE (µg/L)	1,1-DCA (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)	PCE (µg/L)
SS18-MW24	9/10/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW25	9/10/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW26	9/11/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW27	9/11/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW28	9/13/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW29	9/12/2012	0.33	**9.5**	0.76	2.8	3.4	< 0.25
SS18-MW30	9/13/2012	< 0.23	3.7	0.83	< 0.26	< 0.35	< 0.25
USTC508-MW01	10/5/2012	0.2	**6**	0.215	**152**	5.7	0.32
USTC508-MW02	10/5/2012	1.1	**22.9**	0.96	**226**	5.9	1.5
USTC508-MW03	10/5/2012	**64.7**	0.155	4.1	0.12	0.115	0.16

BOLD TEXT – concentration exceeds applicable action level

1,1-DCE – 1,1-dichloroethane
1,1-DCE – 1,1-dichloroethene
cis-1,2-DCE – cis-1,2-dichloroethene
PCE - tetrachloroethene
TCE – trichloroethene
trans-1,2-DCE – trans-1,2-dichloroethene

Table 2-2. Borehole Analytical Data

Borehole	Depth (ft)	Sample Date		1,1-DCE (µg/kg)		TCE (µg/kg)		1,1-DCA (µg/kg)		cis-1,2-DCE (µg/kg)		trans-1,2-DCE (µg/kg)		PCE (µg/kg)
SS18-DP01	Unknown	04-Jun-07	<	0.67	<	0.26	<	0.24	<	0.64	<	0.44	<	0.67
SS18-DP02	3	04-Jun-07	<	0.76	<	0.29	<	0.27	<	0.72	<	0.5	<	0.76
SS18-DP03	3	04-Jun-07	<	0.62	<	0.24	<	0.22	<	0.59	<	0.41	<	0.62
SS18-DP04	5	05-Jun-07	<	0.77	<	0.3	<	0.27	<	0.73	<	0.51	<	0.77
SS18-DP05	5	06-Jun-07	<	0.65	<	0.25	<	0.23	<	0.61	<	0.43	<	0.65
SS18-DP06	5	06-Jun-07	<	0.73	<	0.29		**0.39**	<	0.7	<	0.48	<	0.73
SS18-DP07	3	20-Aug-09	<	1.6	<	1.5	<	2.5	<	2	<	1.5	<	1.5
SS18-DP07	8	20-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP08	3	20-Aug-09	<	1.4	<	1.3	<	2.2	<	1.7	<	1.3	<	1.3
SS18-DP08	8	20-Aug-09	<	1.4	<	1.3	<	2.2	<	1.8	<	1.3	<	1.3
SS18-DP09	3	19-Aug-09	<	1.3	<	1.2	<	1.9	<	1.6	<	1.2	<	1.2
SS18-DP09	8	19-Aug-09	<	1.5	<	1.4	<	2.3	<	1.8	<	1.4	<	1.4
SS18-DP10	3	19-Aug-09	<	1.4	<	1.3	<	2.2	<	1.8	<	1.3	<	1.3
SS18-DP10	7	19-Aug-09	<	1.3	<	1.2	<	2.1	<	1.7	<	1.2	<	1.2
SS18-DP11	4	19-Aug-09	<	1.2	<	1.1	<	1.9	<	1.5	<	1.1	<	1.1
SS18-DP11	7	19-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP12	3	18-Aug-09	<	1.5	<	1.4	<	2.3	<	1.8	<	1.4	<	1.4
SS18-DP12	8	18-Aug-09	<	1.3	<	1.2	<	2.1	<	1.7	<	1.2	<	1.2
SS18-DP13	4	17-Aug-09	<	1.5	<	1.4	<	2.3	<	1.8	<	1.4	<	1.4
SS18-DP13	8	17-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP14	3	18-Aug-09	<	1.3	<	1.2	<	2.1	<	1.6	<	1.2	<	1.2
SS18-DP14	7	18-Aug-09	<	1.4	<	1.3	<	2.2	<	1.8	<	1.3	<	1.3
SS18-DP15	3	18-Aug-09	<	1.6	<	1.5	<	2.5	<	2	<	1.5	<	1.5
SS18-DP15	6	18-Aug-09	<	410	<	380	<	630	<	510	<	380	<	380
SS18-DP16	4	17-Aug-09	<	1.4	<	1.3	<	2.2	<	1.8	<	1.3	<	1.3
SS18-DP16	8	17-Aug-09	<	1.4	<	1.3	<	2.1	<	1.7	<	1.3	<	1.3

Borehole	Depth (ft)	Sample Date		1,1-DCE (µg/kg)		TCE (µg/kg)		1,1-DCA (µg/kg)		cis-1,2-DCE (µg/kg)		trans-1,2-DCE (µg/kg)		PCE (µg/kg)
SS18-DP17	4	17-Aug-09	<	1.6	<	1.4		**8.6**	<	1.9	<	1.4	<	1.4
SS18-DP17	6	17-Aug-09		**6.1**	<	1.3		**195**	<	1.7	<	1.3	<	1.3
SS18-DP18	2	17-Aug-09	<	1.5	<	1.4	<	2.3	<	1.8	<	1.4	<	1.4
SS18-DP18	8	17-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP19	2	17-Aug-09	<	1.5	<	1.4	<	2.4	<	1.9	<	1.4	<	1.4
SS18-DP19	8	17-Aug-09	<	1.4	<	1.3	<	2.1	<	1.7	<	1.3	<	1.3
SS18-DP20	3	18-Aug-09	<	1.4	<	1.3	<	2.1	<	1.7	<	1.3	<	1.3
SS18-DP20	7	18-Aug-09		**2.1**	<	1.5		**58.5**	<	1.9	<	1.5	<	1.5
SS18-DP21	3	17-Aug-09	<	1.7	<	1.6	<	2.6	<	2.1	<	1.6	<	1.6
SS18-DP21	8	17-Aug-09	<	1.6	<	1.5	<	2.5	<	2	<	1.5	<	1.5
SS18-DP22	3	18-Aug-09	<	1.4	<	1.3	<	2.2	<	1.7	<	1.3	<	1.3
SS18-DP22	8	18-Aug-09	<	1.4	<	1.3	<	2.1	<	1.7	<	1.3	<	1.3
SS18-DP23	3	19-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP23	8	19-Aug-09	<	1.2	<	1.1	<	1.9	<	1.5	<	1.1	<	1.1
SS18-DP24	10	8/14/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1
SS18-DP25	8	8/15/2012	<	1.6	<	1.3	<	1.2	<	1.7	<	1.7	<	1.1
SS18-DP26	8	8/14/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1
SS18-DP27	8	8/15/2012		**10.9**	<	1.5		**2.8**	<	1.8	<	1.8	<	1.2
SS18-DP28	7	8/14/2012		**25.8**		**4.2**		**6.3**	<	1.6	<	1.6		**21.7**
SS18-DP29	8	8/15/2012		**4.4**	<	1.2		**5.5**	<	1.6	<	1.6	<	1
SS18-DP30	11	8/15/2012		**3.1**		**9.6**		**7.7**		**2.9**	<	1.4		**94.9**
SS18-DP31	11	15-Aug-12		**17.4**	<	1.2		**2.7**	<	1.5	<	1.5		**2.6**
SS18-DP32	12	8/15/2012		**6.4**		**5.4**		**14.5**	<	1.5	<	1.5		**22.7**
SS18-DP33	8	15-Aug-12	<	1.5	<	1.3	<	1.2	<	1.7	<	1.7	<	1.1
SS18-DP34	8	16-Aug-12	<	1.3	<	1.1	<	1	<	1.4	<	1.4	<	0.94
SS18-DP35	5	8/15/2012	<	1.6	<	1.3	<	1.2		**2.4**	<	1.6	<	1.1
SS18-DP36	7	8/15/2012	<	1.5	<	1.2	<	1.1	<	1.6	<	1.6	<	1
SS18-DP37	8	15-Aug-12	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1.1

Borehole	**Depth (ft)**	**Sample Date**		**1,1-DCE (µg/kg)**		**TCE (µg/kg)**		**1,1-DCA (µg/kg)**		**cis-1,2-DCE (µg/kg)**		**trans-1,2-DCE (µg/kg)**		**PCE (µg/kg)**
SS18-DP38	8	16-Aug-12	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1.1
SS18-DP39	8	8/14/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1
SS18-DP40	8	8/14/2012	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1.1
SS18-DP41	7	8/17/2012	<	1.3	<	1.1	<	1	<	1.4	<	1.4	<	1
SS18-DP42	5	8/16/2012	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1
SS18-DP43	5	8/16/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1
SS18-DP44	7	8/16/2012	<	1.7	<	1.4	<	1.3	<	1.8	<	1.8	<	1.2
SS18-DP45	8	8/17/2012	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1.1
SS18-DP46	8	8/17/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1

BOLD TEXT – Detectable Concentration
1,1-DCE – 1,1-dichloroethane
1,1-DCE – 1,1-dichloroethene
cis-1,2-DCE – cis-1,2-dichloroethene
PDE – tetrachloroethene
TCE – trichloroethene
trans-1,2-DCE – trans-1,2-dichloroethene

Table 5-1. Project Schedule

Name	Duration	Start	Finish
RCRA Field Investigation	**900 days**	**Mon 3/31/14**	**Fri 9/8/17**
RFI Work Plan	**402 days**	**Mon 3/31/14**	**Fri 10/13/15**
Review Current Data and Field Logbooks	5 days	Mon 3/31/14	Fri 4/4/14
Prepare and Submit Draft RFI Work Plan	46 days	Mon 4/7/14	Mon 6/9/14
Air Force Review of Draft RFI Work Plan/Provide Comments	56 days	Fri 6/13/14	Fri 8/29/14
Respond to Comments	11 days	Mon 9/1/14	Fri 9/12/14
Air Force Approval Draft RFI Work Plan Milestone	1 days	Fri 9/12/14	Fri 9/12/14
Prepare and Submit Draft Final RFI Work Plan	1 days	Mon 9/15/14	Fri 9/19/14
Air Force Review of Draft Final RFI Work Plan/Revise as needed	1 days	Mon 9/22/14	Fri 9/26/14
Submit Draft Final RFI Work Plan for Regulatory Review	1 day	Mon 9/29/14	Mon 9/29/14
NMED Request Fee from Air Force	22 days	Tue 9/30/14	Tue 12/9/14
Air Force Pay NMED Fee	33 days	Wed 12/10/14	Fri 1/9/15
Regulator Review of Draft Final RFI Work Plan/Provide Comments	195 days	Mon 1/12/15	Mon 3/2/15
Respond to Regulator Comments on Draft Final and Prepare Final RFI Work Plan	5 days	Tue 3/3/15	Mon 3/16/15
Air Force and Regulator Review of Final RFI Work Plan/Revise as needed	22 days	Tue 8/25/15	Wed 9/23/15
Regulatory and Air Force Approval of Final RFI Work Plan Milestone	0 days	Wed 9/23/15	Wed 9/23/15
Implement RFI Field Activities	**362 days**	**Mon 3/30/15**	**Tue 8/16/16**
Complete Pre-Fieldwork Activities	21 days	Mon 3/30/15	Mon 4/27/15
Obtain Well Drilling Permits	10 days	Mon 3/30/15	Fri 4/10/15
Contact Underground Utility Surveys	1 day	Mon 4/13/15	Mon 4/13/15
Mark Well Locations and Coordinate Utility Surveys	10 days	Tue 4/14/15	Mon 4/27/15
Well Installation	**37 days**	**Tue 4/28/15**	**Wed 6/17/15**
Mobilization	1 day	Tue 4/28/15	Tue 4/28/15
Drill Five Groundwater Monitoring Wells and Sample Soils	25 days	Wed 4/29/15	Tue 6/2/15
Complete Five Groundwater Monitoring Wells	5 days	Wed 6/3/15	Tue 6/9/15
Develop Five Groundwater Monitoring Wells	5 days	Wed 6/10/15	Tue 6/16/15
Demobilize from Well Drilling Activities	1 day	Wed 6/17/15	Wed 6/17/15
Well Completion Report	**229 days**	**Thu 6/18/15**	**Tue 5/3/16**
Prepare and Submit Draft Well Completion Report	24 days	Thu 6/18/15	Tue 7/21/15
Air Force Review of Draft Well Completion Report/Provide Comments	22 days	Wed 7/22/15	Thu 8/20/15
Respond to Comments	10 days	Fri 8/21/15	Thu 9/3/15
Air Force Approval Draft Well Completion Report Milestone	0 days	Thu 9/3/15	Thu 9/3/15

Name	Duration	Start	Finish
Prepare and Submit Draft Final Well Completion Report	10 days	Fri 9/4/15	Thu 9/17/15
Air Force Review of Draft Final Well Completion Report/Revise as needed	5 days	Fri 9/18/15	Thu 9/24/15
Submit Draft Final Well Completion Report for Regulatory Review	1 day	Fri 9/25/15	Fri 9/25/15
NMED Request Fee from Air Force	22 days	Mon 9/28/15	Tue 10/27/15
Air Force Pay NMED Fee	33 days	Wed 10/28/15	Fri 12/11/15
Regulator Review of Draft Final Well Completion Report/Provide Comments	65 days	Mon 12/14/15	Fri 3/11/16
Respond to Regulator Comments on Draft Final and Prepare Final Well Completion Report	15 days	Mon 3/14/16	Fri 4/1/16
Air Force and Regulator Review of Final Well Completion Report/Revise as needed	22 days	Mon 4/4/16	Tue 5/3/16
Regulatory and Air Force Approval of Final Well Completion Report Milestone	0 days	Tue 5/3/16	Tue 5/3/16
Borehole Sampling	**36 days**	**Wed 5/4/16**	**Wed 6/22/16**
Mobilize for Borehole Drilling Activities	10 days	Wed 5/4/16	Tue 5/17/16
Drill 25 Boreholes and Sample Sediments	25 days	Wed 5/18/16	Tue 6/21/16
Demobilize from Boring Activities	1 day	Wed 6/22/16	Wed 6/22/16
Laboratory Analyses	**40 days**	**Wed 6/22/16**	**Tue 8/16/16**
Perform Laboratory Analyses	30 days	Wed 6/22/16	Tue 8/2/16
Review and Validate Analytical Data	10 days	Wed 8/3/16	Tue 8/16/16
RFI Report	**361 days**	**Wed 8/3/16**	**Wed 12/20/17**
Prepare and Submit Draft RFI Report	35 days	Wed 8/3/16	Tue 9/20/16
Air Force Review of Draft RFI Report/Provide Comments	22 days	Wed 9/21/16	Thu 10/20/16
Respond to Comments	5 days	Fri 10/21/16	Thu 10/27/16
Air Force Approval Draft RFI Report Milestone	0 days	Thu 10/27/16	Thu 10/27/16
Prepare and Submit Draft Final RFI Report	6 days	Fri 10/28/16	Fri 11/4/16
Air Force Review of Draft Final RFI Report/Revise as needed	5 days	Mon 11/7/16	Fri 11/11/16
Submit Draft Final RFI Report for Regulatory Review	1 day	Mon 11/14/16	Mon 11/14/16
NMED Request Fee from Air Force	22 days	Tue 11/15/16	Wed 12/14/16
Air Force Pay NMED Fee	33 days	Thu 12/15/16	Mon 1/30/17
Regulator Review of Draft Final RFI Report/Provide Comments	195 days	Tue 1/31/17	Mon 10/30/17
Respond to Regulator Comments on Draft Final and Prepare Final RFI Report	15 days	Tue 10/31/17	Mon 11/20/17
Air Force and Regulator Review of Final RFI Report/Revise as needed	22 days	Tue 11/21/17	Wed 12/20/17
Regulatory and Air Force Approval of Final RFI Report Milestone	0 days	Wed 12/20/17	Wed 12/20/17

FIGURES

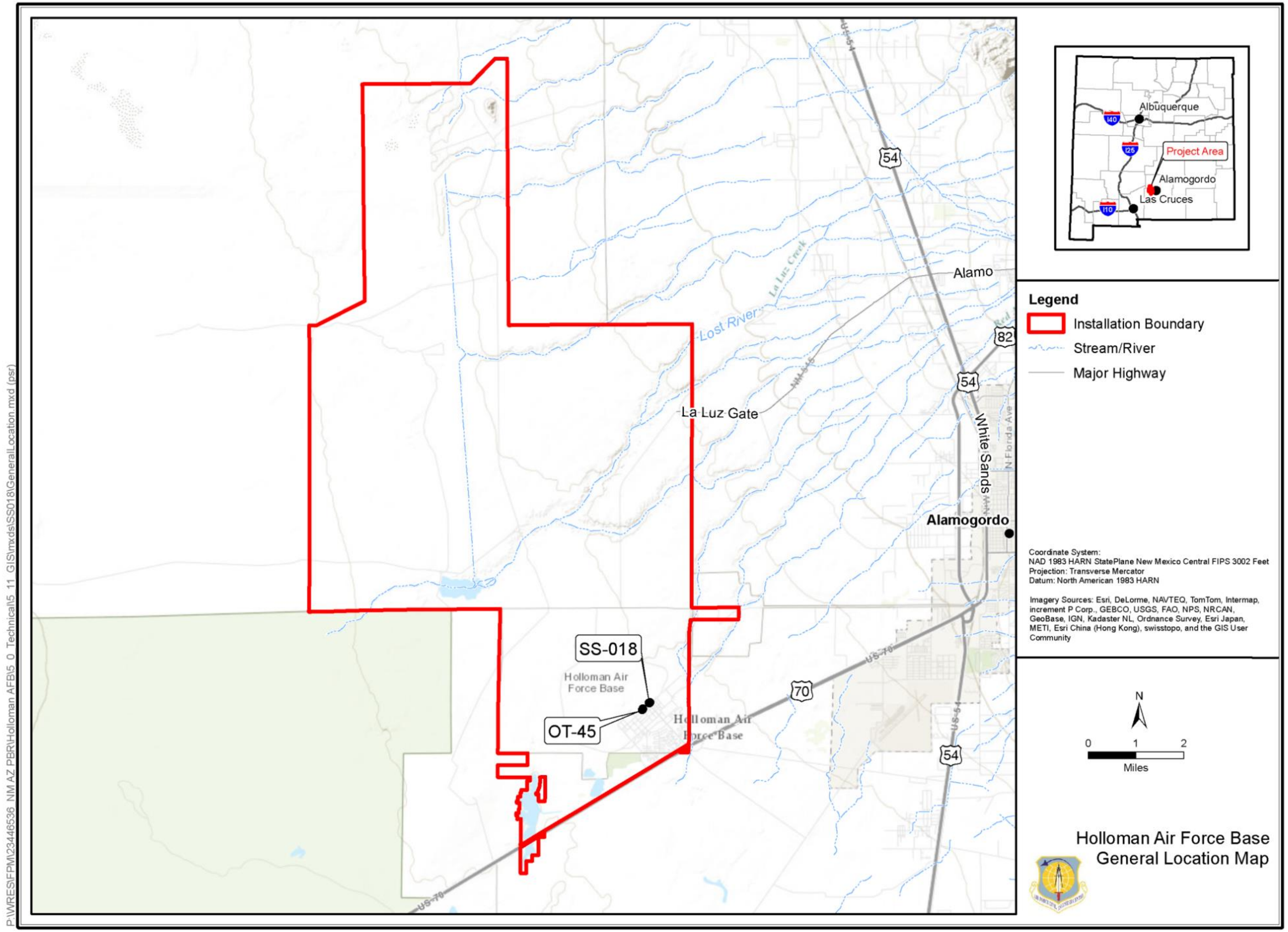


Figure 1-1. Site Vicinity Map

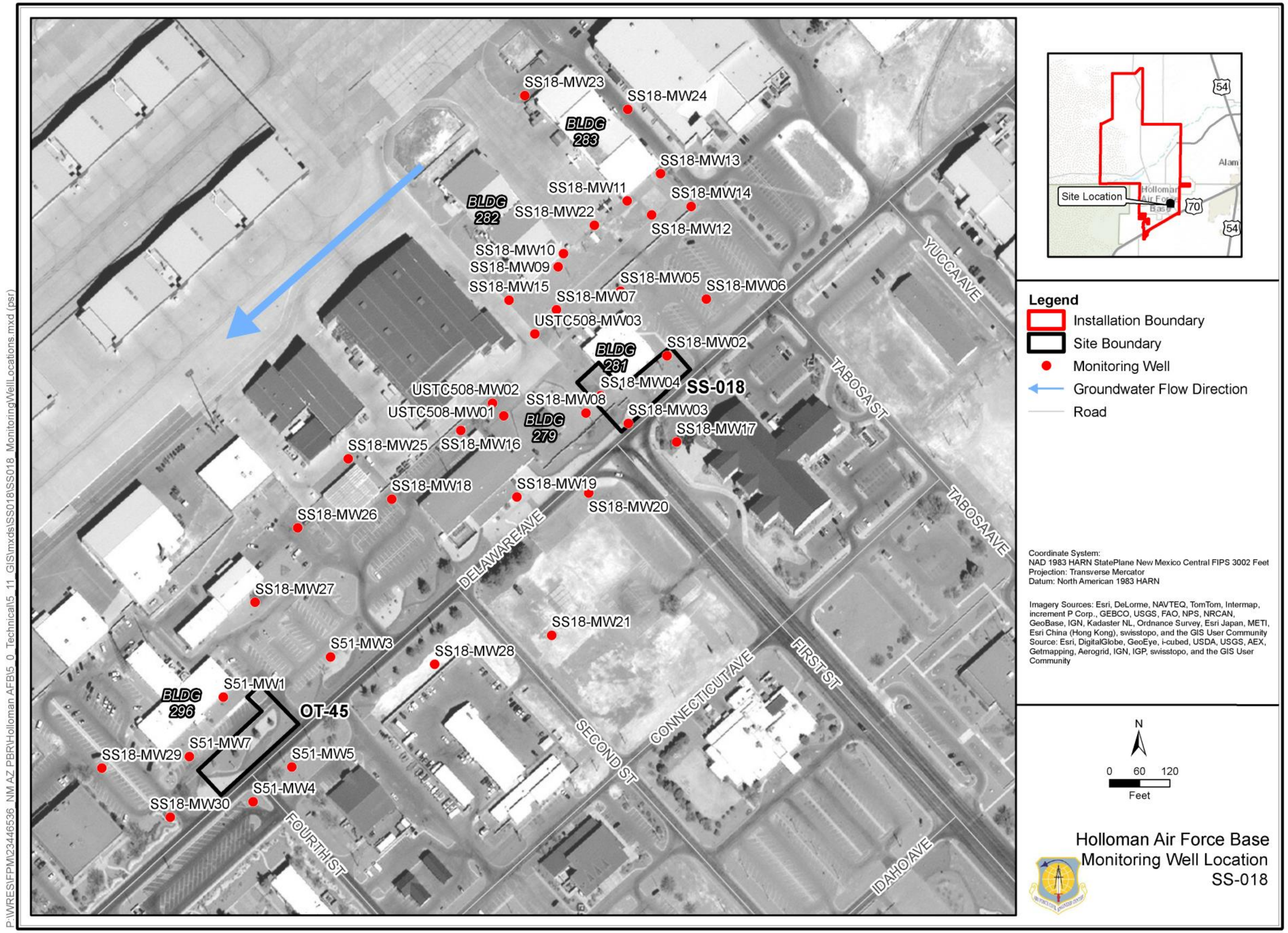


Figure 2-1. Existing Monitoring Well Locations

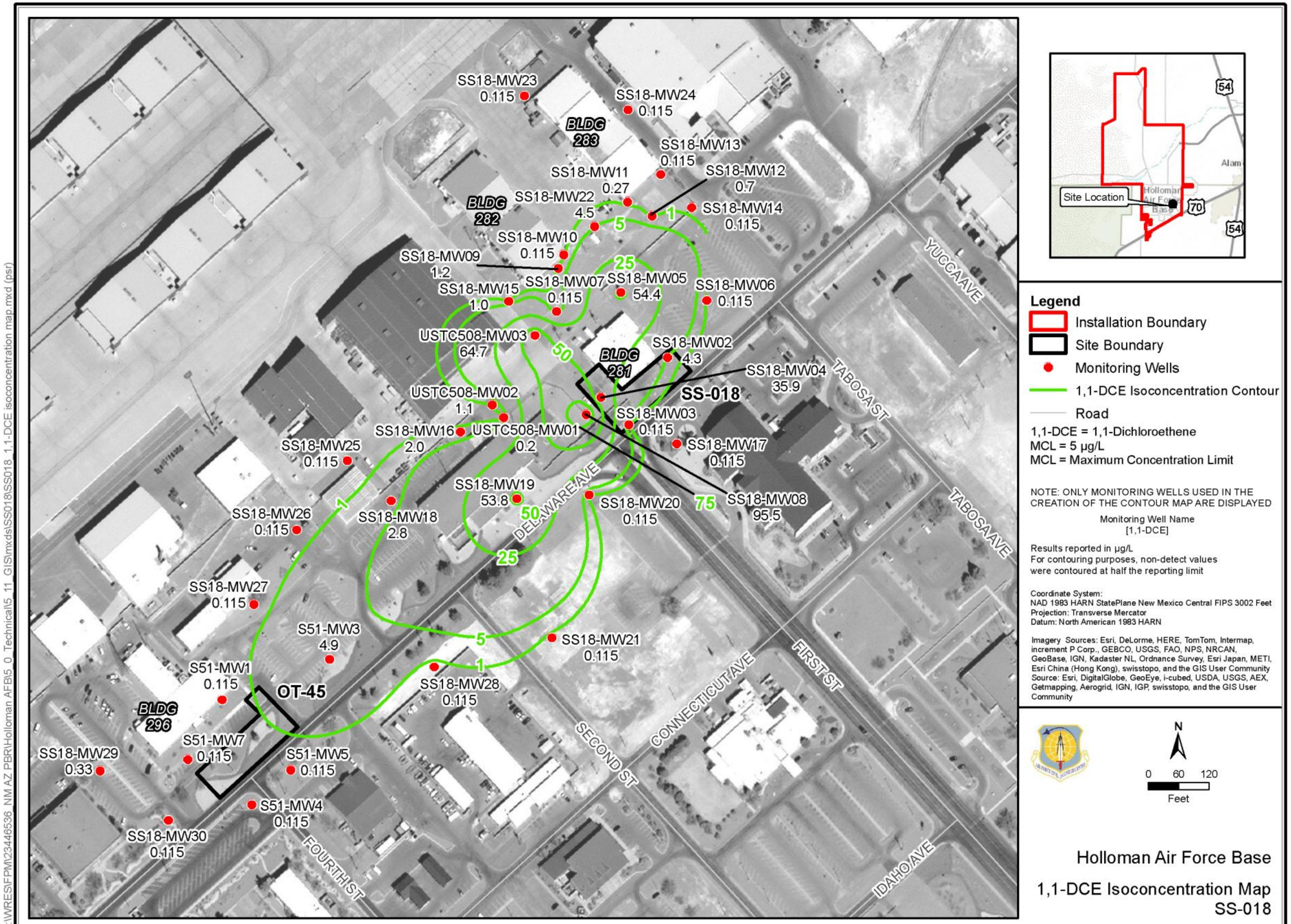


Figure 2-2. 1,1-Dichloroethene Isoconcentration Map

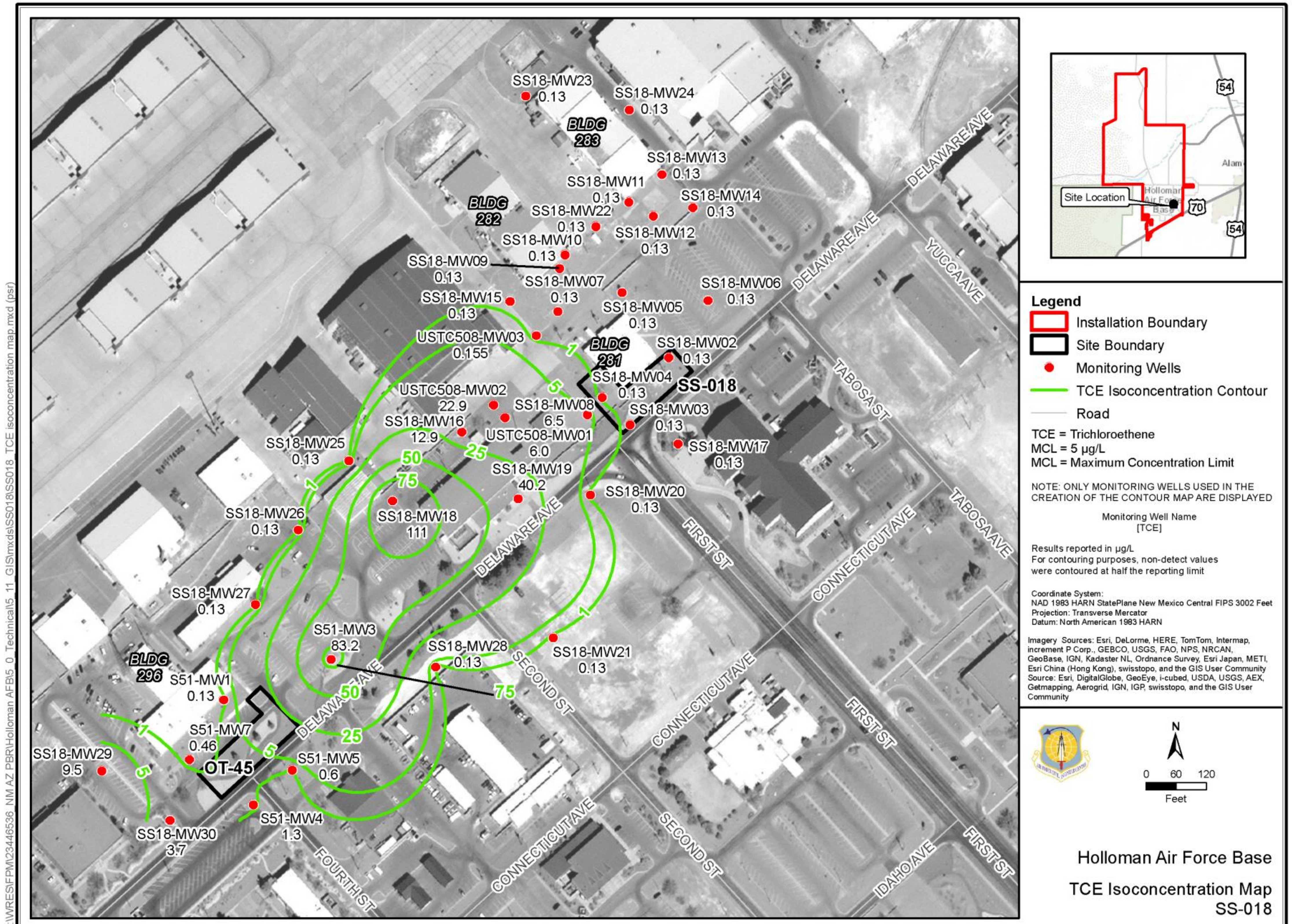


Figure 2-3. Trichloroethene Isoconcentration Map

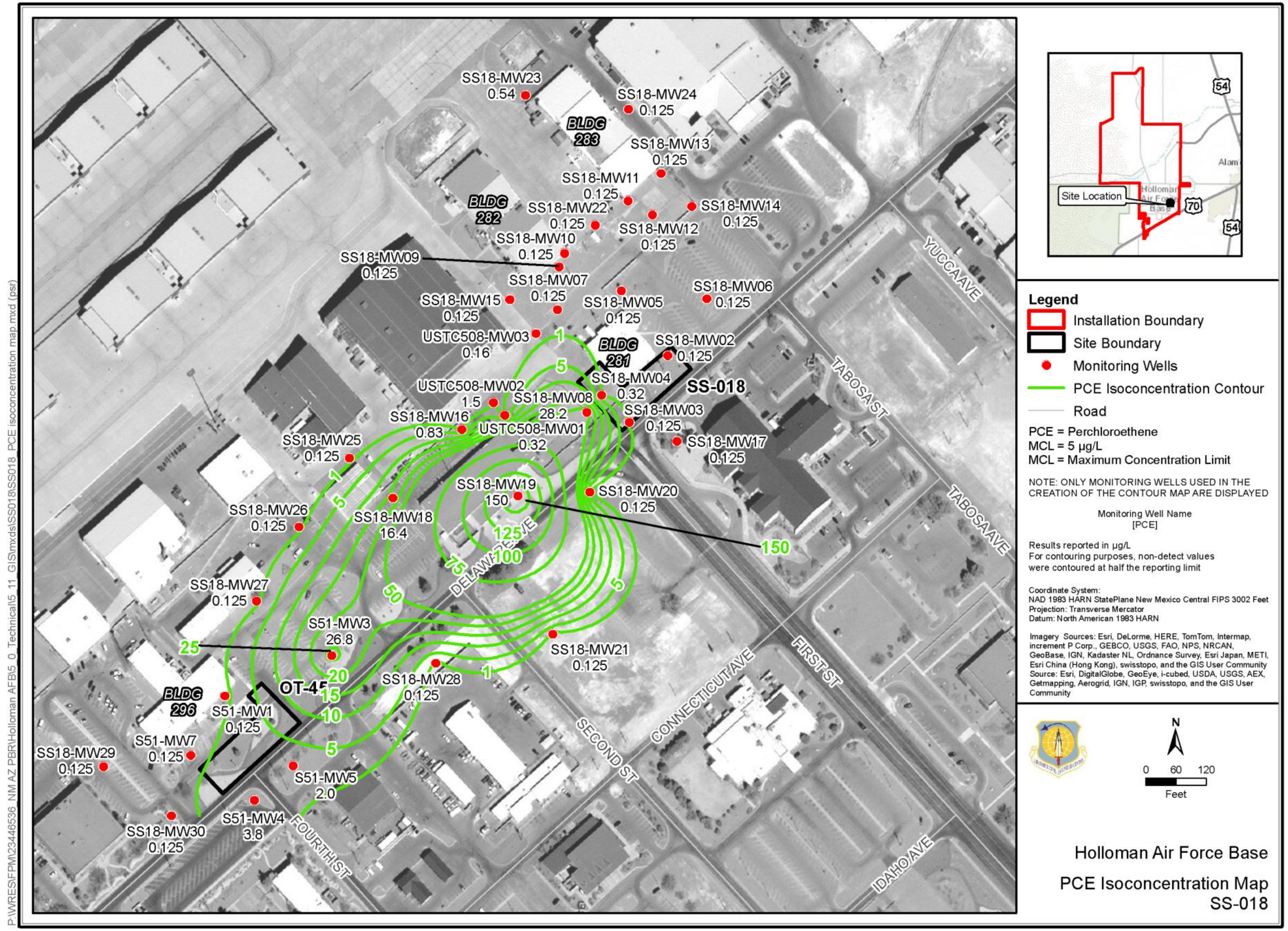


Figure 2-4. Tetrachloroethene Isoconcentration Map

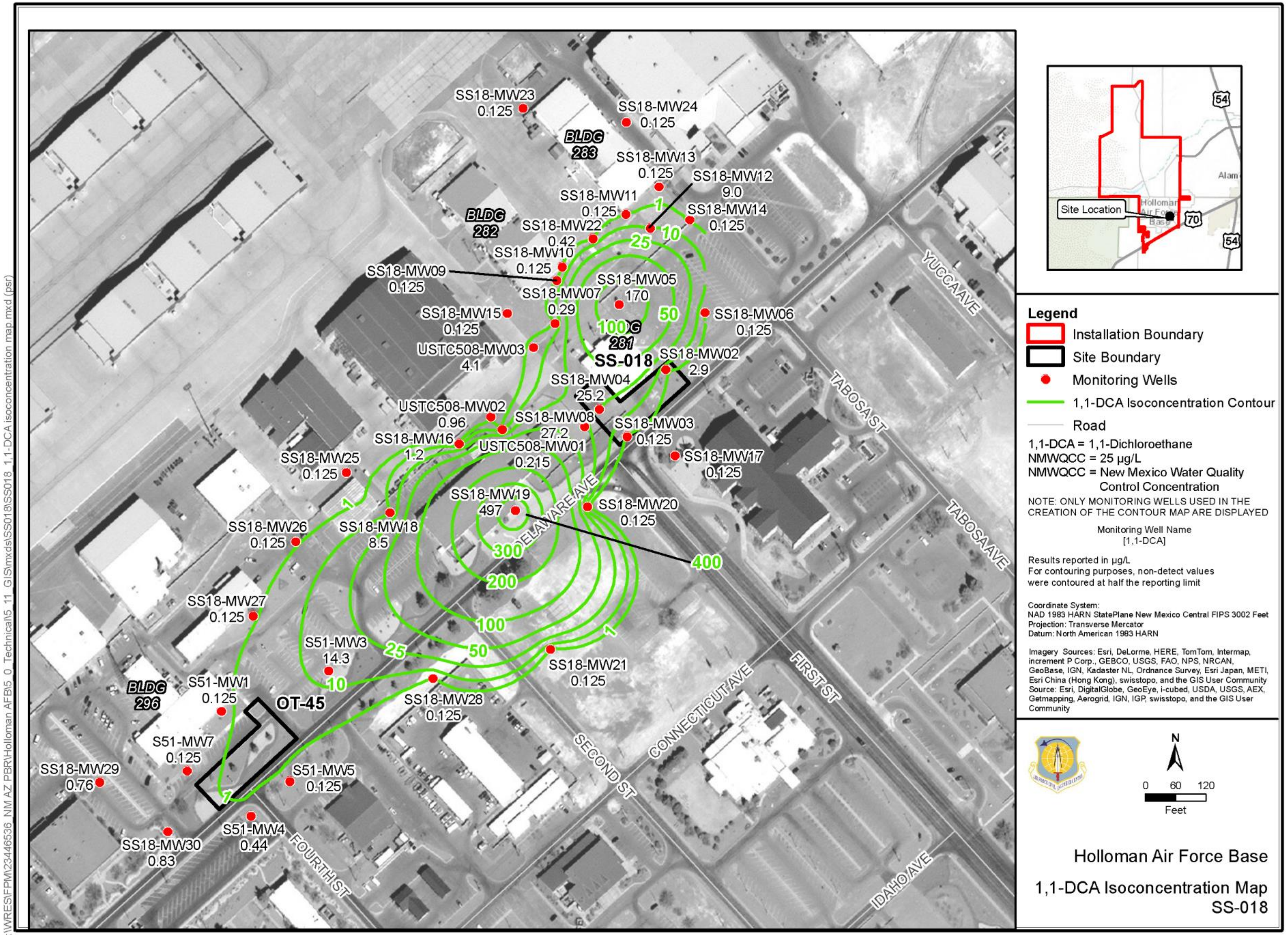
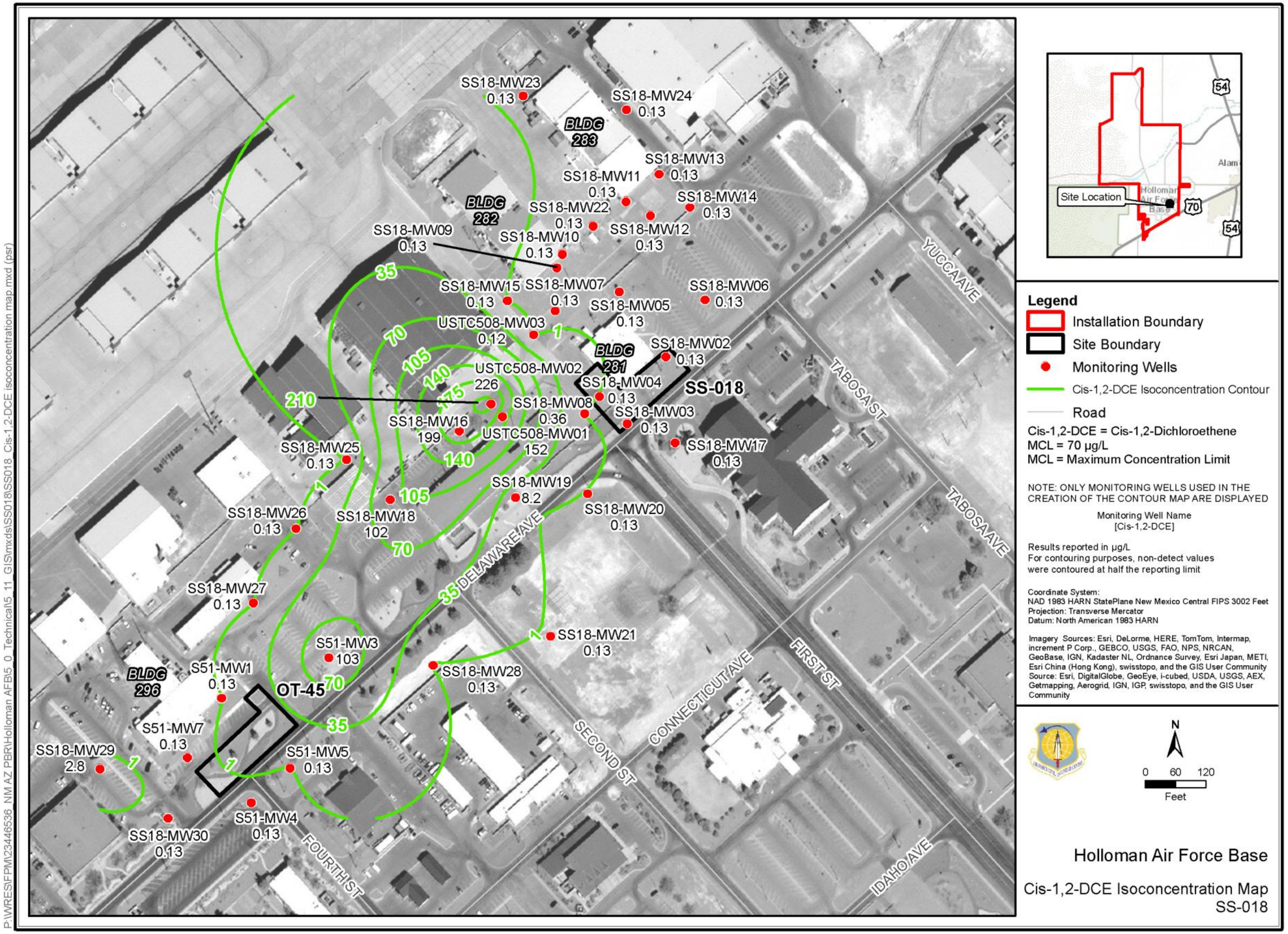


Figure 2-5. 1,1-Dichloroethane Isoconcentration Map



P:\WRES\FPM\23446536_NM AZ PBR\Holloman AFB\5_0_Technical\5_11_GIS\mxds\SS018\SS018_Cis-1,2-DCE isoconcentration map.mxd (psr)

Figure 2-6. cis-1,2-Dichloroethene Isoconcentration Map

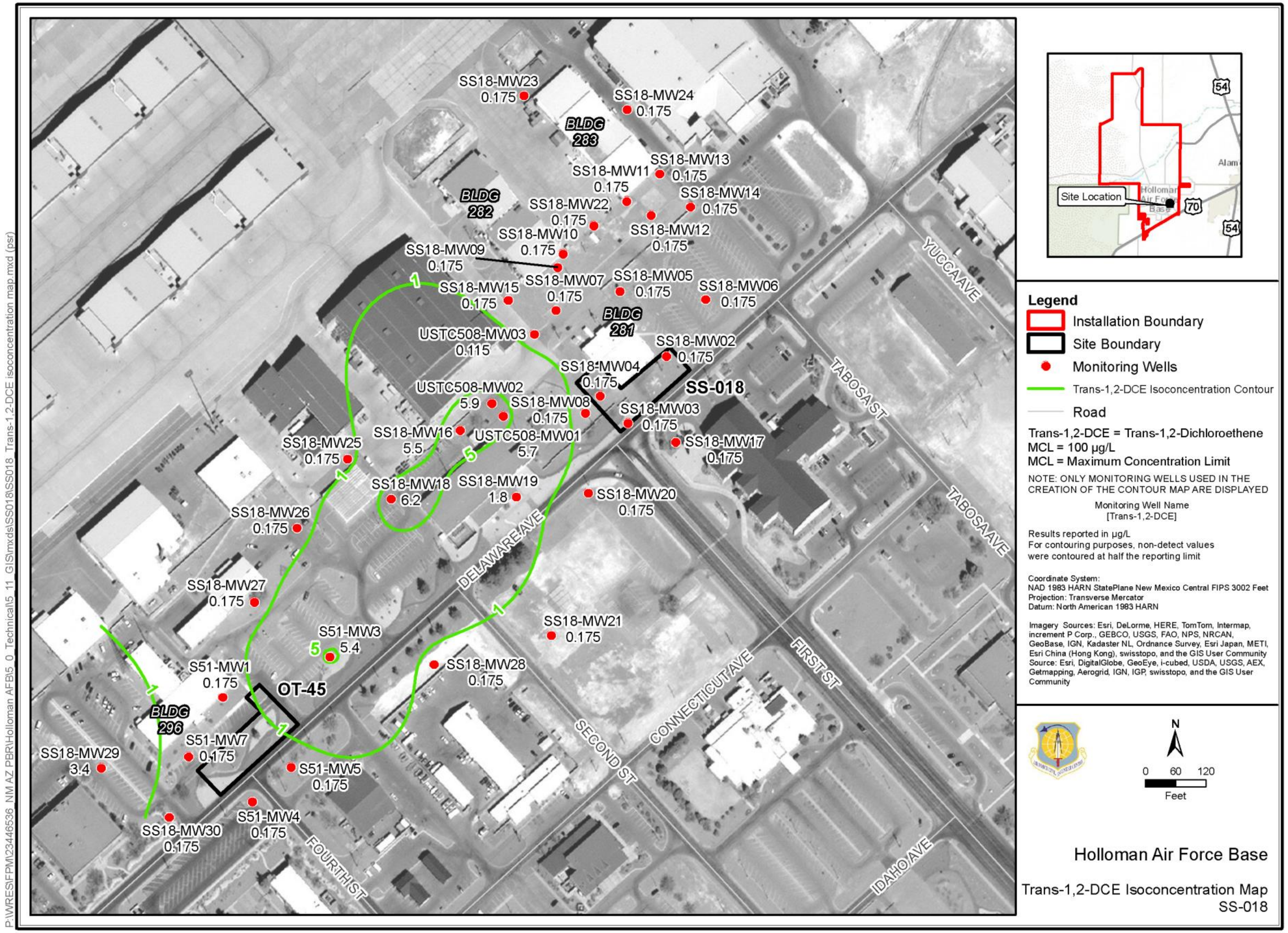


Figure 2-7. trans-1,2-Dichloroethene Isoconcentration Map

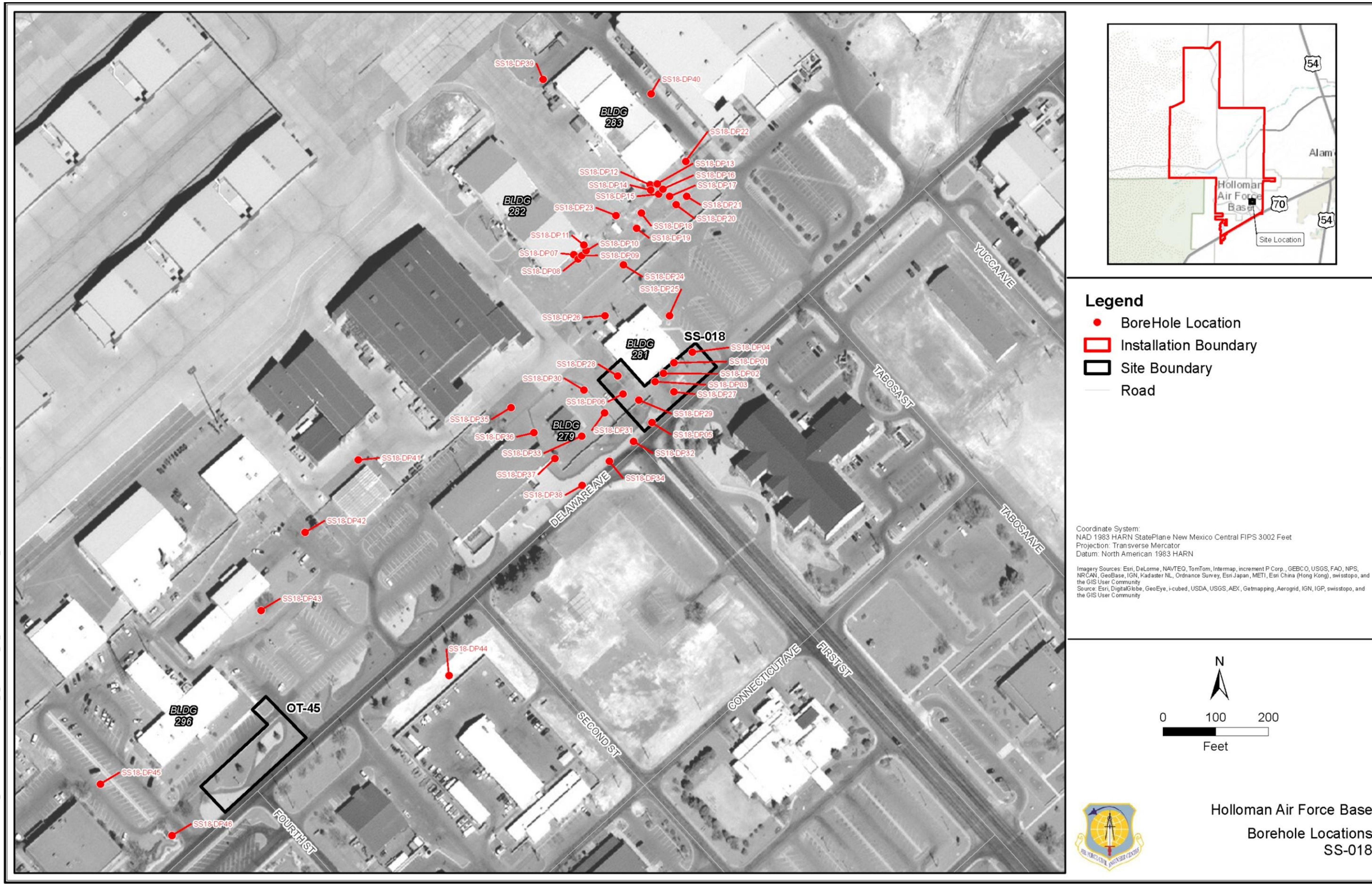


Figure 2-8. SS018 Borehole Locations

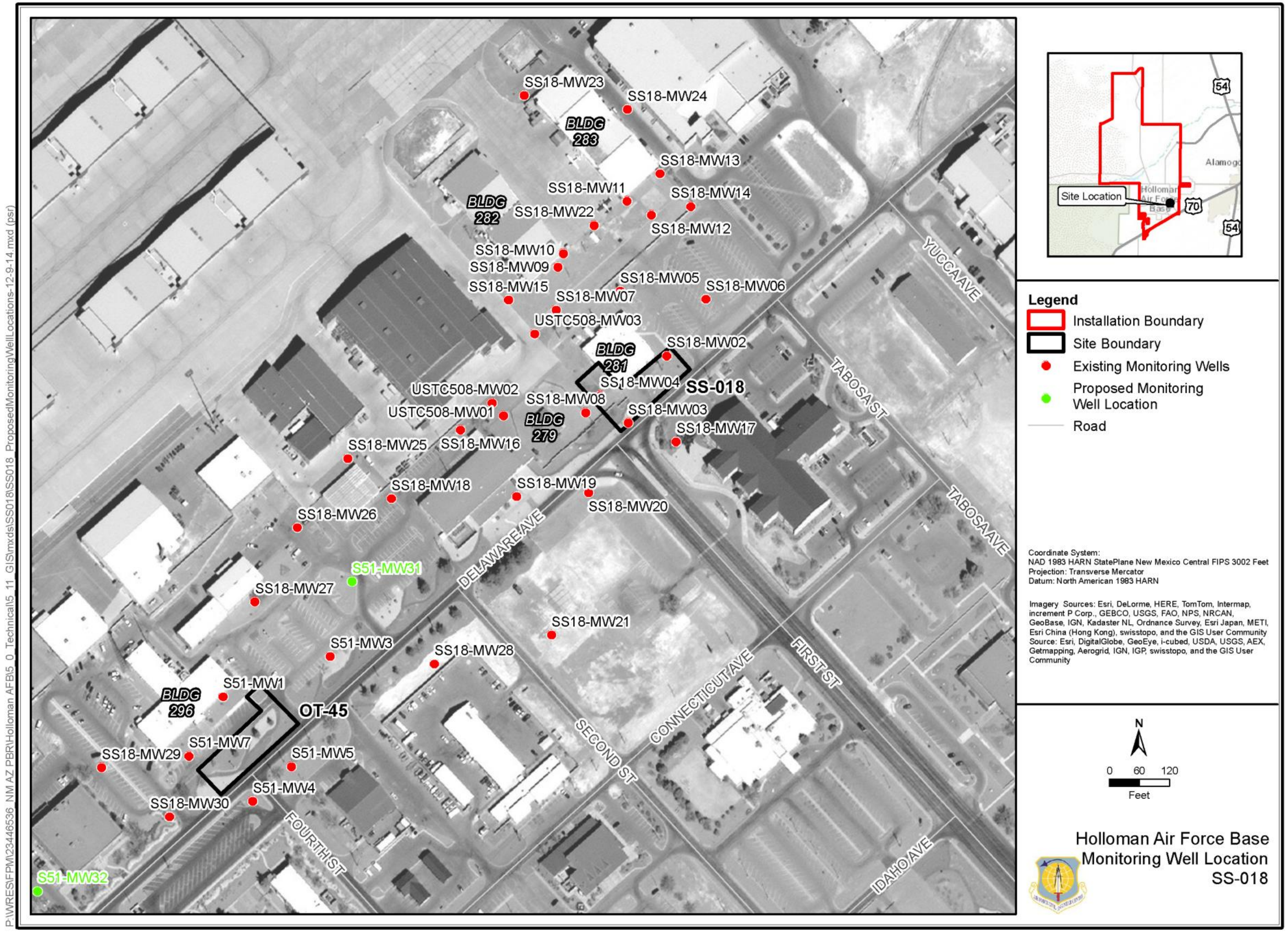


Figure 3-1. Proposed New Monitoring Well Locations

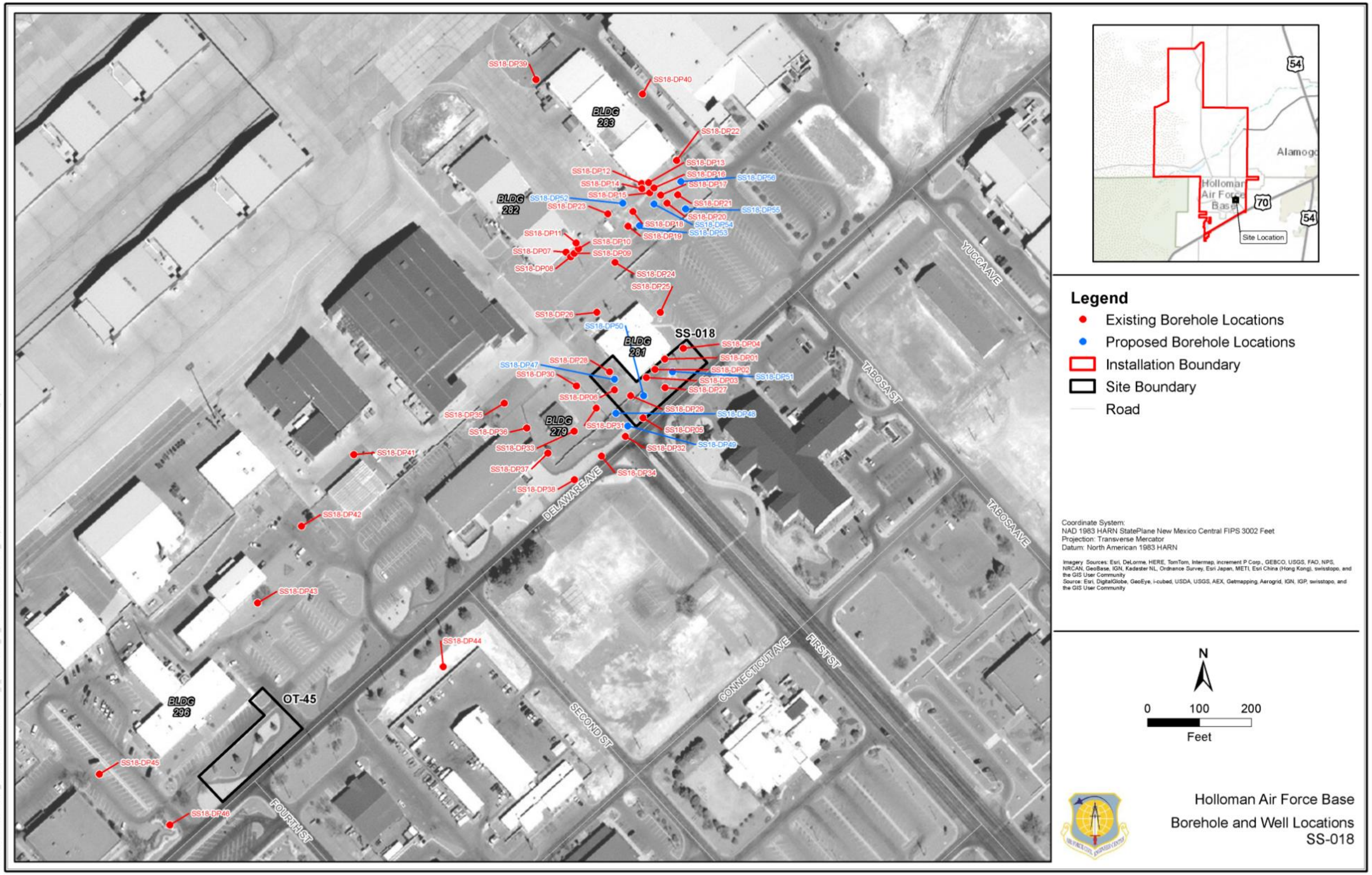


Figure 3-2. Proposed Borehole Locations

NEW MEXICO
ENVIRONMENT DEPARTMENT

SUSANA MARTINEZ
Governor
JOHN A. SANCHEZ
Lieutenant Governor

2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303
Phone (505) 476-6000 Fax (505) 476-6030
www.nmenv.state.nm.us

RYAN FLYNN
Cabinet Secretary
BUTCH TONGATE
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

March 2, 2015

Ms. DeAnna Rothhaupt
Chief, Holloman AFB Environmental
49 CES/CEIE
550 Tabosa Avenue
Holloman AFB, NM 88330-8261

RE: DISAPPROVAL
GROUNDWATER MONITORING PLAN, SS-018 – CHROMIC ACID SPILL SITE, SEPTEMBER 2014
HOLLOMAN AIR FORCE BASE, EPA ID # NM6572124422
HWB-HAFB-14-016

Dear Ms. Rothhaupt:

The New Mexico Environment Department (NMED) has reviewed the Holloman Air Force Base (Permittee) *Groundwater Monitoring Plan, Site SS-018* (AOC-H) – *Chromic Acid Spill Site* dated September 2014 (the Plan) and received on September 30, 2014. The NMED hereby issues this Disapproval for the reasons discussed below.

Comment 1
Section 3.1 of the Plan, *Monitoring Requirements*, proposes that groundwater sampling and analysis be conducted annually for a total of three years. NMED disagrees with this proposal and requires that the sampling and analysis be conducted on a quarterly basis for a minimum of two years, with the submittal of quarterly groundwater monitoring reports for NMED review. Monitoring requirements will be re-evaluated after the initial two-year monitoring period. The Permittee shall amend the Plan to include this change.

Comment 2
The U.S. Air Force, under its Emerging Issues Program, has acknowledged that there is a known co-occurrence of 1,4-dioxane with trichloroethene (TCE) in chlorinated solvent groundwater plumes. TCE is a major contributor to the groundwater contamination at site SS-018 and there is no historical evidence of testing for the presence of 1,4-dioxane.

Therefore, the Permittee shall amend the Plan to include analysis of 1,4-dioxane in the first 3 rounds of the quarterly sampling events from all monitoring wells at the site. The reporting limit for 1,4-dioxane shall not exceed 1 microgram per liter (1 µg/l).

Comment 3

The Plan was originally submitted without a figure depicting the locations of the proposed boreholes and monitoring wells. At NMED's request, on December 9, 2014 the Permittee provided supplemental figures depicting the proposed borehole and monitoring well locations. The Permittee shall include these supplemental figures in the amended Plan. In addition, for all future submittals, combine the figures and tables into separate sections/attachments for inclusion in the document following the text (main body) instead of being placed in different locations throughout the text and ensure that every table page includes the appropriate descriptive header.

The Permittee must submit an amended monitoring plan by no later than **May 27, 2015**. The submittal (including figures and tables) must be in the form of a paper copy in a three-ring binder and one electronic copy (in MS Word/Excel™ format).

If you have any questions regarding this matter, please contact Mr. David Strasser of my staff at (505) 222-9526.

Sincerely,

John E. Kieling
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
W. Moats, NMED HWB
C. Amindyas, NMED HWB
D. Strasser, NMED HWB
D. Rizzuto, HAFB
C. Hendrickson, EPA-Region 6 (6PD-N)

File: HAFB 2015 and Reading
HAFB-14-016

Common Comment and Response Worksheet (Version 3)

Date	Reviewer	Document Title (version)	Contract/TO Number
2-Mar-15	NMED	Groundwater Monitoring Plan, SS-018 - Chromic Acid Spill Site, September 2014, Holloman Air Force Base, New Mexico	23446541.0040AA

Item	Source	Section	Page	Para	Line	Class	ADEQ Comment	FPN/URS Response
							Final Groundwater Monitoring Plan (text)	
1	NMED	3.1	21	1	8	M	Section 3.1 of the Plan, *Monitoring Requirements* , proposes that groundwater sampling and analysis be conducted annually for a total of three years. NMED disagrees with this proposal and requires that the sampling and analysis be conducted on a quarterly basis for a minimum of two years, with the submittal of quarterly groundwater monitoring reports for NMED review. Monitoring requirements will be re-evaluated after the initial two-year monitoring period. The Permittee shall amend the Plan to include this change.	The comment will be incorporated with the following recommended changes. Initially, the groundwater monitoring network will be sampled to establish an analytical baseline. It is anticipated that the site will require implementation of a remedial action to address groundwater impacts. The quarterly monitoring will be implemented following completion of the remedial action to demonstrate the remedy was successful in reducing concentrations to levels that no longer pose an unacceptable risk to human health and the environment.
2	NMED					M	The U.S. Air Force, under its Emerging Issues Program, has acknowledged that there is a known co-occurrence of 1,4-dioxane with trichloroethene (TCE) in chlorinated solvent groundwater plumes. TCE is a major contributor to the groundwater contamination at site SS-018 and there is no historical evidence of testing for the presence of 1,4-dioxane. Therefore, the Permitte shall amend the Plan to include analysis of 1,4-dioxane in the first 3 rounds of the quarterly sampling events from all monitoring wells at the site. The reporting limit for 1,4-dioxane shall not exceed 1 microgram per liter (1 μg/L).	Analysis of 1,4-Dioxane has been included in the monitoring plan (see Table 3-2). Also, the laboratory can achieve the required reporting limit.
3	NMED					S	The Plan was originally submitted without a figure depicting the locations of the proposed boreholes and monitoring wells. At NMED's request, on December 9, 2014 the Permittee provided supplemental figures depicting the proposed borehole and monitoring well locations. The Permittee shall include these supplemental figures in the amended Plan. In addition, for all future submittals, combine the figures and tables into separate sections/ attachments for inclusion in the document following the text (main body) instead of being placed in different locations throughout the text and ensure that every table page includes the appropriate descriptive header.	Figures depicting the locations of the proposed boreholes and monitoring wells have been included. In addition, the documents prepared for Holloman will have the figures and tables provided as separate sections/attachments following the main body of the text complete with appropriate descriptive headers.

NOTE: Sections and page numbers may be inferred if they were not specifically called out in the reviewer's comments.

Column A:	Comment Identifier Number
Column B:	Source (Commenter/Authority)
Column C:	Section Number of Comment
Column D:	Page Number of Comment (first page associated with
Column E:	Paragraph number, on page, of Comment
Column F:	Line Number (within Paragraph above) of Comment
Column G:	Comment Classification
Column H:	Comment
Column I:	Response
Notes:	Comments must be actionable ("add the following text:…", "delete…", "change text to:")
	Place only one comment per row.
	Classify comment as C, M, S, or A.

Comment Classifications
(C) Critical: Critical comments will result in a critical issue. Provide convincing support.
(M) Major: Major comments are significant concerns that may result in a major issue. This category may be used with a general statement of concern followed by a detailed
(S) Substantive: An entry in the document that appears to be or is potentially unnecessary, misleading, incorrect, or confusing.
(A) Administrative: Administrative comments correct inconsistencies between different sections, typographical and grammatical errors.

HOLLOMAN AIR FORCE BASE
NEW MEXICO

FINAL GROUNDWATER MONITORING PLAN
SS-018 – CHROMIC ACID SPILL SITE

March 2015

49 CES/CEI
550 Tabosa Avenue
Holloman AFB, New Mexico 88330-8458

HOLLOMAN AIR FORCE BASE, NEW MEXICO

FINAL GROUNDWATER MONITORING PLAN FOR SITE SS-018

March 2015

Prepared for:

Air Force Civil Engineer Center
Department of the Air Force, 772nd ESS/PKB
3515 S. General McMullen Dr., Suite 155
Joint Base San Antonio Lackland, Texas 78226-2018
Contract FA8903-13-C-0008

Prepared by:

URS Group, Inc.
7720 North 16th Street, Suite 100
Phoenix, AZ 85020

In Association with

FPM Remediations, Inc.
584 Phoenix Drive
Rome, New York 13441

URS Job No. 23446545

NOTICE

This Groundwater Monitoring Plan was prepared for the Air Force Civil Engineer Center by URS Group, Inc. in association with FPM Remediations, Inc. to aid in the implementation of a final remedial action plan under the Installation Restoration Program. As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the Installation Restoration Program, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate.

Government agencies and their contractors registered with the Defense Technical Information Center should direct requests for copies of this report to: Defense Technical Information Center, Cameron Station, Alexandria, Virginia 22304-6145.

Non-government agencies may purchase copies of this document from: National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

REPORT DOCUMENTATION PAGE		*Form Approved OMB No. 0704-0188*
The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Executive Service Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.**		
1. REPORT DATE *(DD-MM-YYYY)* 30-03-2014	**2. REPORT TYPE** Groundwater Monitoring Plan	**3. DATES COVERED** *(From - To)* March 2015 - September 2023
4. TITLE AND SUBTITLE Final Groundwater Monitoring Plan SS-018 Chromic Acid Spill Site Holloman Air Force Base, New Mexico		**5a. CONTRACT NUMBER** FA8903-13-C-0008
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) Wells, Richard		**5d. PROJECT NUMBER**
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) URS Group, Inc. 7720 North 16th Street, Suite 100 Phoenix, Arizona 85020 In Association With: FPM Remediations, Inc. 584 Phoenix Drive Rome, New York 13441		**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Civil Engineer Center Department of the Air Force, 772nd ESS/PKB 3515 S. General McMullen Dr.., Suite 155 Joint Base San Antonio Lackland, Texas 78226-2018		**10. SPONSOR/MONITOR'S ACRONYM(S)** AFCEC
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution is unlimited.		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT This Groundwater Monitoring Plan specifies the activities that will be performed in support of the groundwater monitoring to be conducted at Site SS-018, Holloman Air Force Base, New Mexico. The purpose of this plan is to provide guidance for the groundwater sampling and water level measurements of wells installed at the site.		
15. SUBJECT TERMS Site SS-018, groundwater monitoring, volatile organic compounds		

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON** Richard Wells
					19b. TELEPHONE NUMBER *(Include area code)* 602-861-7409

Reset

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18
Adobe Professional 7.0

PREFACE

This Groundwater Monitoring Plan addresses the groundwater monitoring activities that will be performed for SS-018, Chromic Acid Spill Site, at Holloman Air Force Base, New Mexico. The purpose of the plan is to provide guidance for the groundwater sampling of 37 existing groundwater monitoring wells (29 at the SS-018 site, five at the adjoining OT-045 site, and three associated with the Underground Storage Tank 508) and two future groundwater monitoring wells located at and within the vicinity of the site.

This work will be performed under the authority of the requirements of the Air Force Civil Engineer Center Contract No. FA8903-13-C-0008. This program is conducted under the Holloman Air Force Base Environmental Restoration Chief, Ms. DeAnna Rothhaupt. URS Group, Inc., as a subcontractor to FPM Remediations, Inc., has prepared this Groundwater Monitoring plan as defined in the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland Air Force Bases located in New Mexico, and Luke Air Force Base located in Arizona. Mr. Steven Geiger is the URS Group, Inc. Installation Manager for Installation Restoration Program Project Sites at Holloman Air Force Base.

CONTENTS

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TABLES

FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
amsl	above mean sea level
bgs	below ground surface
EPA	U.S. Environmental Protection Agency
DCE	1,1-Dichloroethene
FPM	FPM Remediations, Inc.
ft	feet
IRP	Installation Restoration Program
GMP	Groundwater Monitoring Plan
MW	monitoring well
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
PCE	Tetrachloroethene
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
SIM	selected ion monitoring
SOP	standard operating procedure
SSL	Soil Screening Level
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TOC	top of casing
TPH	Total Petroleum Hydrocarbons
URS	URS Group, Inc.
USAF	U.S. Air Force
UST	underground storage tank
VOC	volatile organic compound
µg/L	microgram per liter

1.0 INTRODUCTION

This Groundwater Monitoring Plan (GMP) addresses the groundwater monitoring activities that will be performed for the Spill Site #18 (SS-018) located on the south side of Building 281 at Holloman Air Force Base (AFB), New Mexico. The site location is shown in Figure 1. This plan was prepared in accordance with the requirements of the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008. URS Group, Inc. (URS), as a subcontractor to FPM Remediations, Inc. (FPM), has prepared this GMP in accordance with the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland AFBs located in New Mexico, and Luke AFB located in Arizona. Monitoring requirements are further delineated in the *Final Uniform Federal Policy Quality Assurance Project Plan (QAPP), SS-018, Holloman Air Force Base, New Mexico* (USAF, 2014a).

1.1 Purpose and Scope

This plan describes the long-term groundwater monitoring requirements for SS-018. The purpose of this plan is to provide guidance for the groundwater sampling and gauging at the 29 existing monitoring wells at the SS-018 site, two monitoring wells to be installed at the SS-018 site, five existing monitoring wells located at the OT-045 site, and three wells associated with the Underground Storage Tank (UST) 508 located within the area defined by the SS-018 groundwater plume. This plan addresses the following elements:

- General site map showing Holloman AFB in relation to the State of New Mexico and the location of SS-018, OT-045, and the three wells associated with UST-508 within Holloman AFB
- A site map showing the location of the existing and proposed groundwater monitoring wells
- General site description and history
- Groundwater monitoring requirements
- Quality assurance/quality control (QA/QC) sample requirements
- Documentation and reporting requirements

The groundwater monitoring activities may be revised to reflect changes in the monitoring scope or schedule upon agreement with the New Mexico Environment Department (NMED).

2.0 BACKGROUND AND HISTORY

In accordance with the separate *Final Uniform Federal Policy QAPP, SS-018, Holloman Air Force Base, New Mexico* (USAF 2014a), LTM will be performed utilizing the existing 29 groundwater monitoring wells located at SS-018, two future groundwater monitoring wells at SS-018, five existing groundwater monitoring wells at an adjacent site, OT-045, and three wells associated with UST-508. This GMP provides the requirements for groundwater monitoring to be conducted as specified in the work plan for three years following site investigation activities with continued monitoring requirements to be defined following the completion of these three years, if determined to be necessary.

The following background and history information is per reference documents *Final Accelerated Corrective Measures Work Plan Addendum* (NationView, 2009) and *Final Release Assessment Report* (NationView, 2011). SS-018 is located on the south side of Building 281 within the main base area of Holloman AFB and is approximately 0.35 acres. Building 281 operated as a chrome plating shop until the late 1970s. When operations at Building 281 were discontinued, the full chromic acid vats were temporarily stored along the south wall of the building. An estimated 500 gallons of chromic acid were spilled on the ground within the storage area in the late 1970s. A surface drainage ditch is located to the west of the storage area and a portion of the spill was suspected to have infiltrated the subsurface through this ditch. The area of the spill was approximately 30 feet by 30 feet.

Due to the release of chromic acid, several subsurface investigations were performed to evaluate potential chromium contamination within the subsurface. During an investigation by Bhate Environmental Associates, Inc. in June and October 2007 conducted in accordance with the *Final Accelerated Corrective Measures Work Plan Multiple Sites, Holloman Air Force Base, New Mexico* (Bhate, 2007), soil concentrations indicated chromium concentrations were below the NMED residential SSL; furthermore, groundwater samples were collected and the results identified 1,1-DCE as a contaminant of concern with concentrations exceeding the NMWQCC standard of 5 µg/L. Seven monitoring wells were installed to assist in the delineation of the groundwater plume in June through October 2007. Results of this investigation are documented in the *Final Accelerated Corrective Measures Completion Report Sites OT-03 and OT-45 Holloman Air Force Base, New Mexico* (Bhate, 2008).

The 1,1-DCE is a breakdown compound of TCE. TCE was widely used at Holloman AFB as a cleaning solution for approximately 40 years prior to the phase-out of the chemical in the early 1980s; therefore, groundwater contamination is suspected to have originated upgradient (to the north) of SS-018 (Building 281). The 2007 investigation evaluated the surrounding buildings and identified three historical Solid Waste Management Units (SWMUs) associated with Buildings 282 and 283. Results from this investigation did not find any conclusive evidence of a 1,1-DCE source.

Between August and October 2009, a Phase II investigation was performed to define the nature and extent of the VOC impacts that were identified during the Bhate 2007 investigation. The 2009 Phase II performed in accordance with the *Final Accelerated Corrective Measures Work Plan Addendum, Site SS-18 VOC Source Area Delineation, Holloman Air Force Base, New Mexico* (NationView, 2009) advanced 17 soil borings in the vicinity of the SWMUs associated with Buildings 282 and 283. In addition, 14 groundwater monitoring wells were installed. Groundwater data identified the main source area of 1,1-DCE (as well as TCE, PCE, and 1,1-DCA) originating in an area southwest of Building 281. A secondary source of 1,1-DCE was identified as originating from between Buildings 282 and 283. Based on available data, the 1,1-DCE plume appears to have migrated downgradient of Building 282. Results of this evaluation are documented in the *Final Release Assessment Report Site SS-18 Holloman Air Force Base, New Mexico* (NationView, 2011).

As a result of the extent of the VOC groundwater contamination identified during the 2009 fieldwork, a supplemental investigation was performed in 2012 as documented in the *Site S-18 Accelerated Corrective Measures Completion Report – Holloman Air Force Base, New Mexico* (NationView, 2013). Twenty-three soil borings were advanced to 15 ft bgs with a single soil sample collected per borehole from the saturated zone (defined as that point where soil comes in contact with groundwater just below the water table and relatively all pores and fractures are saturated with water) for chemical analysis. Eight of the boreholes were converted into permanent monitoring wells to further delineate the boundaries of the groundwater plumes. Figure 2-1 shows the locations of the buildings and the existing monitoring wells in the vicinity of the Site.

2.1 Groundwater Contamination

During the 2012 investigation, all monitoring wells associated with SS018 along with five wells associated with SS-051 were sampled and analyzed. To supplement the analytical data, results for three wells associated with UST-508 sampled during this same timeframe have been included for evaluation. Groundwater contamination comprised of chlorinated VOCs, including 1,1-DCE, TCE, PCE, 1,1-DCA, and cis-1,2-DCE was identified with analytical results provided in Table 2-1. As a constituent of interest, trans-1,2-dichloroethene (trans-1,2-DCE) is included for completeness. Figures 2-2 through 2 7 provide isoconcentration maps for the six chlorinated VOCs of interest.

As discussed in the Site S-18 Accelerated Corrective Measures Completion Report – Holloman Air Force Base, New Mexico (NationView, 2013), five chlorinated VOCs are of primary interest, including 1,1 DCA, 1,1-DCE, cis-1,2-DCE, PCE, and TCE. Included in the report is a risk evaluation which determined that the groundwater concentrations do not pose an unacceptable risk based on the current commercial/industrial worker, future resident, and future construction worker scenarios. However, the groundwater has been impacted by the five chlorinated VOCs at concentrations above applicable action levels of 25 µg/L, 5 µg/L, 70 µg/L, 5 µg/L, and 5 µg/L, respectively. For trans-1,2-DCE, the applicable action level is 100 µg/L, which was not exceeded for any of the samples collected in 2012. Based on the groundwater data collected during 2007, 2009, and 2012, it appears that biodegradtion is occurring, but it is unclear if there is a potential for complete biodegradation.

To investigate the potential for biodegradation, a compound specific isotope analysis was conducted for chlorinated VOC contamination. Compound specific isotope analysis is an analytical method that measures the ratios of naturally occurring stable isotopes in groundwater samples and can be used to determine potential contaminant sources and the extent of degradation. In order to evaluate the potential for biodegradation, groundwater samples were collected along two transects parallel to the direction of groundwater flow extending from the suspected origin of the contamination to the distal edge of the VOC plumes.

The compound specific isotope analysis study provided evidence regarding the slow biodegradation of 1,1,1-trichloroethane, PCE, and TCE. The active mechanism appears to be a mix of reductive dechlorination and biological oxidation. A review of the historical VOC concentrations showed little change over a five year period from 2007 to 2012. In addition, the isotopic results suggested that there is not a single sourse for the observed groundwater contamination, but rather multiple small sources. Furthermore, the subsurface soil data collected in 2007, 2009, and 2012 have not determined a source area in the vicinity of the impacted groundwater, further supporting the determination of the compound specific isotope study.

As can be seen by examination of the isoconcentration maps, the chlorinated VOCs have migrated downgradient of the suspected source locations. The highest concentrations appear to be northeast of Building 281 and southwest of Building 279. The plumes have reached the furthest downgradient wells of SS18-MW29 and SS18-MW30, with TCE concentrations of 9.5 µg/L and 3.7 µg/L, respectively.

2.2 Soil Contamination

Table 2-2 summarizes the borehole soil results from 2007, 2009, and 2012. Samples were collected from various depths as shown in Table 2-2 ranging from 3 to 12 feet bgs. The majority of the analytical results with the exception of samples collected from boreholes SS18-DP06, SS18-DP17, SS18-DP20, SS18 DP27, SS18-DP28, SS18-DP29, SS18-DP30, DD18-DP31, and SS18-DP32. The boreholes S18 DP-17 and SS18-DP20 are located just south of Building 283 as shown in Figure 2-8. The other boreholes are located off the southern corner of Building 281. The elevated concentrations represented by the soil samples collected from these boreholes support the assertion that the groundwater contamination may be attributed to multiple historic releases with at least two originating from locations adjacent to these two buildings. Figure 2-9 shows the locations of additional boreholes to be installed and sampled in accordance with the *Final SS-018 – Resource Conservation and Recovery Act Facility Investigation Work Plan* (USAF, 2015a).

3.0 LONG-TERM GROUNDWATER MONITORING

3.1 Monitoring Requirements

Groundwater samples will be collected from the 29 existing and two future monitoring wells associated with and in the vicinity of SS-018, the five existing monitoring wells associated with and in the vicinity of OT-045, and three wells associated with UST-508 as described in the *Final Uniform Federal Policy QAPP, SS-018, Holloman Air Force Base, New Mexico* (USAF 2015b). The wells identified by SS18 nomenclature were drilled specifically to evaluate groundwater associated with the SS-018 site that has been impacted by VOCs. The five wells associated with OT-045 and the three wells associated with UST508 were selected for sampling because of their proximity to the groundwater plume defined by site SS-018. Groundwater sampling and analysis will initially be conducted in April 2015 following installation of the two new groundwater monitoring wells to establish a current analytical baseline for the site. Following the completion of interim measures to address groundwater contamination at the site tentatively scheduled to occur in 2017, quarterly monitoring will be performed for a period of two years to demonstrate that the interim measures were successful in reducing contaminant concentrations to levels that no longer pose an unacceptable risk to human health and the environment.

The proposed groundwater monitoring network is displayed on Figure 3-1. Table 3-1 lists the monitoring wells to be sampled within the monitoring well network associated with the SS-018 and OT-045 sites and incorporated survey and well construction information for each well. As shown in Figure 3-1, two new wells will be installed during the investigation phase of the project with one well located between wells SS51-MW3 and SS18-MW18 and the second well located downgradient of wells SS18-MW29 and SS18-MW30.

Groundwater sampling of the monitoring wells will be conducted initially to provide a baseline dataset, then quarterly following implementation of the interim measures for a minimum of two years. Water level measurements will be taken prior to well purging and sample collection during each sampling event. Samples will be collected and analyzed for the parameters as provided in Table 3-2. Water quality parameter measurements will be collected during sampling. Sample handling, analyses, and quality assurance/quality control (QA/QC) procedures will comply with the requirements defined in the *Final Uniform Federal Policy QAPP, SS-018, Holloman Air Force Base, New Mexico* (USAF, 2015b).

Annual LTM reports will be submitted to present the analytical data collected.

3.2 Pre-Sampling Activities

The Holloman AFB personnel will be contacted, as necessary, prior to the annual monitoring events to provide notification of impending activities. The NMED will be notified, as required, of groundwater sampling events to allow for coordination of regulatory oversight activities. The project laboratory will also be notified of each groundwater sampling event, including the number of samples expected to be collected for each specified analysis.

3.3 Health and Safety

All field work will be completed in accordance with the *Health and Safety Plan – Selected Sites Under the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008 (SS-017; SS-018; DP-030/SD-033; SS-039; OT-037/OT-038; SS-065; SS-069; SD-027)* (USAF, 2014). A daily safety tailgate meeting will be conducted at the beginning of each work day. This will include reviewing site-specific safety concerns and the job safety analyses. Personal protective equipment required for this work is not expected to exceed Level D which includes steel-toed boots, nitrile gloves for sample collection, leather gloves, hard hats, safety glasses, and a high-visibility reflective safety vest when on site.

3.4 Groundwater Level Measurements

Groundwater level measurements will be collected in accordance with the requirements delineated in A-1, "Measurement of Groundwater and Fluid Levels in Wells," provided in Appendix A. During the course of collecting water level measurements, observations of well conditions will be collected and recorded. Water level measurements will be collected from the 37 existing and two new monitoring wells located at SS-018 at the time of sample collection. Static water levels and total well depth will be measured prior to purging activities.

3.5 Sample Collection Methods

Groundwater samples will be collected in accordance with the requirements delineated in A-2, "Monitoring Well Purging and Groundwater Sampling," provided in Appendix A. Each well will be purged and sampled in accordance with the A-2. During the purging of each well, field parameter data will be collected in accordance with A-3, "Measurement of Groundwater Field Parameters," also provided in Appendix A.

3.6 Equipment Decontamination

Non-dedicated sampling equipment will be decontaminated between sample locations following the procedures described in A-4, "Decontamination," provided in Appendix A. Dedicated sampling equipment will not require decontamination.

3.7 Sample Labels

Each sample will be labeled with a unique identifier and recorded in the field logbook (A-5, "Sample Identification, Management, and Handling" provided in Appendix A) as it is collected. The sample identification will be documented on the chain-of-custody form. Data pertinent to each sample such as sample identification, location, color, time, and date will be recorded on field data sheets. Each analytical sample will be assigned a unique number in the following format:

- Groundwater Sampling Location (i.e., MW30&33-01)
- Date sampled (MMDDYY)

Under this sample designation format, sample "MW30&33-01-072514" corresponds to a sample collected from monitoring well MW30&33-01 on July 25, 2014.

3.8 Chain-of-Custody

All samples will be accompanied by a chain-of-custody in accordance with A-5, "Sample Identification, Management, and Handling" provided in Appendix A. The chain-of-custody form will be completed by the field sampling technician collecting the sample and will accompany each sample cooler. Whenever a sample is transferred to another responsible party in an unsealed cooler, the receiving party must sign-off on the chain-of-custody form.

The original chain-of-custody form will accompany the samples to the laboratory with a copy retained by field staff, and a final copy will be returned with the analytical results.

4.0 QUALITY ASSURANCE PROJECT PLAN

The objective of this investigation is to provide groundwater sample analytical data of sufficient quality and quantity to adequately characterize and monitor groundwater underlying the SS-018 site. This GMP is used in conjunction with the QAPP (USAF, 2015b) to ensure that the functional activities, organization, and QA/QC protocols are achieved in accordance with the project's data quality objectives. Ultimately, groundwater monitoring data generated during the project will be used to demonstrate that interim measures to address groundwater contamination at the site have successfully reduced concentrations to levels that no longer pose an unacceptable risk to human health and the environment, resulting in revision of the status of the Site to correction action complete without controls.

As outlined in the QAPP, quality assurance objectives are specified to ensure that data produced are of a known and sufficient quality for determining whether a risk to human health or the environment exists. Minimum precision, accuracy, and completeness measurements and minimum detection limits are quantitative objectives specified in the QAPP. Representativeness and comparability are qualitative objectives. During the sampling discussed in this plan, field quality control samples will be collected and analyzed to evaluate the achievement of the precision and accuracy objectives specified in the QAPP. Overall, both field and laboratory precision will be evaluated through the results of duplicate groundwater samples, equipment rinsates, and field blanks. The duplicate samples, equipment rinsates, and field blanks will be analyzed for the same suite of analytes as the regular groundwater samples. For each annual groundwater monitoring event, one equipment rinsate, one field blank, and one field duplicate will be collected per 10 samples collected. Trip blanks to be analyzed for VOCs will be included in each cooler containing VOC samples shipped to the laboratory.

Environmental analyses are critical, because decision-making based on inaccurate measurements or data of unknown quality can have significant economic and health consequences. Data verification and validation will be performed as specified in the QAPP to ensure data meet the project requirements. Method data validation is the process whereby analytical data are reviewed against set criteria to ensure that the results conform to the requirements of the analytical method and any other specified requirements. All laboratory-generated data will be validated in accordance with the requirements of the QAPP. The field-generated data will not be validated, but the quality of the field-generated data will be ensured through adherence to established operating procedures and use of equipment calibration and standardization, as appropriate.

4.1 Duplicate Samples

Field duplicates are samples that are collected at the same time, from the same source, and at the same depth or sample location as the associated field sample. Field duplicates are submitted to the project laboratory as separate samples. The purpose of collecting field duplicates is to assess the consistency of the overall sampling effort, including collection, shipping, and analysis. The purpose of submitting them to the laboratory is to assess the consistency or precision of the laboratory's analytical system. One duplicate sample will be collected and analyzed for the same parameters as the groundwater samples to evaluate sampling and analytical precision. Field duplicates are collected at a frequency of 10 percent of the primary samples collected, with a minimum of one duplicate collected. The precision goal for field duplicate analyses will be plus or minus a 35 relative percent difference.

4.2 Equipment Blanks

Field equipment blanks are samples that are prepared in the field by pouring deionized water over decontaminated sampling equipment and collecting the water in laboratory provided sampling containers. The water is analyzed as a sample. The field equipment blank gives an indication of contamination from field procedures (e.g., improperly cleaned sampling equipment, cross-contamination). One equipment rinsate blank will be collected per 10 field samples during each annual groundwater monitoring event.

4.3 Trip Blanks

Trip blanks are used to evaluate if VOCs may have been introduced to the environmental samples during shipment, handling, or storage. Trip blanks are prepared by the laboratory, shipped to the project site, and then transported back to the laboratory with the field samples. Trip blanks will be analyzed for VOCs only. Trip blanks will be submitted and analyzed with each cooler containing VOC samples.

4.4 Data Validation/Verification

The laboratory will provide a minimum of a Level II Quality Control laboratory data package. In addition, URS will request that a minimum of 10 percent of all samples be reported with a Level IV Quality Control laboratory data package. Following receipt of the Level II or Level IV data package from the laboratory, URS will perform data validation and verification to evaluate the reliability and defensibility of the analytical data. This process involves reviewing the data against a known set of criteria to verify data validity prior to URS submitting the data.

5.0 INVESTIGATION-DERIVED WASTE

The investigation-derived waste generated during the groundwater monitoring will include spent and unused sample material, personal protective equipment, miscellaneous sampling supplies, decontamination water, purge water, and samples. The investigation-derived waste will be managed in accordance with A-6, “Investigation Derived Waste Management” provided in Appendix A. Prior to performing sampling, the field team leader will discuss with the field sampling personnel waste reduction methods. Practices to be instituted to support waste minimization include, but are not limited to, the following:

- Restriction of materials (especially hazardous materials) to those needed for performance of work
- Substitution of recyclable materials for disposable items
- Reuse of items, when practical
- Segregation of contaminated from uncontaminated waste
- Segregation of reusable items (such as personal protective equipment and tools)

Waste characterization will be evaluated based on the comparison of analytical results with applicable regulatory levels.

Wastewater from pre-sampling well purging and equipment decontamination will be stored in tanks pending the receipt of the groundwater analytical results. A sign posted on each tank will identify the contents and convey a warning that no material should be added or removed. Waste characterization will be performed by reviewing the groundwater sample analytical results from the wells. The detected constituent concentrations will be compared to the NMWQCC Regulations, Part 2, 3103, A, B, and C groundwater quality standards (20 New Mexico Administrative Code 6.2).

A Notice of Intent to discharge purge and decontamination water classified as non-hazardous will be prepared following each sampling event and submitted to NMED Ground Water Quality Bureau for approval prior to discharging any groundwater to surface. Results from laboratory analyses will be summarized and concentrations evaluated for individual containers based on the volume added from the wells from which the purge water and decontamination water originated. The maximum concentrations will be used to determine whether purge water meets the discharge requirements. After NMED provides their approval, the water will be discharged to the ground surface at the site. If the results indicate that the water cannot be released to the ground surface, it will be disposed at an appropriate facility.

All personal protective equipment and disposable equipment will be placed in double plastic bags and sealed for disposal in dumpsters at the base.

As part of the contract with the subcontracted laboratories, all laboratory and sample waste is managed in accordance with the subcontract. Analytical waste streams may include unused/unaltered sample material, analytical residues, and sample containers. Unused/unaltered sample material will be generated from the sampling activities in the form of groundwater not required for analysis. Generally, the laboratory will be responsible for disposal of the unused/unaltered sample material. In those cases where samples must be returned from the laboratory, this excess material will be documented and disposed in accordance with the requirements for disposal of purge and decontamination water. Analytical residues will be generated from the sample analytical activities conducted by the subcontracted laboratories. Although the laboratories are required to dispose of analytical residues under terms of the subcontract, the potential does exist for return of analytical residues. If analytical residues are returned, this will be documented and the waste disposed at an appropriate facility.

Sample containers will become a waste stream following analyses. The laboratories are required to dispose of the sample containers in accordance with established waste management procedures. Sample containers will only be returned to the project should unused/unaltered sample material need to be returned as discussed above.

6.0 RECORDKEEPING

URS will maintain a field logbook in accordance with A-5, "Documentation," found in Appendix A, which requires that field logbooks be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the logbook. The primary document used to record site data is the field logbook. Entries will be made in indelible ink and corrections made by a single stroke through the error with the recorder's initials. All entries to the logbook will include, at a minimum:

- Location, date, start and finish times
- Names of personnel present
- Names of visitors
- General weather conditions
- Health and safety briefings
- Details of work performed
- Summary of samples collected
- Field measurement readings and field equipment calibration information
- Photograph log and drawings/sketches
- General observations

7.0 REPORTING

Upon receipt of analytical results from sampling activities, URS will prepare a written report summarizing the groundwater monitoring. The annual monitoring reports will summarize field activities, observations, and results. The report will include the evaluation of trends and statistical analysis, as appropriate.

Analytical results will also be presented within the report in a table format, and include sample identifier, date and time of collection, sample location, and concentrations. Analytical results will be compared to the applicable NMWQCC standards. Field notes and laboratory reports will be included as appendices within the report.

In addition, within 90 days of sample collection, all data will be exported for upload to AFCEC's Environmental Restoration Program Information Management System database.

8.0 REFERENCES

Bhate. 2007. *Final Accelerated Corrective Measures Work Plan Multiple Sites, Holloman Air Force Base, New Mexico*. Bhate Environmental Associates, Inc. May.

______. 2009. *Final Accelerated Corrective Measures Completion Report Sites OT-03 and OT-45 Holloman Air Force Base, New Mexico.* Bhate Environmental Associates, Inc. November.

NationView. 2009. *Final Accelerated Corrective Measures Work Plan Addendum, Site SS-18 VOC Source Area Delineation, Holloman Air Force Base, New Mexico*. July.

______. 2011. *Final Release Assessment Report, Site SS-18, Holloman Air Force Base, New Mexico*. February.

______. 2013. *Final Site SS-18 Accelerated Corrective Measure Completion Report Holloman Air Force Base, New Mexico.* NationView, LLC. June.

USAF. 2015a. *Final SS-018 – Resource Conservation and Recovery Act Facility Investigation Work Plan*. March.

______. 2015b. *Final Uniform Federal Policy Quality Assurance Project Plan, SS-018, Holloman Air Force Base, New Mexico*. March.

______. 2014. *Health and Safety Plan – Selected Sites Under the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008 (SS-017; SS-018; DP-030/SD-033; SS-039; OT-037/OT-038; SS-065; SS-069; SD-027).* U.S. Air Force, Holloman AFB, New Mexico. July.

20 § 6.2 NMAC. Ground and Surface Water Protection, New Mexico Administrative Code, Title 20, Chapter 6, Part 2. Current Revision.

TABLES

Table 2-1. Fiscal Year 2012 Groundwater Monitoring Data

Well	Sample Date	1,1-DCE (µg/L)	TCE (µg/L)	1,1-DCA (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)	PCE (µg/L)
S51-MW1	9/12/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
S51-MW3	9/12/2012	4.9	**83.2**	14.3	**103**	5.4	**26.8**
S51-MW4	9/12/2012	< 0.23	1.3	0.44	< 0.26	< 0.35	3.8
S51-MW5	9/12/2012	< 0.23	0.6	< 0.25	< 0.26	< 0.35	2
S51-MW7	9/12/2012	< 0.23	0.46	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW02	9/13/2012	4.3	< 0.26	2.9	< 0.26	< 0.35	< 0.25
SS18-MW03	9/14/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW04	9/14/2012	**35.9**	< 0.26	**25.2**	< 0.26	< 0.35	0.32
SS18-MW05	9/12/2012	**54.4**	0.26	**170**	< 0.26	< 0.35	< 0.25
SS18-MW06	9/12/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW07	9/10/2012	< 0.23	< 0.26	0.29	< 0.26	< 0.35	< 0.25
SS18-MW08	9/10/2012	**95.5**	**6.5**	**27.2**	0.36	< 0.35	**28.2**
SS18-MW09	9/11/2012	1.2	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW10	9/11/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW11	9/11/2012	0.27	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW12	9/11/2012	0.7	< 0.26	9	< 0.26	< 0.35	< 0.25
SS18-MW13	9/12/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW14	9/10/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW15	9/10/2012	1	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW16	9/13/2012	2	**12.9**	1.2	**199**	5.5	0.83
SS18-MW17	9/12/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW18	9/13/2012	2.8	**111**	8.5	**102**	6.2	**16.4**
SS18-MW19	9/13/2012	**53.8**	**40.2**	**497**	8.2	1.8	**150**
SS18-MW20	9/14/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW21	9/13/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW22	9/11/2012	4.5	< 0.26	0.42	< 0.26	< 0.35	< 0.25
SS18-MW23	9/10/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	0.54

Well	Sample Date	1,1-DCE (µg/L)	TCE (µg/L)	1,1-DCA (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)	PCE (µg/L)
SS18-MW24	9/10/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW25	9/10/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW26	9/11/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW27	9/11/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW28	9/13/2012	< 0.23	< 0.26	< 0.25	< 0.26	< 0.35	< 0.25
SS18-MW29	9/12/2012	0.33	**9.5**	0.76	2.8	3.4	< 0.25
SS18-MW30	9/13/2012	< 0.23	3.7	0.83	< 0.26	< 0.35	< 0.25
USTC508-MW01	10/5/2012	0.2	**6**	0.215	**152**	5.7	0.32
USTC508-MW02	10/5/2012	1.1	**22.9**	0.96	**226**	5.9	1.5
USTC508-MW03	10/5/2012	**64.7**	0.155	4.1	0.12	0.115	0.16

BOLD TEXT – concentration exceeds applicable action level

1,1-DCE – 1,1-dichloroethane
1,1-DCE – 1,1-dichloroethene
cis-1,2-DCE – cis-1,2-dichloroethene
PCE - tetrachloroethene
TCE – trichloroethene
trans-1,2-DCE – trans-1,2-dichloroethene

Table 2-2. Borehole Analytical Data

Borehole	Depth (ft)	Sample Date		1,1-DCE (µg/kg)		TCE (µg/kg)		1,1-DCA (µg/kg)		cis-1,2-DCE (µg/kg)		trans-1,2-DCE (µg/kg)		PCE (µg/kg)
SS18-DP01	Unknown	04-Jun-07	<	0.67	<	0.26	<	0.24	<	0.64	<	0.44	<	0.67
SS18-DP02	3	04-Jun-07	<	0.76	<	0.29	<	0.27	<	0.72	<	0.5	<	0.76
SS18-DP03	3	04-Jun-07	<	0.62	<	0.24	<	0.22	<	0.59	<	0.41	<	0.62
SS18-DP04	5	05-Jun-07	<	0.77	<	0.3	<	0.27	<	0.73	<	0.51	<	0.77
SS18-DP05	5	06-Jun-07	<	0.65	<	0.25	<	0.23	<	0.61	<	0.43	<	0.65
SS18-DP06	5	06-Jun-07	<	0.73	<	0.29		**0.39**	<	0.7	<	0.48	<	0.73
SS18-DP07	3	20-Aug-09	<	1.6	<	1.5	<	2.5	<	2	<	1.5	<	1.5
SS18-DP07	8	20-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP08	3	20-Aug-09	<	1.4	<	1.3	<	2.2	<	1.7	<	1.3	<	1.3
SS18-DP08	8	20-Aug-09	<	1.4	<	1.3	<	2.2	<	1.8	<	1.3	<	1.3
SS18-DP09	3	19-Aug-09	<	1.3	<	1.2	<	1.9	<	1.6	<	1.2	<	1.2
SS18-DP09	8	19-Aug-09	<	1.5	<	1.4	<	2.3	<	1.8	<	1.4	<	1.4
SS18-DP10	3	19-Aug-09	<	1.4	<	1.3	<	2.2	<	1.8	<	1.3	<	1.3
SS18-DP10	7	19-Aug-09	<	1.3	<	1.2	<	2.1	<	1.7	<	1.2	<	1.2
SS18-DP11	4	19-Aug-09	<	1.2	<	1.1	<	1.9	<	1.5	<	1.1	<	1.1
SS18-DP11	7	19-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP12	3	18-Aug-09	<	1.5	<	1.4	<	2.3	<	1.8	<	1.4	<	1.4
SS18-DP12	8	18-Aug-09	<	1.3	<	1.2	<	2.1	<	1.7	<	1.2	<	1.2
SS18-DP13	4	17-Aug-09	<	1.5	<	1.4	<	2.3	<	1.8	<	1.4	<	1.4
SS18-DP13	8	17-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP14	3	18-Aug-09	<	1.3	<	1.2	<	2.1	<	1.6	<	1.2	<	1.2
SS18-DP14	7	18-Aug-09	<	1.4	<	1.3	<	2.2	<	1.8	<	1.3	<	1.3
SS18-DP15	3	18-Aug-09	<	1.6	<	1.5	<	2.5	<	2	<	1.5	<	1.5
SS18-DP15	6	18-Aug-09	<	410	<	380	<	630	<	510	<	380	<	380
SS18-DP16	4	17-Aug-09	<	1.4	<	1.3	<	2.2	<	1.8	<	1.3	<	1.3
SS18-DP16	8	17-Aug-09	<	1.4	<	1.3	<	2.1	<	1.7	<	1.3	<	1.3
SS18-DP17	4	17-Aug-09	<	1.6	<	1.4		**8.6**	<	1.9	<	1.4	<	1.4

Borehole	Depth (ft)	Sample Date		1,1-DCE (µg/kg)		TCE (µg/kg)		1,1-DCA (µg/kg)		cis-1,2-DCE (µg/kg)		trans-1,2-DCE (µg/kg)		PCE (µg/kg)
SS18-DP17	6	17-Aug-09		**6.1**	<	1.3		**195**	<	1.7	<	1.3	<	1.3
SS18-DP18	2	17-Aug-09	<	1.5	<	1.4	<	2.3	<	1.8	<	1.4	<	1.4
SS18-DP18	8	17-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP19	2	17-Aug-09	<	1.5	<	1.4	<	2.4	<	1.9	<	1.4	<	1.4
SS18-DP19	8	17-Aug-09	<	1.4	<	1.3	<	2.1	<	1.7	<	1.3	<	1.3
SS18-DP20	3	18-Aug-09	<	1.4	<	1.3	<	2.1	<	1.7	<	1.3	<	1.3
SS18-DP20	7	18-Aug-09		**2.1**	<	1.5		**58.5**	<	1.9	<	1.5	<	1.5
SS18-DP21	3	17-Aug-09	<	1.7	<	1.6	<	2.6	<	2.1	<	1.6	<	1.6
SS18-DP21	8	17-Aug-09	<	1.6	<	1.5	<	2.5	<	2	<	1.5	<	1.5
SS18-DP22	3	18-Aug-09	<	1.4	<	1.3	<	2.2	<	1.7	<	1.3	<	1.3
SS18-DP22	8	18-Aug-09	<	1.4	<	1.3	<	2.1	<	1.7	<	1.3	<	1.3
SS18-DP23	3	19-Aug-09	<	1.3	<	1.2	<	2	<	1.6	<	1.2	<	1.2
SS18-DP23	8	19-Aug-09	<	1.2	<	1.1	<	1.9	<	1.5	<	1.1	<	1.1
SS18-DP24	10	8/14/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1
SS18-DP25	8	8/15/2012	<	1.6	<	1.3	<	1.2	<	1.7	<	1.7	<	1.1
SS18-DP26	8	8/14/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1
SS18-DP27	8	8/15/2012		**10.9**	<	1.5		**2.8**	<	1.8	<	1.8	<	1.2
SS18-DP28	7	8/14/2012		**25.8**		**4.2**		**6.3**	<	1.6	<	1.6		**21.7**
SS18-DP29	8	8/15/2012		**4.4**	<	1.2		**5.5**	<	1.6	<	1.6	<	1
SS18-DP30	11	8/15/2012		**3.1**		**9.6**		**7.7**		**2.9**	<	1.4		**94.9**
SS18-DP31	11	15-Aug-12		**17.4**	<	1.2		**2.7**	<	1.5	<	1.5		**2.6**
SS18-DP32	12	8/15/2012		**6.4**		**5.4**		**14.5**	<	1.5	<	1.5		**22.7**
SS18-DP33	8	15-Aug-12	<	1.5	<	1.3	<	1.2	<	1.7	<	1.7	<	1.1
SS18-DP34	8	16-Aug-12	<	1.3	<	1.1	<	1	<	1.4	<	1.4	<	0.94
SS18-DP35	5	8/15/2012	<	1.6	<	1.3	<	1.2		**2.4**	<	1.6	<	1.1
SS18-DP36	7	8/15/2012	<	1.5	<	1.2	<	1.1	<	1.6	<	1.6	<	1
SS18-DP37	8	15-Aug-12	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1.1
SS18-DP38	8	16-Aug-12	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1.1

Borehole	Depth (ft)	Sample Date		1,1-DCE (µg/kg)		TCE (µg/kg)		1,1-DCA (µg/kg)		cis-1,2-DCE (µg/kg)		trans-1,2-DCE (µg/kg)		PCE (µg/kg)
SS18-DP39	8	8/14/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1
SS18-DP40	8	8/14/2012	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1.1
SS18-DP41	7	8/17/2012	<	1.3	<	1.1	<	1	<	1.4	<	1.4	<	1
SS18-DP42	5	8/16/2012	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1
SS18-DP43	5	8/16/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1
SS18-DP44	7	8/16/2012	<	1.7	<	1.4	<	1.3	<	1.8	<	1.8	<	1.2
SS18-DP45	8	8/17/2012	<	1.5	<	1.3	<	1.2	<	1.6	<	1.6	<	1.1
SS18-DP46	8	8/17/2012	<	1.4	<	1.2	<	1.1	<	1.5	<	1.5	<	1

BOLD TEXT – Detectable Concentration

1,1-DCE – 1,1-dichloroethane
1,1-DCE – 1,1-dichloroethene
cis-1,2-DCE – cis-1,2-dichloroethene
PDE – tetrachloroethene
TCE – trichloroethene
trans-1,2-DCE – trans-1,2-dichloroethene

Table 3-1. Groundwater Monitoring Well Network

Site	Well	Northing	Easting	Elevation TOC (ft amsl)	Diameter (inches)	Screen Interval (ft bgs)	Total Depth (ft bgs)
SS-018	SS18-MW02	671135.39	1692158.98	4,077.59	1	4.2 – 14.2	15.5
	SS18-MW03	671001.60	1692081.90	4,075.50	1	4.9 – 14.9	16.4
	SS18-MW04	671055.90	1692026.80	4,077.10	1	4.2 – 14.2	15.0
	SS18-MW05	671263.60	1692066.00	4,078.57	2	3.5 – 13.5	15.0
	SS18-MW06	671248.10	1692236.90	4,081.09	2	4.5 – 14.5	15.5
	SS18-MW07	671226.60	1691939.00	4,077.31	2	4.5 – 14.5	15.5
	SS18-MW08	671022.20	1691997.80	4,076.56	2	4.5 – 14.5	15.5
	SS18-MW09	671312.00	1691942.34	4,076.48	1	4.75 – 14.75	15.0
	SS18-MW10	671338.23	1691952.93	4,077.12	1	4.75 – 14.75	15.0
	SS18-MW11	671443.01	1692079.40	4,078.09	1	4.75 – 14.75	15.0
	SS18-MW12	671415.19	1692128.04	4,078.21	1	4.75 – 14.75	15.0
	SS18-MW13	671497.30	1692145.91	4,078.91	1	4.75 – 14.75	15.0
	SS18-MW14	671432.33	1692206.94	4,079.45	1	4.75 – 14.75	15.0
	SS18-MW15	671245.97	1691844.74	4,074.18	1	3.75 – 13.75	14.0
	SS18-MW16	670987.56	1691748.86	4,073.72	1	4.75 – 14.75	15.25
	SS18-MW17	670964.40	1692177.89	4,076.41	1	4.75 – 14.75	15.25
	SS18-MW18	670850.93	1691611.45	4,072.63	1	4.75 – 14.75	15.0
	SS18-MW19	670855.07	1691860.52	4,073.98	1	4.75 – 14.75	15.0
	SS18-MW20	670862.93	1692003.35	4,073.63	1	4.75 – 14.75	15.25
	SS18-MW21	670580.21	1691929.69	4,073.83	1	4.75 – 14.75	15.0
	SS18-MW22	671394.79	1692014.10	4,076.81	1	4.75 – 14.75	15.0
	SS18-MW23	671652.71	1691875.84	4,077.81	2	4.75 – 14.75	15.5
	SS18-MW24	671625.27	1692080.59	4,079.27	2	4.75 – 14.75	15.5
	SS18-MW25	670931.10	1691524.85	4,072.68	2	4.75 – 14.75	15.5
	SS18-MW26	670793.58	1691424.34	4,070.71	2	4.75 – 14.75	15.5
	SS18-MW27	670645.78	1691339.97	4,071.00	2	4.75 – 14.75	15.5
	SS18-MW28	670522.57	1691697.02	4,070.88	2	4.75 – 14.75	15.5
	SS18-MW29	670316.02	1691035.29	4,071.23	2	4.75 – 14.75	15.5
	SS18-MW30	670218.25	1691171.04	4,070.42	2	4.75 – 14.75	15.5
	SS18-MW31	To be determined following well installation.					
	SS18-MW32	To be determined following well installation.					
OT-045	S51-MW1	670457.30	1691277.00	4,071.54	2	2.0 – 17.0	17.5
	S51-MW3	670537.30	1691490.00	4,071.03	2	6.99 – 16.99	17.5
	S51-MW4	670249.30	1691336.00	4,070.83	2	7.04 – 17.04	17.5
	S51-MW5	670318.30	1691413.00	4,070.19	2	6.95 – 16.95	17.5
	S51-MW7	670339.30	1691209.00	4,069.87	2	7.56 – 17.56	18.0
UST-508	USTC508-MW01	671016.50	1691834.19	4,075.10	2	7.0 – 11.7	12.0
	USTC508-MW02	671041.59	1691811.68	4,074.98	2	6.0 – 10.7	11.0
	USTC508-MW03	671178.74	1691896.12	4,075.18	2	6.5 – 11.2	11.5

amsl – above mean sea level
ft – feet
TOC – top of casing
bgs – below ground surface
MW – monitoring well

Table 3-2. Groundwater Sample Analyses and Methods

Analysis	Method
Volatile organic compounds (VOCs)	EPA Method 8260B
Total Petroleum Hydrocarbons (TPH)	EPA Method 8015M
TPH-Gasoline Range Organics	EPA Method 8015M
TPH-Diesel Range Organics	EPA Method 8015M
TPH-Oil Range Organics (ORO)	EPA Method 8015M
Target Analyte List Metals	EPA Method 6010B/6020B/7470A
Total Dissolved Solids	EPA Method 2540C
1,4-Dioxane[a]	EPA Method 8260-SIM

a. Samples for 1,4-dioxane analysis will be collected during the first three quarters of quarterly monitoring. If 1,4-dioxane is detected, monitoring for the analyte may be continued.
EPA – U.S. Environmental Protection Agency
SIM – Selected Ion Monitoring

FIGURES

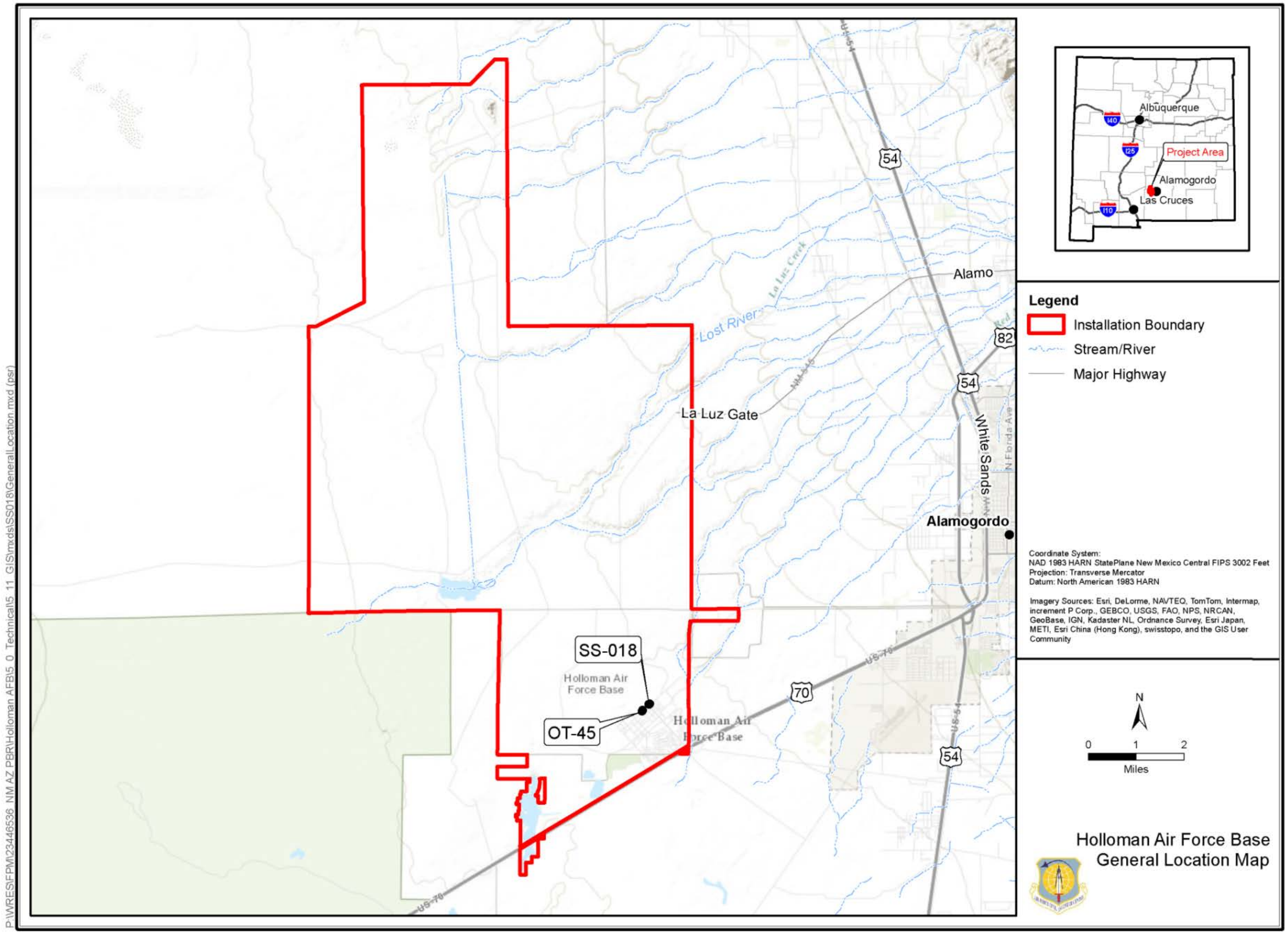

Figure 1-1. S-018 Site Location

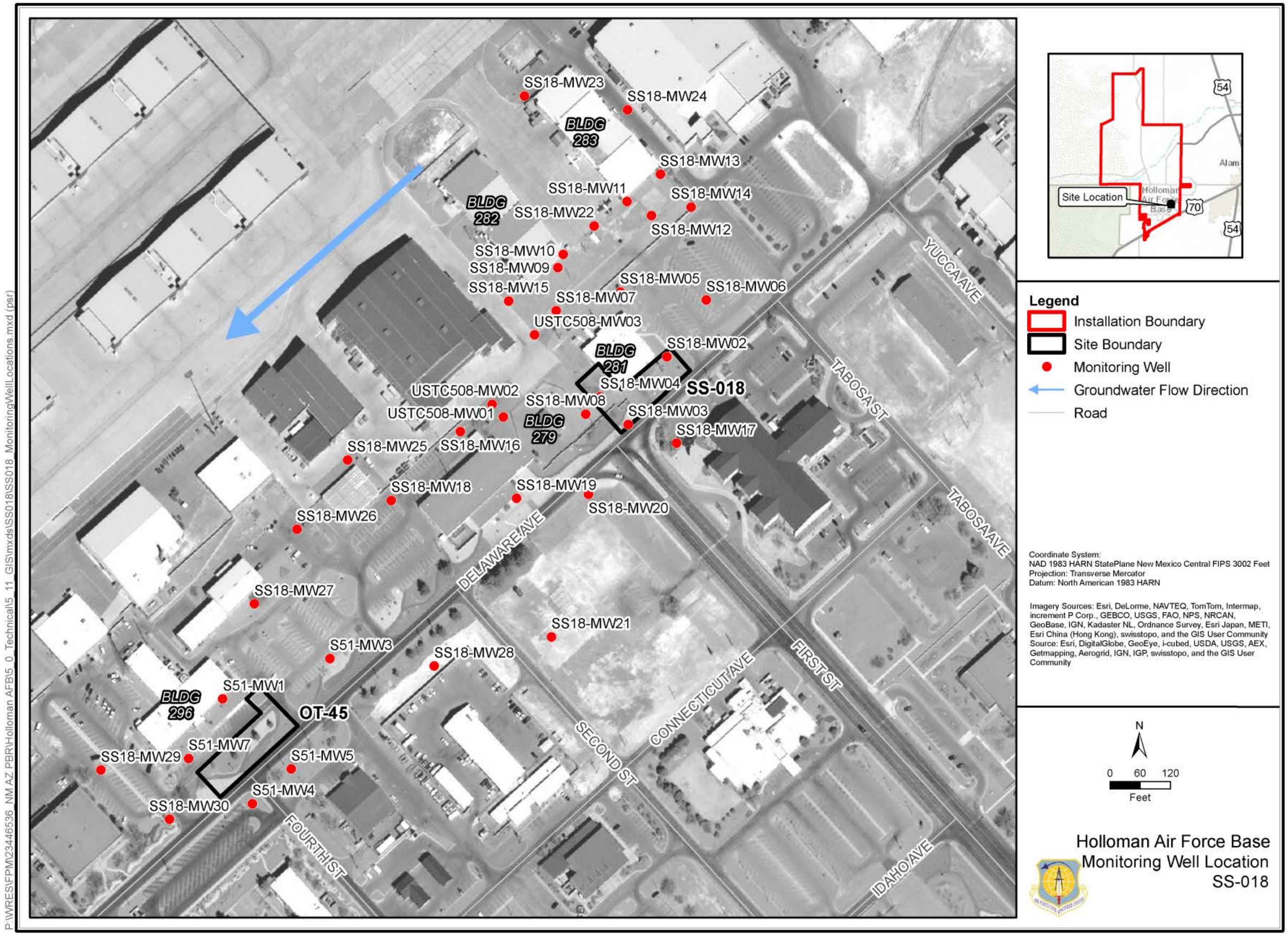

Figure 2-1. Existing Monitoring Well Locations

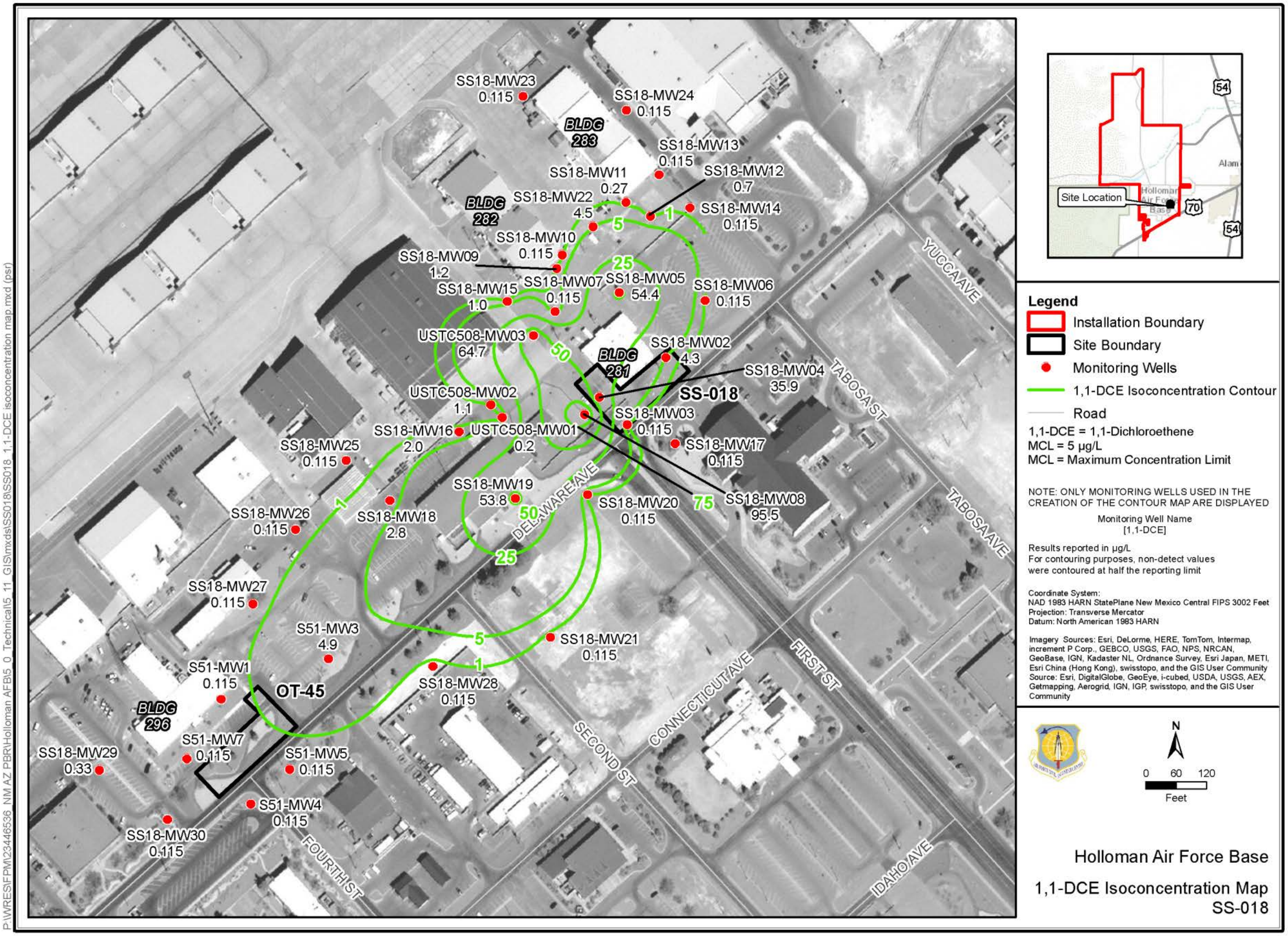

Figure 2-2. 1,1-Dichloroethene Isoconcentration Map

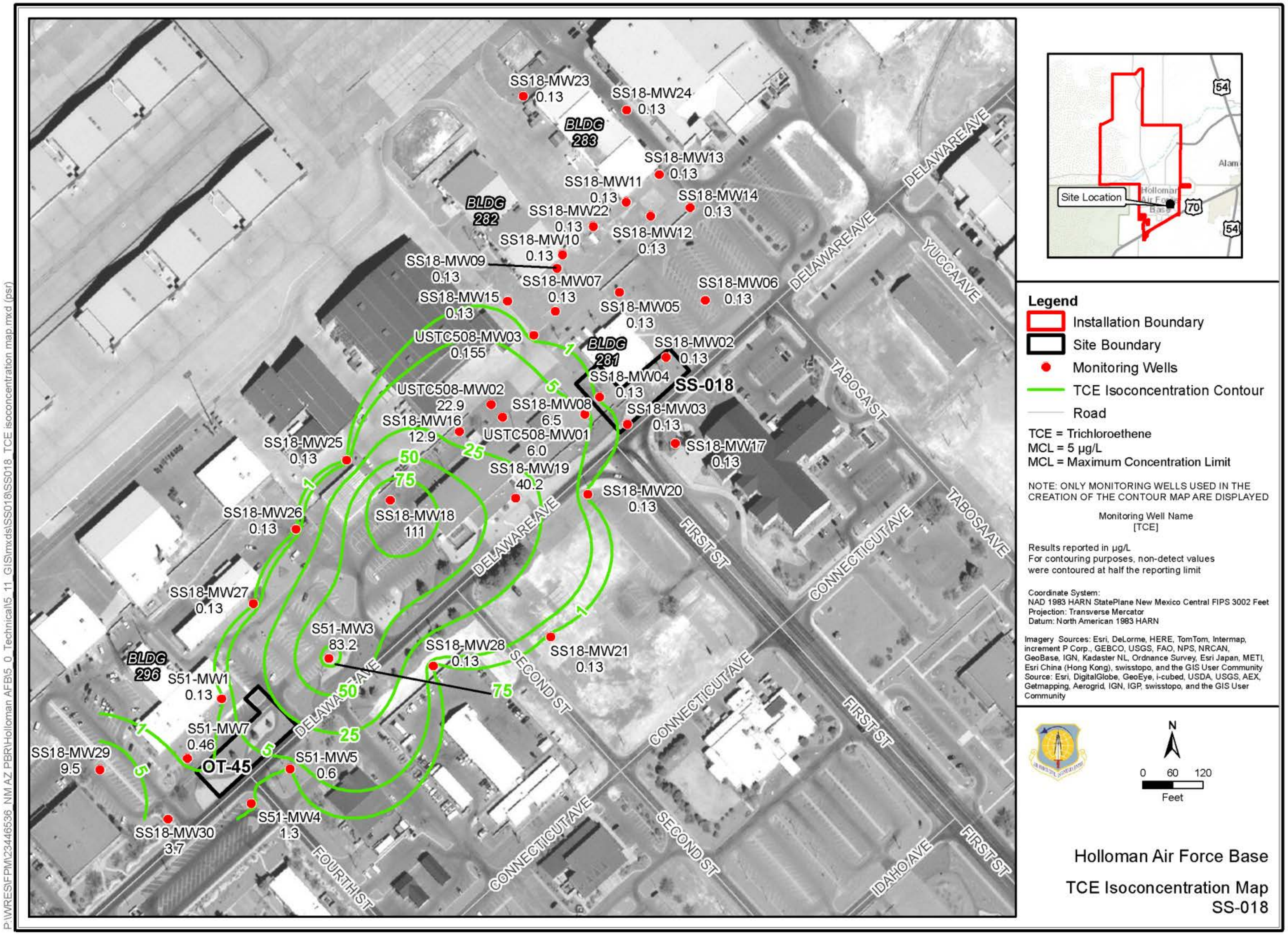

Figure 2-3. Trichloroethene Isoconcentration Map

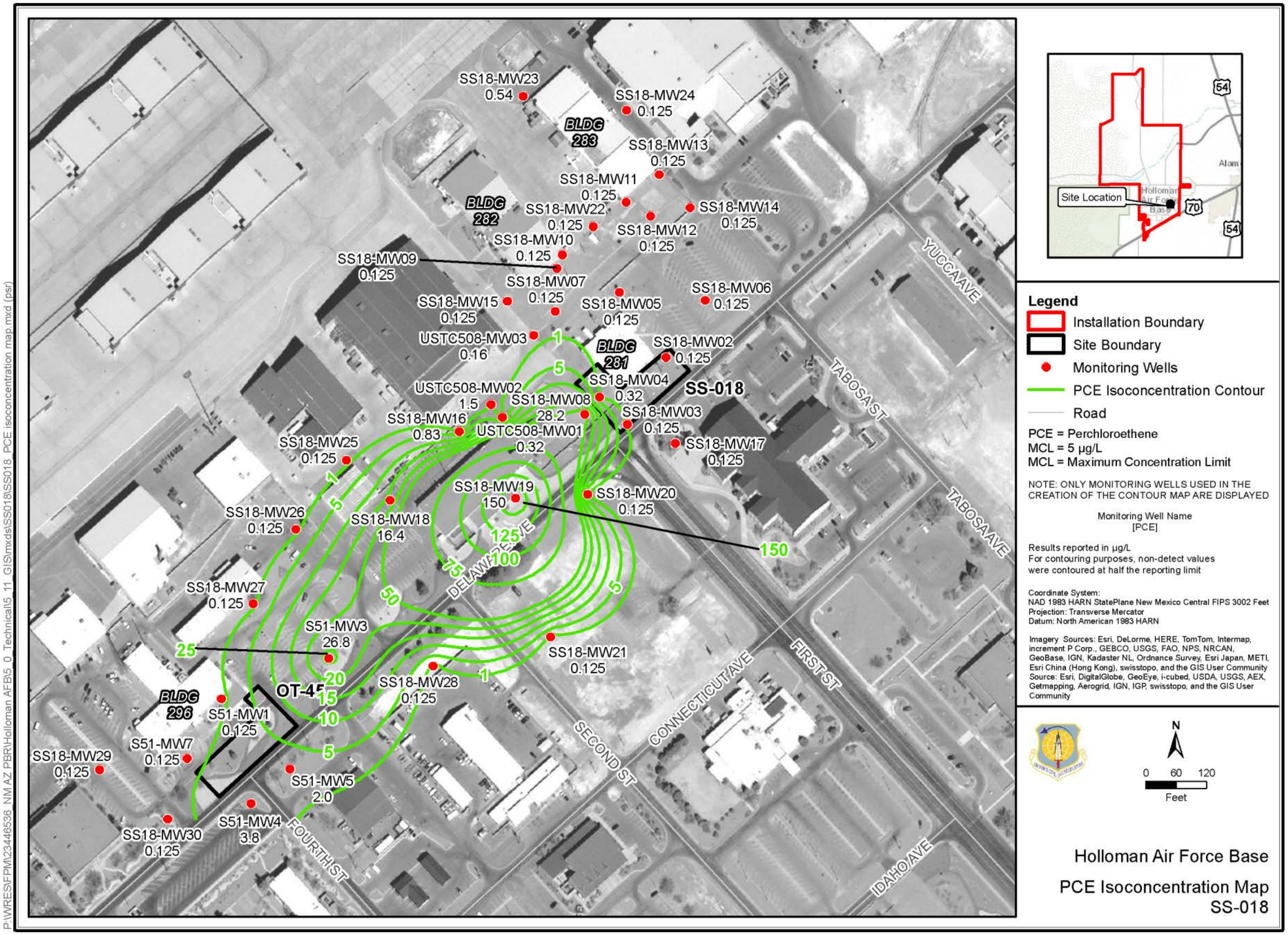

Figure 2-4. Tetrachloroethene Isoconcentration Map

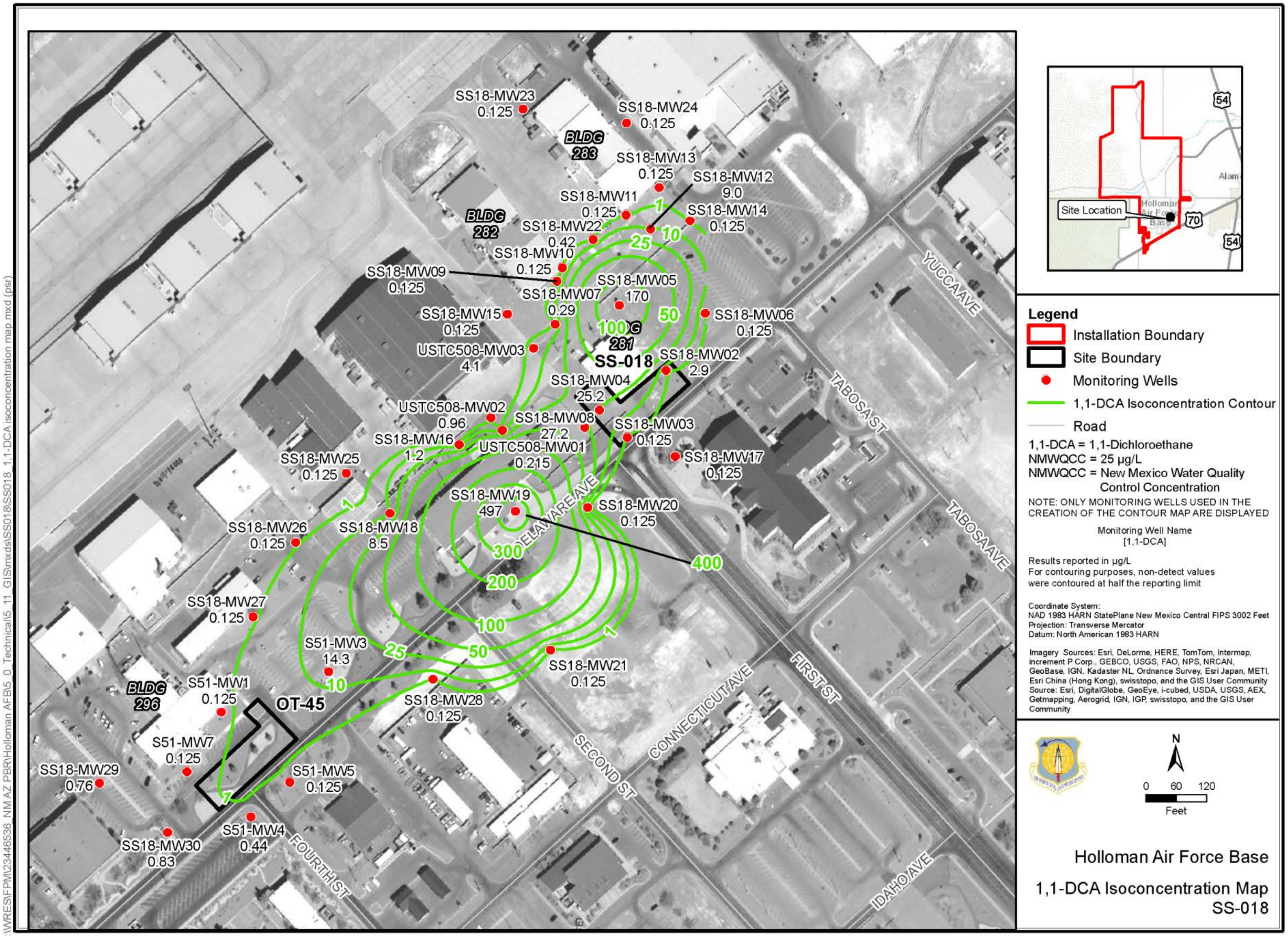

Figure 2-5. 1,1-Dichloroethane Isoconcentration Map

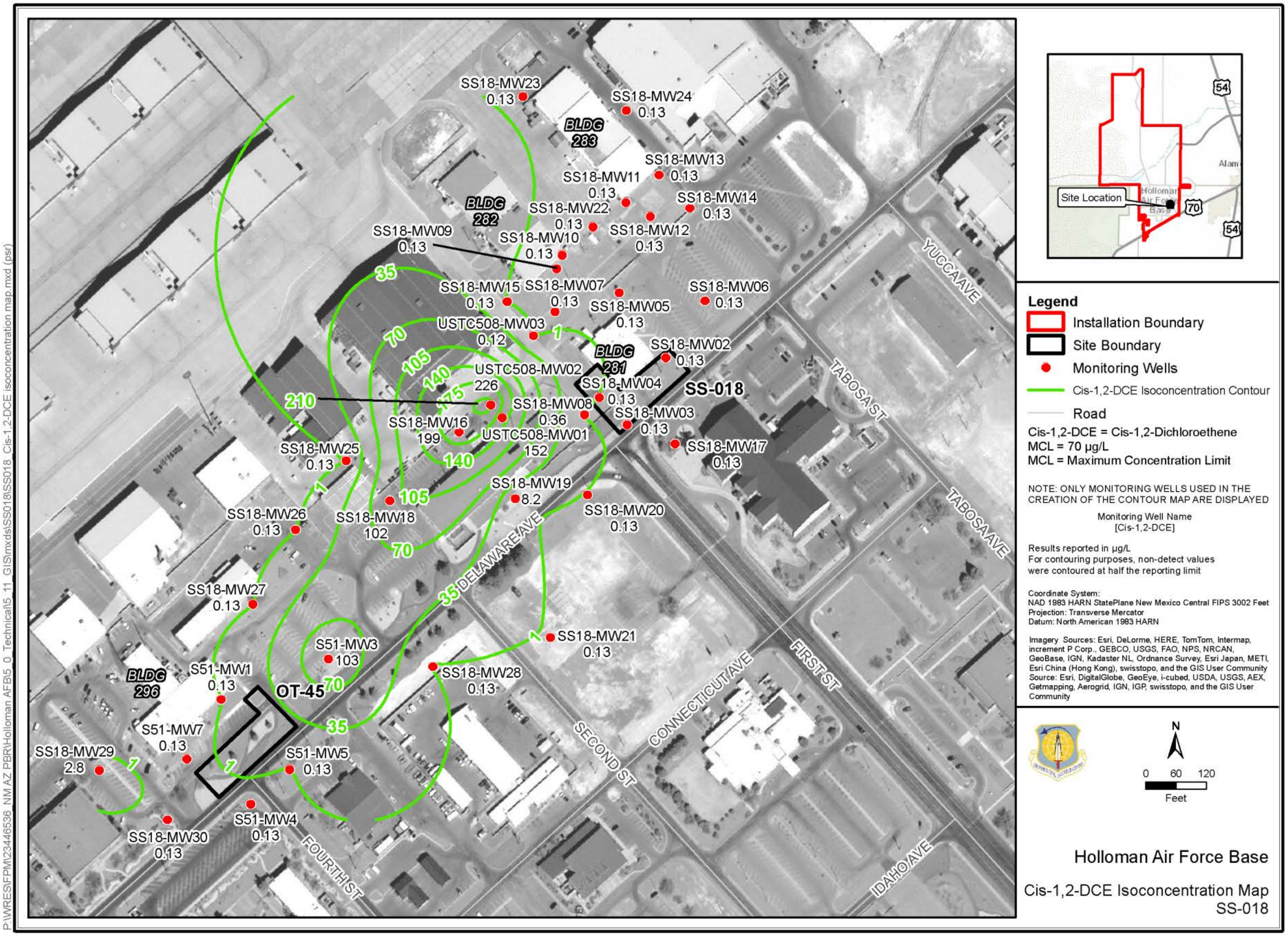

Figure 2-6. cis-1,2-Dichloroethene Isoconcentration Map

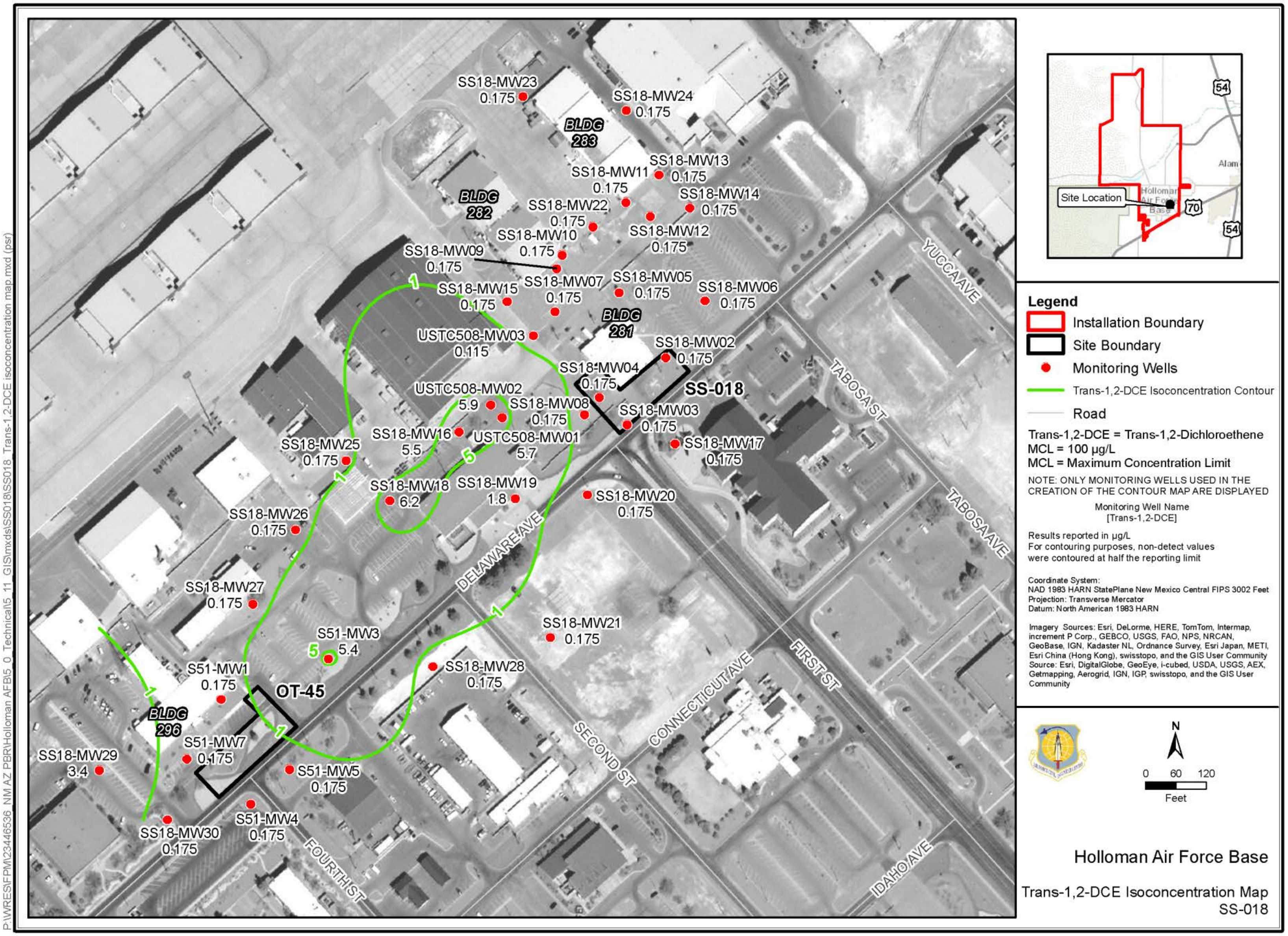

Figure 2-7. trans-1,2-Dichloroethene Isoconcentration Map

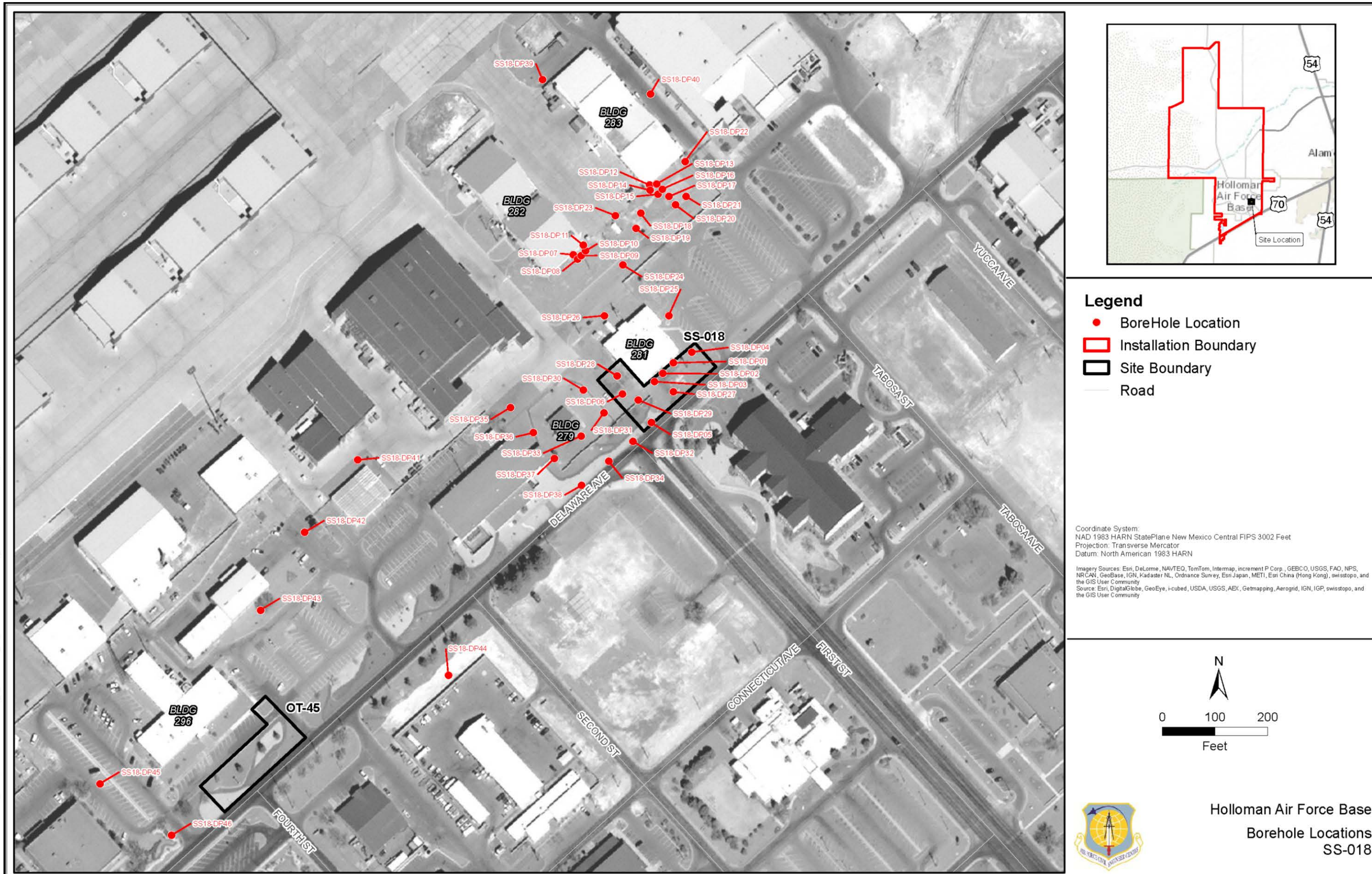

Figure 2-8. SS018 Borehole Locations

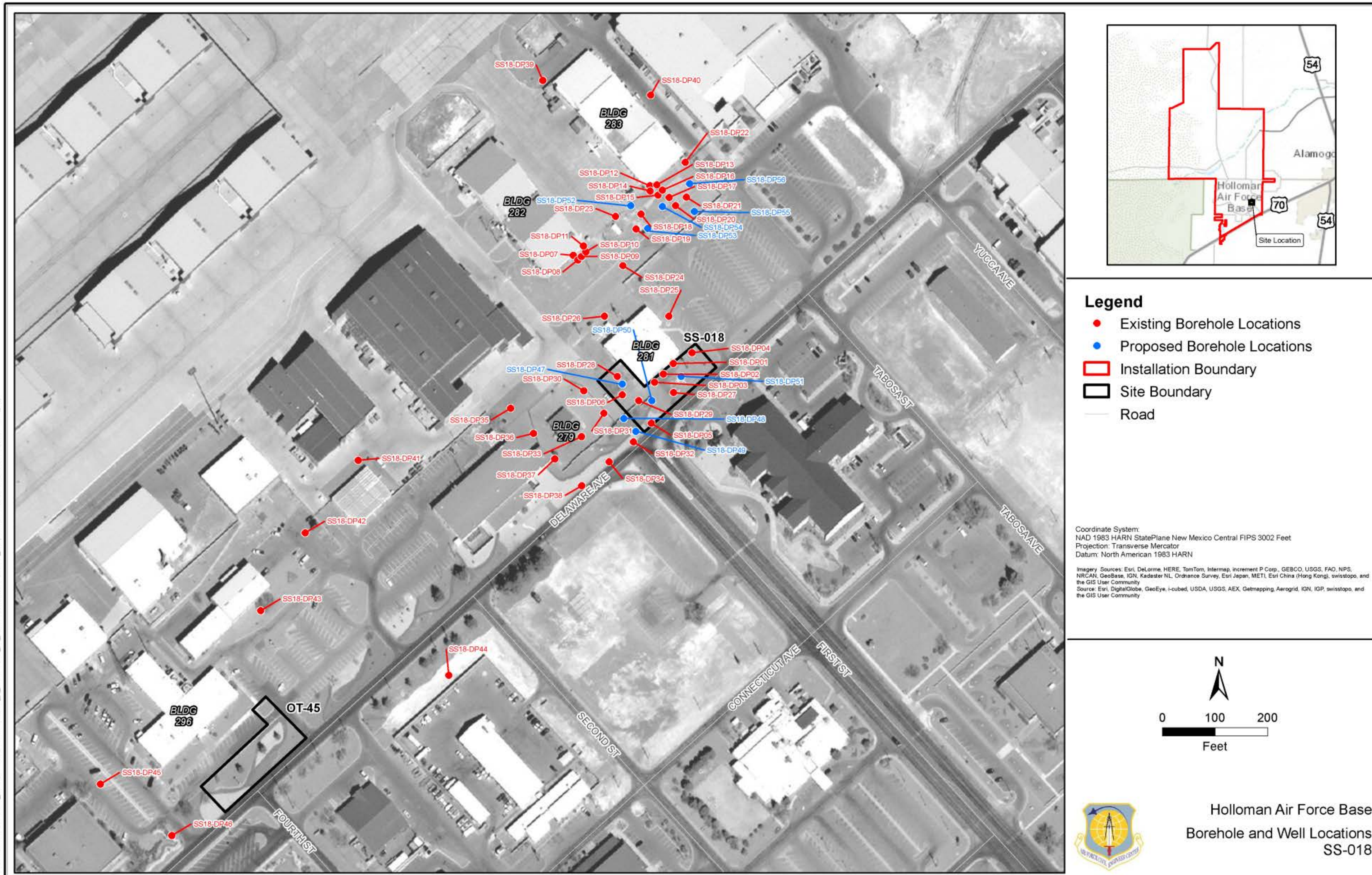

Figure 2-9. Proposed Borehole Locations

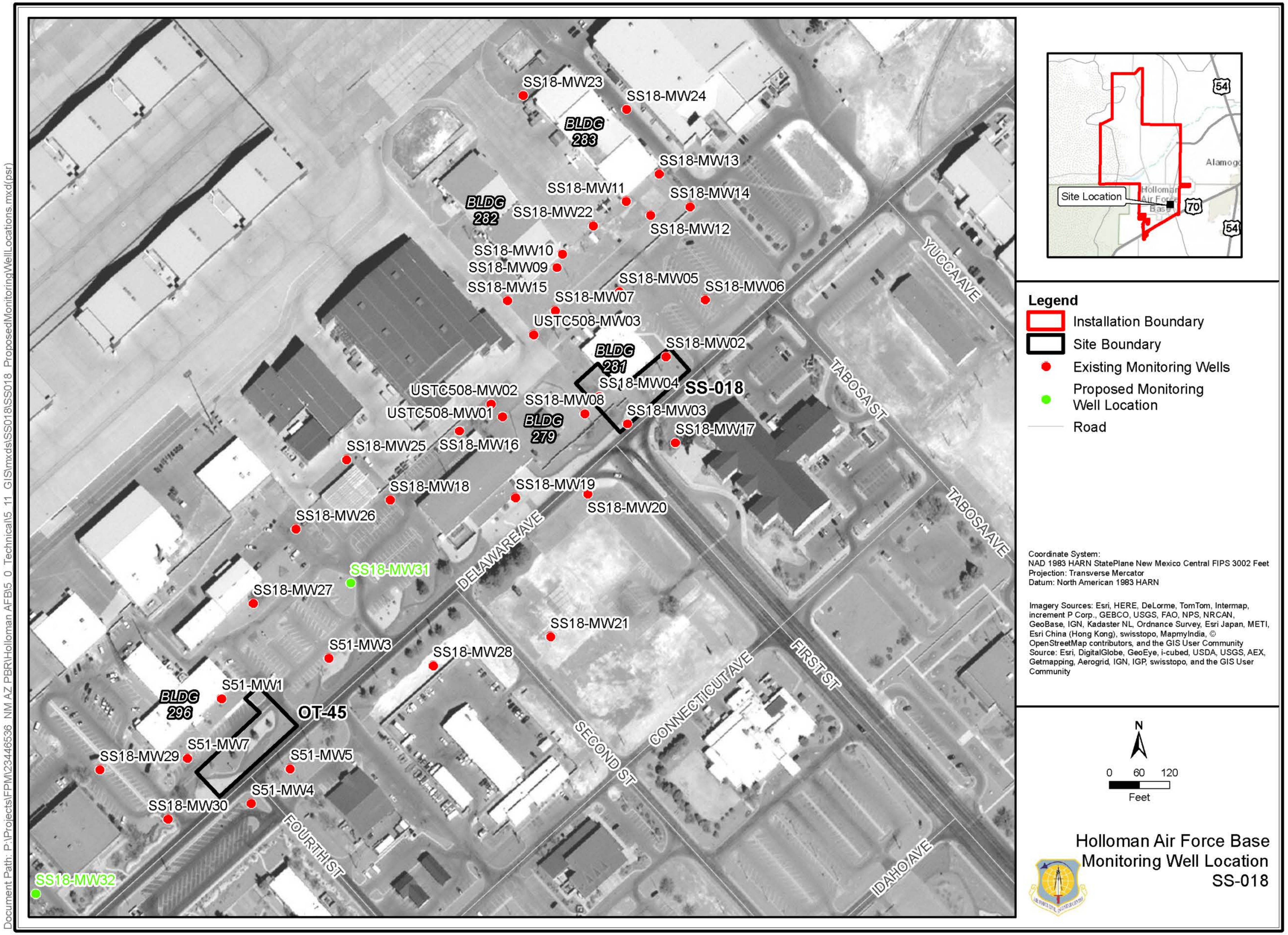

Figure 3-1. Proposed Monitoring Well Network

APPENDIX A

Procedures

This procedure provides technical guidance and methods to be used for measurement of groundwater and fluid levels in wells (well gauging). In addition to groundwater, fluid levels that are routinely monitored are light and dense non-aqueous phase liquids (LNAPL and DNAPL, respectively). Where possible, well gauging should be conducted first in areas least affected by Site constituents, followed by increasingly affected areas. Sampling locations are specified in the long-term monitoring plan. All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

The following equipment is may be used for the collection of fluid level data:

- Field log book
- Monitoring well gauging form (Attachment 1 to Appendix A-1)
- Electronic water level indicator with depth intervals marked to the nearest 0.01 feet
- Oil/water interface probe with depth intervals marked to the nearest 0.01 feet
- Weighted steel measuring tape with decimal foot increments (if depth to the bottom of the well is to be determined)
- Peristaltic pump (for evaluating the presence/absence of DNAPL)
- Standard hand tools (wrench, pliers, screwdrivers, cutting tools, etc.)
- Keys to well locks
- Decontamination equipment
- Appropriate health and safety equipment as required by the HASP
- Personal protective equipment (PPE) as required by the HASP

2.0 METHODOLOGY

The methodology for measuring groundwater levels, well depths, LNAPL levels, and DNAPL levels is provided below. The owner’s manual for the water level indicator meter and the oil/water interface probe shall be referenced to ensure proper operation of the instruments.

2.1 GROUNDWATER LEVEL MEASUREMENTS

Groundwater level measurements will be performed using a water level indicator meter that has been decontaminated in accordance with Appendix A-4. Efforts should be made to complete the groundwater level gauging event during one day. Should one day prove to be insufficient time, gauging shall be completed over further consecutive days, as necessary.

The following procedures will be followed to measure the depth to groundwater in wells:

1. Locate and open the monitoring well or piezometer. Sometimes vapor pressure builds up within the well casing due to the well cap restricting the ability of the well to vent to atmosphere. The pressure build up may depress the water/fluid level in the well. Allow fluid levels to equilibrate to atmospheric pressure for several minutes prior to gauging.

2. Check the operation of the water level indicator meter by turning on the indicator switch and pressing the test button.
3. Holding the water level meter above the well casing, lower the probe into the well until the indicator contacts the water surface. The contact with water is indicated by the buzzer sounding and illumination of the indicator light.
4. Record the point on the graduated cable that corresponds to the surveyed well casing measuring point when the alert is first produced. If necessary, grasp cable with thumb and index finger exactly at the measuring point marked at the top of the well casing. Pull tape out of well slowly and read measurement.
5. Record the depth to water surface to the nearest 0.01 ft on the gauging form.
6. Remove the water level cable and probe from the well. Inspect the probe for evidence of LNAPL. Evidence includes petroleum or solvent odor or a visible oil sheen or film on the probe. Record presence or absence of LNAPL on the gauging form (see Section 2.3 for instructions on LNAPL level measurements).
7. Decontaminate the water level probe in accordance with Appendix A-4.

2.2 MEASURING TOTAL DEPTH OF WELL

In situations where it is necessary to measure the total depth of a well (such as during well development, etc.), the following procedures may be followed:

1. Lower a weighted steel measuring tape slowly from center of well to sound the bottom of the well. Sounding the bottom of the well prior to sampling of the well is not recommended due to the potential for re-suspension of settled formation solids in the well.
2. When the weight is felt to hit the bottom or tape slackens noticeably, draw tape up very slowly until it is taut again.
3. Record the well depth at the surveyed well casing measuring point to the nearest 0.1 feet.
4. A water-level indicator or oil/water interface probe may also be used; however, the depth measured on the tape may reference a point other than the tip of the probe. In this case, a measurement from the tip of the probe to the measuring point should be made and that length added to the total measured depth.

2.3 LNAPL LEVEL MEASUREMENTS

The following steps will be followed to measure the thickness of LNAPL in wells:

1. LNAPL level measurements will be preceded by groundwater level measurements. Complete Steps 1 through 8 of Section 2.1 prior to measuring LNAPL levels.
2. Use a clean oil/water interface probe that has been decontaminated in accordance with Appendix A-4.

3. Lower the oil/water interface probe into the well until the air/LNAPL interface is detected by the instrument. Record the depth relative to the well casing measuring point to the nearest 0.01 foot on the well gauging form or in the field logbook.
4. Continue to lower the oil/water interface probe in the well to detect the oil/water interface. Once the instrument detects the water surface, continue to lower the probe approximately one foot and gently raise the probe up and down in the water column to rinse off LNAPL that has adhered to the probe that may affect the reading. Then slowly raise the probe to detect the water/oil interface and record the depth relative to the well casing measuring point to the nearest 0.01 foot on the well gauging form or in the field logbook. *Note: If the thickness of LNAPL is small enough that the lower bound of LNAPL cannot be measured with the oil/water interface probe, then record this observation as a film or sheen on the fluid level gauging form or field logbook.*
5. If gauging of DNAPL level is also to be performed in the well, proceed to Section 2.4. If not, proceed to Step 6 below.
6. Remove the oil/water interface cable and probe from the well.
7. Decontaminate the oil/water interface probe and cable in accordance with Appendix A-4.

2.4 DNAPL LEVEL MEASUREMENT

The oil/water interface of DNAPL in a well, if present, will be estimated using the following procedures:

1. DNAPL level measurements will be preceded by groundwater level measurements (Section 2.1) and LNAPL level measurements (Section 2.3), if LNAPL exists in the well.
2. After measuring the thickness of LNAPL in the well (if present), lower the oil/water interface probe in the well until DNAPL is encountered, if any. Measure the depth to the water/oil interface of DNAPL in the same manner as that for air/oil interface of LNAPL, as described in Section 2.3 above.
3. A high suspended solids content at the bottom of a well has been found to produce false positive results for the detection of DNAPL with an oil/water interface probe. Therefore, if DNAPL is detected using an oil/water interface probe, a peristaltic pump, or similar methods, should be used to confirm the presence or absence of DNAPL. About one pint of fluid may be pumped from the bottom of the well for visual inspection of the presence or absence of DNAPL.
4. The results of the visual inspection will be recorded on the well gauging form or in the field logbook.
5. Peristaltic pump tubing, if not dedicated, will be disposed of in accordance with IDW handling specified in Appendix A-6. The oil/water interface probe and cable will be decontaminated in accordance with Appendix A-4.

3.0 DOCUMENTATION

Documentation during well purging and sampling will be in accordance with Appendix A-5. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on a well gauging form and in the field logbook.

3.1 FIELD NOTES

The following information will be recorded in a bound field logbook using indelible ink:

- Names of gauging personnel
- Weather conditions
- Date
- Start time of gauging
- End time of gauging
- Gauging locations
- Gauging equipment used
- Any significant difference in time between gauging individual wells
- Decontamination records
- Any other pertinent information

3.2 FIELD FORMS

A well gauging form will be completed for each day of gauging. The form will contain entries for each well gauged during that day. The following information will be recorded:

- Project name / number
- Location
- Date
- Gauging personnel
- Monitoring well identification numbers
- Static LNAPL depths (if any)
- Static water depths
- Static DNAPL depths (if any)
- Well depth (sounding), if measured

Attachment 1

Water Level Measurement Form

URS

8181 E. Tufts Avenue
Denver, Colorado 80237
Tel: 303.694.2770
Fax: 303.694.3946

Groundwater Level Measurement Form

Date: ________________

Page

________ of ________

Project Name: ________________________________ **Location:** ________________________________

Project Number: ________________________________ **Measured By:** ________________________________

Well ID	TOC Elevation (ft MSL)	LNAPL Depth (ft bTOC)	Water Depth (ft bTOC)	DNAPL Depth (ft bTOC)	Comments

Casing Volume

Casing I.D. (in.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
1.5	0.09
2.0	0.16
2.2	0.20
3.0	0.37
4.0	0.65
4.3	0.75
5.0	1.00
6.0	1.55
7.0	2.00
8.0	2.60

Additional Remarks

This procedure provides technical guidance and methods that will be used for monitoring well purging and groundwater sampling using low-flow sampling methods. The samples will be analyzed to provide data on the presence and concentration of Site constituents in groundwater on the site. The procedures outlined herein are accordance with groundwater sampling methods recommended by the U.S. Environmental Protection Agency (EPA) (1992, 1996). Details on site-specific sampling activities, equipment selection (i.e., pumps), site-specific field parameters, and laboratory analyses are presented in the Work Plan and/or the Quality Assurance Project Plan (QAPP).

This procedure will provide descriptions of equipment, field procedures, and documentation necessary to properly collect groundwater samples for laboratory analysis. Sampling locations are specified and shown in the long-term monitoring plan.

All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

- Field log book
- Electronic water level indicator or interface probe
- Peristaltic pump, bladder pump, centrifugal pump, bailer, or submersible pump
- Appropriate power source and cords for pump (i.e., generator, compressor, or inverter)
- Flow-rate controller for pump, as applicable
- Graduated cylinder or other volumetric measuring device
- Plastic sheeting or other clean work surface
- Disposable polyethylene discharge tubing
- Disposable Pharmed®, Tygon®, or equivalent tubing (for peristaltic pump only)
- Water quality meters (at a minimum pH, conductance, and temperature; ORP, and turbidity may also be used)
- New disposable or decontaminated stainless-steel bailer, if specified in the Work Plan
- Rope or twine: nylon, polypropylene, or similar
- Watch
- Purge water collection system (bucket(s) with lid(s), drum, etc.)
- Standard hand tools (wrench, pliers, screwdrivers, cutting tools, etc.)
- Keys to well locks
- Decontamination equipment per Appendix A-4
- Appropriate health and safety equipment as required by the HASP
- Personal protective equipment (PPE) as required by the HASP

- Paper towels
- Copies of well drilling and installation records, including boring logs and well completion diagrams for the wells to be sampled
- 0.45-µm in-line filter or other appropriate filtering approaces (for dissolved constituents only), if applicable
- Flow-through cell
- Sample containers (including temperature blanks)
- Sample labels
- Sample logs / well sampling forms
- Chain of custody forms
- Custody seals
- Shipping labels / AirBills
- Strapping / shipping tape
- Garbage bags
- Ziploc®, or similar, bags
- Cooler(s)
- Ice

2.0 PURGING AND SAMPLING METHODOLOGY

Groundwater sampling incorporates several phases of multiple steps in order to achieve the highest possible accuracy and precision of laboratory analytical results. Proper preparation, purging, and sampling techniques greatly reduce the risk of cross-contamination or other unwanted variances of the analytical data. Where possible, sampling should be conducted first in areas least affected by Site constituents, followed by increasingly affected areas. The proper information will be recorded in the field log book or well sampling form as specified in Section 3 of this procedure.

2.1 PREPARATION FOR SAMPLING

Preparation for sampling includes inspecting the condition of the well, monitoring health and safety conditions, and calibrating and decontaminating sampling equipment. General procedures are presented below:

1. Make sure area around well head is clean and free of debris.
2. Inspect condition of well (e.g., well locked, loose-fitting cap, measuring point well marked, surface casing disturbed, well casing straight, condition of concrete pad). Indicate condition of well on the sampling form.

3. Remove well cap. If the HASP identifies organic compounds as potential contaminants of concern and requires breathing zone monitoring, screen well headspace and breathing zone headspace for organic vapors using the appropriate field monitoring instrument.
4. All equipment should be decontaminated in accordance with Appendix A-4 before introduction to each well. Protective latex or nitrile gloves should be worn during possible water-contact or equipment-contact activities. At a minimum, gloves should be changed between each well or when introduction of potential contaminants to the well is possible.
5. Measure water level using a decontaminated electronic water level meter as described in Appendix A-1. Sounding the bottom of the well using a weighted tape (i.e., for well casing volume calculations) prior to sampling is not recommended due to the potential for resuspension of settled solids in the formation. Well depth information should be obtained from the well logs or collected after sampling activities are complete, if possible.
6. If light non-aqueous phase liquid (LNAPL) is suspected, measure fluid level in accordance with Appendix A-1.
7. Calculate the well casing volume as follows:

   $$\text{well casing volume (gal)} = \pi\,(r^2)(h)(7.48\ \text{gal/ft}^3)$$

   Where h = height of water in the well casing (i.e., depth to bottom of the well minus depth to water (in ft), and r = radius of well casing in feet. Record this volume on the well sampling form.
8. Calibrate water quality meters for measuring field parameters as specified by the equipment manufacturer(s). At a minimum, temperature, pH, and specific conductance measurements will be collected during purging and prior to sampling; however, do not immerse water quality meter probes into purge water containing free product. Other field parameters, including dissolved oxygen, Eh (redox, ORP), and turbidity (recommended for inorganics), etc. may be required as specified in the Work Plan. Record equipment calibration and maintenance in the field book. Decontaminate meters between wells by rinsing with distilled water. Manage rinse water used for these measurements in the same manner as purge water, as defined in the Work Plan.

2.2 WELL PURGING METHODS

Monitoring wells will be purged prior to collecting groundwater samples for analyses. Low flow purging procedures (EPA 1996) generally will be followed; however, certain wells or sites may also be sampled by purging three well volumes of groundwater prior to sample collection. The purpose of well purging is to remove stagnant groundwater from the well (which has interacted with air in the well casing). Field parameters (i.e., pH, temperature, and specific conductance) are measured during the purging process to verify that stagnant water has been removed and groundwater conditions are stable prior to sampling. A variety of pumps may be used to purge and sample the monitoring well: the pump type will be specified in the Work Plan. Refer to the manufacturer's instructions for operation of the specified pump. General procedures for purging are outlined below:

1. Lower the pump intake, bailer, or tubing (as applicable) into the water column. The pump intake or tubing should be placed at the middle or slightly above the bottom of the screened interval.
2. For low-flow purging, conduct purging at a rate that will minimize drawdown in the well (i.e., purge at a rate less than or equal to recharge, if possible). Recommended purge rates are generally less than 0.13 gal/min (0.5 L/min), or a rate that results in minimal drawdown in the well (e.g., less than 1 foot). Actual purge rates will vary based on aquifer material and well construction.
3. Continue purging the well until field parameters have stabilized within 10 percent, according to Appendix A-3. Once field parameters have stabilized, reduce the pump rate to approximately 0.025 to 0.13 gal/min (0.1 L/min to 0.5 L/min). The pump should continue to operate at the lower rate to allow the water collected at that rate to travel to the surface discharge point.
4. In the event that even very low purge rates result in evacuation of the well, groundwater samples for laboratory analyses should be collected as soon as sufficient groundwater accumulates in the well, regardless of field parameters or total volume purged.
5. If the three-volume purge method is utilized, field parameters will be recorded after each well volume of groundwater is purged.

2.3 GROUNDWATER SAMPLING METHODS

Groundwater sampling is conducted following purging of the well. Where possible, groundwater samples for analyses should be collected directly from the pump discharge at the lowest rate possible to minimize cross contamination, suspension of solids, and aeration of the sample. Bladder pumps, peristaltic pumps, and submersible pumps (e.g. Grundfos®, Whale, Typhoon) are generally suitable for purging and sampling of all groundwater parameters. Bailers are generally not recommended for purging or sampling of groundwater monitoring wells due to the potential for agitating solids in and adjacent to the well; however, the three-volume purge method often uses bailers, especially when turbidity of the groundwater is not a concern.

Target analytes, container types, and preservatives are specified in the Work Plan, or QAPP.

The general procedures for groundwater sample collection are as follows:

1. Groundwater samples should be introduced directly from the pump discharge into the proper sample container and filled to capacity.
2. In general, groundwater samples collected for multiple compounds should be collected in the following order (EPA 1992):
   - VOCs
   - Dissolved gases and total organic carbon (TOC)
   - SVOCs
   - Metals and cyanide
   - Major water quality cations and anions

- Radionuclides
- Other analytes

3. When collecting samples for VOCs, direct flow from the pump discharge down the interior side of the sample container to minimize aeration. Hold caps in hand to minimize contamination of sample. Fill all VOC sample containers to the top. A positive meniscus at the top of the container will help ensure that no air is trapped inside when cap is screwed down on the container. No air bubbles should be trapped in the sample when the container is sealed.
4. In some cases, field filtration may be required (recommended for dissolved metals). If applicable, attach a new, disposable filter cartridge (typically 0.45 µm) to the discharge line. Filtered water should be introduced directly into the appropriate sample container. Alternate field filtration methods may be specified in the Work Plan or QAPP. *Although not recommended, the laboratory can sometimes filter the samples if the samples are NOT preserved and are filtered within 24–48 hours of collection.*
5. Collect quality assurance and quality control (QA/QC) samples (i.e., field duplicate, laboratory matrix spike, and laboratory matrix spike duplicate, as applicable) at the same time by filling all bottles from the same flow. Ambient or field blanks should be filled using distilled or de-ionized (DI) water (supplied by the laboratory) in the same area as the primary samples. The number and types of QA/QC samples are specified in the Work Plan or QAPP.
6. Sample bottles must be labeled with date, sample number, time, sampler's name, and type of preservative, as described in the QAPP. Sample bottles must be placed in a cooler or on ice to keep the sample cool (≤6 °C). Samples must be cooled continuously from time of collection to time of receipt at the laboratory.
7. Disconnect the peristaltic pump from the dedicated tubing in the well. If using a submersible pump, remove the pump and tubing from the well. Close and lock the well. Decontaminate the sampling equipment in accordance with Appendix A-4. Purge, wash, and rinse water should be managed as specified in the Work Plan.
8. Complete chain-of-custody forms, package samples for shipment, and ship samples or arrange for courier to laboratory.
9. All field observations made and data generated in conjunction with the sample collection will be documented on the groundwater field sampling form.

3.0 DOCUMENTATION

Documentation during well purging and sampling will be in accordance with the work plan. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on a well sampling form and in the field logbook.

3.1 FIELD NOTES

The following groundwater purging and sampling information will be recorded in a bound field logbook using indelible ink:

- Names of sampling personnel
- Weather conditions
- Date and time of sampling
- Sampling locations, including locations of QA/QC samples
- Start and stop time for each well sampled
- Decontamination and calibration records
- Other information as specified in the Work Plan
- Any other pertinent information that may have a bearing on sample quality

3.2 FIELD FORMS

A well sampling form will be completed for each well sampled. The following information will be recorded:

- Project name / number
- Location
- Date
- Sampling personnel
- Monitoring well identification number
- Static water depth
- Well depth and diameter
- Water column thickness and well volume, if necessary
- Depth of pump or tubing intake
- Time of purge monitoring readings
- Sample time
- Identification of QA/QC samples
- Sampling equipment (pump and tubing types, etc.)
- Sampling pump rate

4.0 REFERENCES

EPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste, Washington, DC EPA/530/R-93/001, NTIS PB 93-139350, November.

EPA. 1996. Low-flow (minimal drawdown) ground-water sampling procedures, by R.W. Puls and M.J. Barcelona. U.S. EPA Ground Water Issue: EPA/540/S-95/504, April.

Attachment 1

Example of Well Sampling Form

8181 E. Tufts Avenue
Denver, Colorado 80237
Tel: 303.694.2770
Fax: 303.694.3946

Groundwater Sample Collection Form

Well Identification _______________

Project Name: ______________________ **Sampled By:** ______________________
Project Number: ______________________ **Sample ID:** ______________________
Location: ______________________ **Sample Date:** ______________________
Date: ______________________ **Sample Time:** ______________________

Equipment

Purging Method/Equipment ______________________
Sampling Equipment ______________________
Filtering Equipment ______________________

Field Parameters

Initial Water Temp. (C) ______________
Initial pH: ______________
Initial Conductance (mS/cm): ______________
Reference Point ______________

Sampling Packaging

Number	Type and Volume of Container(s)	Filtered	Preservatives	Parameters

Purging Information

Casing I.D. [a] (in.): ______________
Unit Casing Volume [b] (gal/ft) ______________
Depth to Water [c] (ft, bgs): ______________
Depth to Bottom of Well [d] (ft, bgs): ______________

Length of Static Water Column [e] = [d] - [c] (ft): ______________
Casing Water Volume [f] = [b] x [e] (gal) ______________
Total Purged Volume [g] (gal): ______________
Number of Purged Volumes [h] = [g] / [f]: ______________

Volume Purged (gal)	Temp (C)	pH	Conductance (mS/cm)	Time	DO (mg/L)	Turbidity (NTU)	Water Description

Total Volumes Removed (gallons): ________ **Time:** ___________ **Purged Dry (Y/N):** ___________

Casing Volume

Casing I.D. (in.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
1.5	0.09
2.0	0.16
2.2	0.20
3.0	0.37
4.0	0.65
4.3	0.75
5.0	1.00
6.0	1.55
7.0	2.00
8.0	2.60

Additional Remarks

This procedure provides technical guidance and methods that will be used for field measurement of water quality parameters (e.g., pH, specific conductance, oxidation-reduction potential, dissolved oxygen, and temperature) in the field. The measurements will be taken to provide data on the general quality of surface water and groundwater, as well as to verify the presence of non-stagnant groundwater during monitoring well sampling. The procedures outlined herein are in accordance with groundwater sampling methods recommended by the U.S. Environmental Protection Agency (U.S. EPA 1992, 1996). Details on Site-specific sampling activities are presented in the Work Plan. Where possible, field parameter measurement should be conducted first in areas least affected by Site constituents, followed by increasingly affected areas.

This procedure will provide descriptions of equipment, field procedures, and documentation necessary to properly measure selected field parameters. Due to the variety and complexity of water quality meters available, calibration and measurement procedures should be conducted in accordance with manufacturer's recommendations for specific meters used.

All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

- Field log book
- Water quality parameter multimeter or meters specific to parameters of interest (i.e., pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature, and turbidity)
- 250- to 500-mL beakers or flow-through cell for groundwater
- Calibration solutions and deionized distilled water
- Sample logs / well sampling forms
- Sampling equipment

2.0 METHODOLOGY

Calibrate meter(s) in the field at the beginning of each day of field or laboratory work when water quality parameters will be measured. Check meters with calibration standards after every four hours of continuous use. If drift is evident, recalibrate. Record appropriate information in accordance with Section 3 of this procedure.

The measurement of surface water and groundwater field parameters will be conducted in the following steps:

1. Fill multimeter cell, beaker, or jar with fresh sample water.
2. Immerse electrodes in sample while swirling the sample, if needed, to provide thorough mixing. If a flow-through cell is used, install probes and connect sample water to bottom port of flow-through cell, directing sample water up through the cell, exiting through the top port. Direct effluent tubing into an appropriate container for storage and handling.
3. When the readings have stabilized, record the measurements displayed on the meter. It is important to determine that the correct units and unit scale are displayed on the meter and

recorded for each parameter measured. Record and correct any problems encountered during measurement. Note: parameter measurements may not stabilize for a given measurement when using a flow-through cell- professional judgment should be used when selecting parameters to be recorded in this case.

4. If available, field measurement results should be compared to previous measurements for quality control.

3.0 DOCUMENTATION

Documentation during water quality parameter measurement will be in accordance with the work plan. Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on a sampling log (i.e., well sampling form) and in the field logbook.

3.1 FIELD NOTES

The following water quality parameter measurement information will be recorded in a bound field logbook using indelible ink:

- Names of sampling personnel
- Weather conditions
- Decontamination and calibration records
- Other information as specified in the Work Plan
- Any other pertinent information that may have a bearing on data quality

3.2 FIELD FORMS

A well sampling form will be completed for each well location where field water quality parameters are measured. The following information will be recorded:

- Project name / number
- Location
- Date and time of parameter measurement
- Sampling personnel
- Monitoring well identification number or sampling location
- Static water depth
- Depth of pump or tubing intake
- Water quality measurement equipment (meter model, etc.)
- Sampling locations, including locations of QA/QC samples

4.0 REFERENCES

U. S. EPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste, Washington, DC EPA/530/R-93/001, NTIS PB 93-139350, November.

U.S. 1996. Low-flow (minimal drawdown) ground-water sampling procedures, by R. W. Puls and M.J. Barcelona. U.S. EPA Ground Water Issue: EPA/540/S-95/504, April.

This procedure details the procedures for decontamination of personnel and equipment during field activities. Decontamination of personnel and equipment (e.g., water and soil sampling equipment, vehicles, etc.), is required to minimize the possibility of cross-contamination of environmental samples between sampling locations. In addition to this procedure, refer to the site-specific Health and Safety Plan (HASP) for additional requirements regarding decontamination procedures.

1.0 EQUIPMENT

The following is a list of equipment that may be necessary to perform decontamination activities:

- Personal protective equipment (PPE) as outlined in the HASP
- Paper towels
- Alconox® / Liquinox® detergent (or equivalent)
- Potable or non-potable water
- Deionized or distilled water
- Water sprayers or hand-held spray bottles
- Disposable nitrile gloves
- Clean plastic sheeting, and/or trash bags

2.0 DECONTAMINATION PROCEDURES

Section 2 describes decontamination of sampling equipment that may be utilized to prevent cross-contamination between sampling locations. Decontamination procedures to be implemented for the protection of worker and public health, safety, and the environment are also set forth in the following section. Different types of decontamination may be necessary for the following:

- Soil sampling equipment;
- Water sampling equipment;
- Instruments; and
- Vehicles and personnel.

2.1 DECONTAMINATION OF SAMPLING EQUIPMENT

The procedures in this section are designed to prevent cross-contamination of samples collected in different sample locations. Procedures for decontamination of sampling equipment apply to equipment that is re-usable (e.g. funnels and shovels) and contacts a sampled medium (e.g., water). Decontamination of sampling equipment may be performed at each sample collection location upon completion of sampling.

General requirements for decontamination are listed below:

- Personnel may wear appropriate safety equipment to reduce personal exposure, as required by the HASP.
- New nitrile gloves may be worn when performing equipment decontamination.
- Detergent and rinse solutions to be used for decontamination procedures may be replaced with new solutions between sample collection events unless the solution is stored in a water sprayer.
- Bulk contamination, such as large pieces of soil, may first be removed by hand or tools.
- Equipment may then be washed in a detergent/water solution, using brushes and other tools, as appropriate, until clean. The water used may be clean and may be potable, non-potable, deionized, or distilled.
- Washed equipment may be rinsed first by potable water, or by deionized/distilled water, if potable water is not available.
- A final rinse may be by deionized or distilled water.
- Equipment may be inspected for visible contamination and washed again if necessary.
- Equipment may be dried and stored in a clean location. Air-drying is an acceptable method for most equipment.

2.2 DECONTAMINATION OF PERSONNEL

The procedures in this section are designed to protect the worker and public health, safety, and the environment. Procedures for decontamination of personnel apply to any person (including clothing) who is exposed to contaminated site material such as groundwater or soil. Decontamination of personnel may be performed prior to leaving the site, or as necessary to protect health and safety.

General requirements for decontamination are listed below:

- Personnel may wear appropriate safety equipment to reduce personal exposure, as required by the HASP.
- Bulk contamination, such as large pieces of soil, may first be removed by hand or tools, with special attention to boots and coveralls.
- Personnel and clothing may then be washed with a detergent/water solution, using brushes and other tools, as appropriate, until clean. The water used may be clean and may be potable, non-potable, deionized, or distilled.
- Following washing, a water rinse may be conducted to flush contaminated media and detergents from the affected area.

2.3 DECONTAMINATION OF VEHICLES

The procedures in this section are designed to protect the worker and public health, safety, and the environment. Procedures for decontamination of vehicles apply to any vehicle or piece of heavy equipment that is exposed to contaminated site material such as groundwater or soil. Decontamination of vehicles may be performed prior to leaving the site, or as necessary to protect health and safety.

General requirements for decontamination are listed below:

- Personnel may wear appropriate safety equipment to reduce personal exposure, as required by the HASP.
- Bulk contamination, such as large pieces of soil, may first be removed by hand or tools, with special attention to tires or tracks, wheel-wells, and compartments such as dump truck beds and excavator or backhoe buckets.
- A rinse with water may be conducted to flush contaminated media from the affected area. If necessary, a high-pressure washer and/or detergent solution may be used to remove contaminated media.

2.4 INVESTIGATION DERIVED WASTE MANAGEMENT

Solid and liquid IDW generated during decontamination procedures may be managed as described in Appendix A-6 for IDW.

Solid IDW generated during decontamination procedures may consist of: (1) PPE used during the decontamination process and (2) disposable material used to decontaminate equipment.

Liquid IDW may generally consist of wash/rinse water, and may contain a substantial amount of solids. It is permissible, after solids settle, to decant clear water from such a container to another IDW container, thus separating solid and liquid IDW.

3.0 DOCUMENTATION

Sampling personnel may document the decontamination that occurs within a sample collection site in the field log book. The information entered in field log books concerning decontamination may include the following:

- Decontamination personnel
- Date/time
- Location
- Type of containment for decontamination fluids
- Other pertinent information

This procedure provides technical guidance and methods that will be used for sample identification, labeling, packing, documentation, and Chain-of-Custody (COC) procedures. All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT NECESSARY FOR SAMPLE HANDLING, SHIPPING, AND DOCUMENTATION

The following equipment may be used for sample labeling, packing, documentation, and COC procedures:

- Personal protective equipment (PPE) as specified in the Health and Safety Plan (HASP)
- Decontamination equipment and supplies
- Clean sample containers with preservatives, if required.
- Shipping coolers
- Re-sealable plastic bags (Ziplock® or equivalent)
- Sample labels
- Shipping forms (provided by shipping courier)
- Shipping labels (e.g. Fragile, This Side Up, etc.)
- Chain-of-Custody forms
- Custody seals
- Bubble wrap or equivalent packing material
- Tape (e.g., clear tape, strapping/packing tape)
- Ice or other refrigeration method
- Paper towels
- Large trash bags

2.0 SAMPLE IDENTIFICATION

Each sample collected will have a unique sample identification (ID). These IDs are necessary to identify and track each sample collected for analysis during the project. Accurate and comprehensive sampling records are necessary to create a complete record of field procedures, including circumstances of collection and integrity of a given sample.

3.0 SAMPLE HANDLING, SHIPPING, AND DOCUMENTATION PROCEDURES

3.1 FIELD SAMPLE PROCESSING AND CUSTODY

A Chain-of Custody (COC) for each sample will be maintained and documented from the sampling location through its delivery to the laboratory for analysis. Each sample must be in the custody of the sampling team or Sample Manager from the moment it is extracted and containerized until sample shipment. Samples will be containerized and labeled at the sample collection location. Samplers may relinquish containerized samples to the Sample Manager for completion of the documentation and preparation of the samples for shipment. Changes in custody (e.g. from sampler to Sample Manager) will be documented in logbooks that identify the personnel relinquishing custody and personnel receiving the custody of the samples. The COC accompanies the samples and is used by the Sample Manager to document transfer of custody from the field team to the shipping agent.

3.2 SAMPLE LABELING

Sample labels may be filled out partially before field sampling activities begin. The date, time, and sampler's initials or signature should not be completed until the time of sample collection. Sample labels will be filled out using waterproof ink.

Care will be taken during labeling and taping to preclude the possibility of sample contact with label or tape adhesive.

3.3 SAMPLE HANDLING

This section discusses proper sample containers, preservatives, and handling and shipping procedures.

3.3.1 Sample Containers

Commercially clean sample containers will be obtained from a subcontracted analytical laboratory or vendor and filled with sample material in accordance with these procedures.

3.3.2 Sample Preservation and Storage

All samples collected for chemical analysis will be stored on ice (or similar) in an insulated cooler to maintain a temperature of <6°C and shipped on ice (or similar) to the laboratory for preparation and analysis.

3.3.4 Sample Packaging and Shipping

The Sample Manager is responsible for confirming that samples collected by the sampling team have been properly containerized, packed, and labeled. Once the Sample Manager has custody of samples, he/she is responsible for maintaining custody (i.e., keeping samples in the designated secure location), and packaging and shipping the samples in a timely and proper manner.

Samples and sample containers will be packaged properly to protect the integrity of the sample and its seal, prevent breakage of containers, and prevent leakage of contents.

A copy of the shipping bill will be retained by the Sample Manager for attachment to the corresponding copy of the COC form, and these forms will be maintained by the URS Field Manager in accordance with this procedure.

Packing and Shipping Samples for Chemical Analysis

- Place sufficient amounts of packing material (e.g., bubble wrap) in the bottom and sides of the shipping cooler to prevent movement of contents.
- Line the inside of the cooler with a plastic trash bag, add enough ice (in double bags) to the cooler to maintain the required temperature of <6°. Line the bottom, sides, and top of cooler to retain proper shipment temperature; using at least 3-4 one gallon bags of ice per 48-quart cooler is recommended.
- A bottle containing tap water and identified as a temperature blank will be included with each cooler containing samples cooled to <6°C. Upon receipt of the samples at the laboratory, the temperature blank will be used to determine the cooler temperature. The temperature blank will not be assigned a sample identification number and will not appear as a line item on the chain-of-custody form.
- Place samples and temperature blank inside the bag in an upright position. Tie shut the trash bag holding the samples and ice.
- Fill excess space in the cooler with ice bags or other packing material (e.g., bubble wrap) to prevent movement of sample containers.
- Place the original signed copy of the COC form inside a plastic bag, and tape the bag inside the cooler lid, reserve the carbon copy or photocopy of the COC for URS' records.
- Close the cooler lid, and seal the cooler and the cooler spout with appropriate packaging tape.
- Place two custody seals (tampering seals) after signing and dating on the cooler in separate areas across the gap between the lid and the cooler base. Tape the custody seals to the cooler to confirm that custody seal is adequately affixed.

Samples may be shipped for Saturday delivery; however, Saturday delivery will require laboratory approval before shipment.

3.3.5 Sample Container Tampering

If, at any time after samples have been sealed and secured, custody seals on the sample container, or cooler are identified as having been tampered with, the following procedures will be conducted:

- Check with personnel having access to sample coolers/containers to evaluate whether inadvertent tampering can be documented.
- Document findings of the incident in a logbook.

If it cannot be confirmed and documented that the custody seal was broken inadvertently and that the integrity of samples is unimpaired, the samples will be re-collected and the URS Project Manager and URS Quality Assurance Manager (QAM) will be notified.

3.3.6 Holding Times and Analyses

The holding time is specified as the maximum allowable time between sample collection and analysis or extraction, based on the analyte of interest, stability factors, and preservative (if any) used. Any storage of samples on Site will be scheduled to be kept to the minimum period, based on logistic considerations (e.g. samples will not be shipped over weekends unless advance arrangements for receipt have been made with the laboratory).

4.0 CHAIN-OF-CUSTODY PROCEDURES

The custody of samples shall be documented on the COC. These forms document possession of the sample from collection through laboratory receipt, including transfer, handling, and shipping of samples.

Sample custody and documentation procedures will be followed to preserve sample integrity and to confirm the validity of field and laboratory data. As a result, sample data will be traceable from the time and location of sample collection through chemical analyses and data reporting. The following information will be recorded on the COC form that will accompany samples to the laboratory:

- Sample ID
- Sampling date and time
- Required analyses
- Number of containers
- Sample Manager (or designee) signature

The objective of the custody identification and control system for the samples is to confirm, to the extent practicable, that the following occur:

- Samples scheduled for collection are uniquely identified.
- The correct samples are analyzed and are traceable to their records.
- Samples have been appropriately preserved.
- Samples are protected from loss or damage.
- A record of sample integrity is established.
- Legally traceable custody and possession records are maintained.

Observe general documentation rules, including the use of blue or black ink. Make any changes to the COC form by drawing a single line through the incorrect information and initialing the mark-out. Put a line through and initial blank lines on the COC form.

Upon receiving the samples, the laboratory's representative shall do the following:

- Sign and keep copies of shipping documents.
- Sign the COC form and return the second copy to the URS Project Manager or designee (may be included with the analytical results).
- Measure and document the temperature of the samples using temperature blank.
- Document the condition of the custody seals and of the samples.
- Notify the URS Project Manager or designee if any breakage or improper preservation has occurred or if there is a discrepancy between the COC form, sample labels, and requested analyses.
- Provide copies of the above documentation to the URS Project Manager or designee with the final laboratory data package.
- At the laboratory, custody of samples will be in accordance with the laboratory's SOPs from sample receipt through sample residual disposal.

This procedure provides technical guidance and methods for the management, storage, characterization, transportation, and disposal of waste generated. Waste generated at the Site during field activities is referred to as Investigation Derived Waste (IDW). The project has been carefully designed to avoid the creation of a substantial volume of IDW. IDW will be properly managed and disposed off-Site in compliance with RCRA, CERCLA, and other applicable legal authorities as detailed below or in the Work Plan. All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 MATERIALS AND EQUIPMENT

- Personal protective equipment (PPE) as outlined in the HASP; and
- Labeling materials (e.g., permanent markers, labels, etc.).

2.0 APPLICABLE LAWS, REGULATIONS, AND GUIDANCE

This procedure is designed to confirm that all waste generated during the course of the investigation is managed in compliance with applicable laws and regulations. It is also based on waste management policy and guidance documents, such as the "*Guide to Management of Investigation-Derived Wastes*" (U.S. Environmental Protection Agency [EPA] 1992). CERCLA activities conducted entirely on Site must comply with the substantive requirements of other applicable laws and regulations, but not permitting and other procedural requirements. CERCLA activities conducted off Site, however, must comply with both administrative and substantive requirements. See CERCLA Section 121 (e).

Off-site disposal of CERCLA waste will be in compliance with CERCLA Section 121 (d)(3) and 40 C.F.R Section 300.440 (also known as the "CERCLA Off-Site Rule"), as well as applicable NRC, DOT, RCRA, and state regulations, as further explained below or in the Work Plan.

3.0 TYPES AND MANAGEMENT OF IDW

<u>Solid IDW may include the following</u>:

- Drill cuttings or soil/rock.
- Disposable used PPE (e.g., gloves) and other disposable investigation materials (e.g., paper towels).
- Trash

PPE and trash will be disposed of in a normal trash receptacle following their usage in the field.

<u>Liquid IDW may include the following</u>:

- Groundwater produced by well development or purging, etc.
- Decontamination water.

Solid and liquid IDW shall be containerized in proper containers, in good repair, which are suitable for short-term storage, transportation, and disposal by a subcontractor. Examples of proper containers include DOT-approved steel or plastic drums, roll-off containers, and fractionation tanks.

Spray bottle discharge from the washing of small sampling equipment within each sample collection point. The spray discharge may be considered *de minimis* and may be discharged to the ground at the corresponding sampling locations.

4.0 LOG BOOK DOCUMENTATION

An inventory log of waste will be entered into the log book and must include the following**:**

- Project Name
- Name of person logging the waste
- Date waste generated
- Type of waste material (e.g., PPE, instrument, or trash), and solid or liquid
- Estimated waste volume
- Characterization and disposition of equipment and instruments.
- Comments
- Any variance to procedures described in this procedure

5.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992 (April). *Guide to Management of Investigation-Derived Wastes*. Office of Emergency and Remedial Response Hazardous Site Control Division. OSWER Publication Number 9345.3-03FS.

U.S. Occupational Safety and Health Administration (OSHA) Standard – Ionizing Radiation – 29 C.F.R. 1910.1096

U.S. OSHA Standard – Ionizing Radiation – 29 C.F.R. 1926.53

Department of Transportation Standard – Hazardous Materials and Oil Transportation – 49 C.F.R. 100-180