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SITE INSPECTION REPORT AND DATA SUMMARIES

**PRELIMINARY ASSESSMENT AND SITE INVESTIGATION
FORMER ATLAS MISSILE SITES 1 AND 4
LARAMIE COUNTY, WYOMING**

AUGUST 2002

Prepared for:

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LIST OF ACRONYMS

AFB	Air Force Base
AMSL	Above Mean Sea Level
AST	Aboveground Storage Tank
BGS	Below Ground Surface
BOPU	Cheyenne Board of Public Utilities
BTEX	Benzene, Toluene, Ethylbenzene, and Total Xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DNAPL	Dense Non-Aqueous Phase Liquid (DNAPL)
DRO	Diesel Range Organics
DOD	U.S. Department of Defense
EPA	U.S. Environmental Protection Agency
GPM	Gallon Per Minute
GRO	Gasoline Range Organics
HSP	Health and Safety Plan
ICBM	Intercontinental Ballistic Missiles
LTE	LT Environmental, Inc.
MCAWW	Methods for Chemical Analysis of Water and Wastes
mg/kg	Milligrams per Kilogram
NFA	No Further Action
PA/SI	Preliminary Assessment/Site Investigation
PCBs	Polychlorinated Biphenyls
QA/QC	Quality Control/Quality Assurance
RP-1	Kerosene Based Rocket Fuel
SI	Site Investigation
SOP	Standard Operating Procedure
TCE	Trichloroethene
TOC	Top of Casing
TPH	Total Petroleum Hydrocarbons
µg/L	Micrograms per Liter
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
WDEQ	Wyoming Department of Environmental Quality
WP	Work Plan

SECTION 1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This Site Investigation (SI) Report, SI Checklist, and SI Data Summaries are being submitted by LT Environmental, Inc. (LTE) to the State of Wyoming, Department of Environmental Quality (WDEQ), Water Quality Division, Groundwater Pollution Control Program for the Preliminary Assessment/Site Investigation (PA/SI) at Former Atlas Missiles Sites 1 and 4 (Sites 1 and 4) located in Laramie County, Wyoming. The overall goal for the project is to complete a PA/SI for Sites 1 and 4.

This SI Narrative Report provides the site descriptions, the known operation history of Sites 1 and 4, the field procedures used, and results of soil and groundwater sampling at Sites 1 and 4. The SI Narrative Report was prepared, in part, using reference documents obtained from the U.S. Environmental Protection Agency (EPA) and WDEQ. The reference documents include:

- Localized Potentiometric-Surface Map of the High Plains Aquifer in Wyoming 1984, Charles Avery and Robert A. Pettijohn, 1984;
- Final Expanded Remedial Investigation/Streamlined Risk Evaluation, Former F.E. Warren AFB Atlas "E" Missile Site No. 5, Chugwater Wyoming, U.S. Army Corps of Engineers [USACE], September 2000;
- Borie Wellfield Trichloroethene (TCE) Assessment Project FY-2000, Section 319 Funding Proposal, City of Cheyenne Board of Public Utilities (BOPU) Water Department, April 2000;
- Cheyenne Wellhead Protection Plan, M.S. thesis and consultant's report submitted to the Cheyenne BOPU Water Department, 1998; and
- Guidance for Performing Site Inspections under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), EPA, September 1991.

1.2 ORGANIZATION

This SI Narrative Report is divided into eight sections including this introduction. Section 2.0 provides site descriptions. Descriptions of the sampling and quality control/quality assurance (QA/QC) procedures are provided in Section 3.0. The groundwater pathway is discussed in Section 4.0. Section 5.0 provides a description of the soil pathway. The summary and

conclusions are detailed in Section 6.0. Section 7.0 contains recommendations and references are provided in Section 8.0.

The soil borehole logs are provided in Appendix A. Appendix B contains well construction diagrams. The well development and sample forms are provided in Appendix C. The SI Checklist and SI Data Summary for Site 1 is provided in Appendix D. Appendix E contains the SI Checklist and SI Data Summary for Site 4. Appendix F contains analytical data and chain-of-custody documentation.

SECTION 2 SITE DESCRIPTIONS

2.1 SITE LOCATION

Sites 1 and 4 are located in Laramie County, Wyoming (Figure 1). Site 1 is located approximately 16 miles north and six miles west of Cheyenne, Wyoming in Sections 2 and 11, Township 16 North, Range 68 West. Site 4 is located approximately 15 miles west of Cheyenne in Section 20, Township 13 North, Range 69 West.

2.2 SITE DESCRIPTION

2.2.1 Site 1

Site 1 covers approximately 900 acres with an average elevation of 6,300 feet above mean sea level (amsl). The land was acquired by purchase and condemnation by the U.S. Department of Defense (DOD) between 1959 and 1961 (USACE, 1993). Site 1 is currently owned by Whitaker East Limited Partnership (Whitaker Partnership) and is used for cattle grazing. Whitaker Partnership has made no improvements to the site. The terrain gently slopes to the east and with two intermittent streams that flow from west to east across the site (Figure 2). Surface water runoff on the site drains into the intermittent streams. The surface water streams drain into Lodgepole Creek approximately 12 miles east of Site 1.

There are six abandoned launch buildings that exist as hollowed and partially demolished structures. Each former launch facility has an associated waste channel that was designed to collect quench liquid generated during missile launch operations. The site has two burnout pits that retained the quench liquid from the waste channels for separation prior to water being discharged into the northern intermittent stream (Figure 2). The site has a former guidance operation building, a former pump station complex, and several other small structures. All structures have been abandoned and are partially demolished from salvage operations. The site has two existing water wells, which are currently not in use. The site also has two former lagoons previously used for disposal of sewage generated from the facility operations.

Site 1 had a total of 12 underground storage tanks (USTs) that stored fuel oil and kerosene based (RP-1) rocket fuel. In July 1993, the USACE excavated and removed all 12 USTs (USACE, 1993). The closure soil sample results indicated residual petroleum hydrocarbons in soil along the northwestern walls of the excavations for fuel oil tanks at Launch Buildings #1, #2, #3, and #4. The petroleum hydrocarbon levels were below the WDEQ action levels and therefore the WDEQ granted closure with no further action (NFA) for all 12 USTs at Site 1 (USACE, 1993).

2.2.2 Site 4

Site 4 covers approximately 111 acres with an average elevation of 7,240 feet amsl. The site was constructed between 1959 and 1961 on land acquired through purchase by the DOD. Site 4 is

currently owned by Timnath Farms, Inc. (Timnath Farms) and is used for cattle grazing and as a cattle-holding area. The Site 4 terrain slopes to the east with one intermittent stream flowing west to east across the site (Figure 3). Surface water runoff is to the east and towards the intermittent stream that drains into Lone Tree Creek approximately one mile northeast of Site 4.

There are three abandoned and partially demolished launch buildings at Site 4. Each launch building had an associated waste channel that drained into an unlined earthen burnout pit (Figure 3). The site contained a guidance operation building, a pump station complex, and other small structures. All structures have been abandoned and are partially demolished from salvage operations. The site also had one sewage lagoon that was used for the disposal of sewage facility operations. Site 4 has three existing water wells located northeast of the site (Figure 4). Timnath Farms utilizes one of the water wells for stock watering and fire fighting. The water wells are discussed in more detail in Section 4.0.

Site 4 had a total of nine USTs that stored fuel oil and RP-1 fuel. In July 1993, the USACE excavated and removed all nine USTs (USACE, 1993a). The soil sample closure results obtained during UST removals indicated petroleum hydrocarbons were below the WDEQ action levels and therefore the WDEQ granted closure with NFA (USACE, 1993a).

Modern day improvements to the missile site by Timnath Farms include fenced cattle holding areas near Launch Buildings #1 and #3 (Figure 3). Timnath Farms also has installed a water pipeline east of the site. According to Timnath Farms personal, water for the pipeline is supplied by a former Site 4 water well (P322W), located northeast of the site (Figure 4). The pipeline supplies water to the Rim Pasture located approximately 10 miles south of Site 4. The pipeline also has four spurs. The spurs include the Site 4 spur, the Ottoline pasture spur, the Polarity storage tank spur, and the Harriman pasture spur. The exact layout of the pipeline and spurs is unknown. The Site 4 spur connects to the original water supply system for Site 4. Timnath Farms uses the water system to supply water for stock tanks at the cattle holding areas and for fighting grass fires. Timnath Farms also pipes water into a former 20,000-gallon diesel aboveground storage tank (AST) for water storage. The water stored in the AST is used as a backup water supply for cattle.

2.3 OPERATION HISTORY AND WASTE CHARACTERISTICS

Sites 1 and 4 are two of five former Atlas "D" Missile launch facilities associated with F.E. Warren Air Force Base (AFB). The sites were active between 1960 and 1965 (USACE, 1993). The operational history and waste characteristics for Sites 1 and 4 are based on historical information obtained by the USACE for operations associated with Atlas Missile Site 5 located near Chugwater, Wyoming and from previous investigations performed by LTE personnel at similar missile launch facilities in Colorado.

During the operation of the missile facilities, the intercontinental ballistic missiles (ICBMs) were regularly fueled as part of readiness operations (USACE, 2000). After the readiness exercises, the kerosene based (RP-1) rocket fuel was pumped back into the fuel UST and the missile's RP-1 fuel tanks and lines were flushed with approximately 25-gallons of TCE. At these facilities, the

flushing was performed to remove any residual RP-1 fuel in the lines and tanks to prevent accidental explosions. The waste TCE and residual RP-1 fuel were then released into drainage sumps and subsequently discharged onto the ground surface. During periods of elevated Cold War tensions, missile readiness exercises may have been conducted a few times each week (USACE, 2000).

At Sites 1 and 4, waste TCE and residual RP-1 were likely discharged into each launch building's waste channel. At Site 1, the liquids in the waste channels drained into two unlined burnout pits for separation. Subsequently residual liquids from the Site 1 burnout pits were discharged at two locations along the northern intermittent stream (Figure 2). At Site 4, the liquids from the readiness exercises were drained into the unlined burnout pits for separation. No connection was observed between the burnout pits and the intermittent stream at Site 4 (Figure 3).

As described in Section 2.2, there are two former sewage lagoons at Site 1 and one at Site 4. A review of engineering design schematics for the facilities show that the lagoons were used to dispose of liquid wastes from the launch operations building and missile launch buildings through a sanitary sewer system. Investigations performed at ICBM missile launch facilities in Colorado have identified polychlorinated biphenyls (PCBs) in surface and near-surface soil within former sewage lagoons (Parsons, Inc., 1996).

In summary, the waste channels, burnout pits, and intermittent streams are likely source areas for TCE and residual RP-1 fuels previously released during readiness operations. The sewage lagoons may be sources of PCBs, other unknown hazardous wastes, and waste TCE used during normal facility operations. The USTs appear to have been closed although the level of hydrocarbons identified in the soil suggest releases have occurred.

SECTION 3.0 FIELD PROCEDURES

This section provides a description of the field procedures to collect soil and groundwater samples for the SI. The fieldwork for the SI was performed in two phases. In January 2002, LTE collected samples from water wells in the vicinity of Sites 1 and 4. The water well sampling was performed according to the procedures outlined in the *Water Well Sampling for Preliminary Assessment and Site Investigation Former Atlas Missile Sites 1 and 4* (Phase I WP; LTE, 2001).

Between April and May 2002, LTE collected soil and groundwater samples for the SI. The field investigation was completed according to the procedures outlined in the following documents:

- Final Work Plan for Preliminary Assessment and Site Investigation Former Atlas Missile Sites 1 and 4 (Final WP; LTE, 2002a);
- Standard Operating Procedures Preliminary Assessment and Site Investigation Former Atlas Missile Sites 1 and 4 (SOPs; LTE, 2002b);
- Quality Assurance/Quality Control Plan Preliminary Assessment and Site Investigation Former Atlas Missile Sites 1 and 4 (QA/QC Plan; LTE, 2002c); and
- Final Health and Safety Plan Preliminary Assessment and Site Investigation Former Atlas Missile Sites 1 and 4 (HSP; LTE, 2002d).

3.1 WATER WELL SAMPLING PROCEDURES

The water well investigation included researching the Wyoming State Engineer's well database for recorded wells in the vicinity of Sites 1 and 4; researching WDEQ, City of Cheyenne, and United States Geological Survey (USGS) files for historical well data and hydrogeologic information; and the sampling of selected wells in the vicinity of Sites 1 and 4. The objectives of the water well investigation were as follows:

- Inventory permitted water wells in the vicinity of Sites 1 and 4; and
- Determine if private water wells are impacted by releases from operations Sites 1 and 4.

This section describes the procedures for water sampling. The inventory of water wells near Sites 1 and 4 are included in Section 4.0.

A total of 15 water wells were identified as potential targets in the vicinity of Sites 1 and 4. The groundwater sampling followed the procedures outlined in the Phase I WP, as described below.



3.1.1 Site 1 Sampling Procedures

The Phase I WP and Final Work Plan recommended that water samples be collected six target water wells in the vicinity of Site 1. The wells are referenced by permit numbers: P7806W, P7807W, P6285P, P21312P, P1943P and P40632W. The location of wells is shown in Figure 5. The following describes the procedures used to obtain the samples from the water wells:

- Well P7807W, a former water well for Site 1, was sampled by lowering a disposable bailer through the 2-inch diameter well sounding access port. At some point in the past, the turbine pump had been removed from the well. Water was encountered at a depth of approximately 140 feet bgs in the well. The groundwater sample was obtained from a depth of approximately 250 feet bgs.
- Well P40632W is a stock and domestic use well owned by Ms. Richard Stone. The well is equipped with a submersible pump. The well is located at the Stone's residence near the corral. Water for domestic use is pumped to a cistern for use in the residence. The well was sampled on January 3, 2002 and on April 8, 2002. Groundwater samples were collected from a faucet installed at the well head. The faucet was allowed to flow for approximately 15 minutes prior to sampling. Groundwater level measurements could not be obtained from the well and the well owner did not know the depth of the submersible pump.
- Well P6285P is a stock well owned by Ms. Mary Weppner. The well is equipped with a nonfunctioning windmill pump. The groundwater sample was collected by lowering a disposable bailer down the well. Water was encountered at a depth of 160 feet bgs in the well. The groundwater sample was collected at a depth of 250 feet bgs.
- Well P1943P is also a stock well owned by Ms. Mary Weppner. The well is equipped with a windmill pump. The groundwater sample was collected by lowering a disposable bailer down the well. Water was encountered at a depth of 9.81 feet bgs. The groundwater sample was collected from a depth of approximately 25 feet bgs.

Groundwater samples could not be obtained from wells P21312P and P7806W due to the following:

- An access agreement with the owner of well P21312P was not obtained; and
- P7806W is one of the two original water wells used at Site 1 and is equipped with a turbine pump. Upon retrieving the bailer from the well, approximately 1.5 feet of gear oil was observed in the bailer. The presence of gear oil in the well is likely the result of the deterioration of the seals in the pump, which allowed the gear oil to drain from the pump. Due to the presence of gear oil, P7806W was not sampled.

3.1.2 Site 4 Sampling Procedures

The Phase I WP and Final WP identified nine private water wells as targets that potentially could have been impacted by operations at Site 4. As with Site 1, the wells are defined by permit numbers: P76007W, P19734P, P94458W, P169C, P4912P, P322W, P323W, P9105P, and P119470W. With the exception of well P119470 that is upgradient of Site 4, the locations of the wells and hydrant are shown in Figure 4. A water sample was also collected from a water hydrant located near Launch Building #3 at Site 4. The water hydrant is connected to a pipeline that supplies water from well P322W to stock holding areas at Site 4. The following describes procedures used to obtain the water samples:

- Wells P322W, P4912P, and P323W were used to supply water for facility operations at Site 4. The stock wells are presently owned by Timnath Farms. Wells P322W and P4912P are equipped with submersible pumps but no information was available regarding the depths of the pumps. Well P323W is an open well casing located inside a well house. Wells P322W and P323W were sampled by lowering a bailer into the wells. Groundwater was encountered at depths of 10.80 feet below top of casing (TOC) and 12.21 feet below TOC in wells P322W and P323W, respectively. The groundwater samples obtained from depths of 240 feet below TOC and 100 feet below TOC in wells P322W and P323W, respectively. Well P4912P is a flowing well. The water sample was collected by reducing the water flow to a trickle and placing the sample bottles directly in the water flow coming from the well casing.
- Well P9105P is a stock well owned by Timnath Farms. The well is equipped with a submersible pump, of which the depth is unknown. The well was sampled by turning the pump on, purging the water from the well for approximately 35 minutes, reducing the water flow, and placing sample bottles directly in the water flow.
- Wells P76007W and P19734P are stock and domestic use wells. The wells are equipped with submersible pumps. The well owners did not have information for the depth of the well pumps. The wells were sampled from faucets installed at the well head, prior to the water flowing into the associated cisterns. The wells were purged for approximately 20 minutes. Samples were collected by reducing the flow to a trickle and placing sample bottles directly in the water flow.
- The water hydrant sample was collected by opening the hydrant, purging the hydrant for 10 minutes, reducing the flow to a trickle, and placing sample bottles directly in the water flow.

Water samples were not collected from wells P94458W, P169C, and P119470W due to the following reasons:

- Well P94458W is connected to a water pipeline that is used to transfer water to a stock holding area approximately two miles south of the well. The pipeline is connected at a

depth of approximately 15 feet bgs preventing the bailer from being lowered past the connection;

- An access agreement with the owner of well P169C could not be obtained; and
- Well P119470W is located upgradient of Site 4. The well may be sampled in the future, based on the results of the water well sampling.

3.1.3 Water Well Sample Handling and Analysis

All groundwater sampling was conducted according to the Phase I WP (LTE, 2001). Groundwater samples were placed directly into appropriately labeled and preserved laboratory containers, logged on a Chain-of-Custody form, and preserved on ice for overnight delivery to the Test America, Inc. laboratory located in Nashville, Tennessee. Groundwater samples were analyzed for volatile organic compounds (VOCs) by EPA Method 8260. Excess groundwater from sampling was dispersed on the ground surface near the wells.

3.2 SI SAMPLING PROCEDURES

The field work for the SI was performed between April 1, 2002 and May 16, 2002. The field work for the SI began at Site 4. The field investigation followed procedures in the Final WP, SOPs, QA/QC Plan, and HSP.

3.2.1 Site 1 SI Sampling Procedures

3.2.1.1 Hand Auger boreholes

The borehole logs for hand auger boreholes are included in Appendix A. Three boreholes were hand augered at Site 1 (Figure 6). The Final WP indicated that boreholes would be drilled to a depth of 10 feet bgs at the each of the two sewage lagoons (S1HA01 and S1HA02) and at the westernmost waste channel discharge point in the northern intermittent stream (S1HA03). Due to presence of cobbles and very hard soil, the total depths of hand auger boreholes S1HA01 and S1HA02 were 4.5 feet bgs and 5.0 feet bgs, respectively. The field crew attempted to move borehole locations but was unable to penetrate any deeper.

On April 4, 2002, the sample bucket broke off the hand auger at a depth of 1.0 feet in borehole S1HA03. On April 9, 2002, the field crew obtained a replacement hand auger and augered borehole S1HA03A to 10 feet bgs approximately two feet west of S1HA03. Near surface and subsurface soil samples were submitted for laboratory analysis from both S1HA03 and S1HA03A.

3.2.1.2 Hollow Stem Auger Boreholes

The Final WP indicated that the drilling program at Site 1 would begin at borehole S1BH01. Borehole S1BH01 would be advanced five feet into the shallow water-bearing zone, auger

refusal, or a maximum depth of 120 feet bgs. The remaining available footage would be used to drill and sample boreholes S1BH02 and S1BH03.

Borehole logs are included in Appendix A. On April 5, 2002, the auger drill string broke at a depth of 65 feet bgs at S1BH01. The field crew was unsuccessful at retrieving 10 feet of drill string and the borehole was abandoned. On April 9, 2002, borehole S1BH01 was re-drilled using solid stem augers approximately two feet east of the original location. At a depth of 90 feet bgs, the drill string broke. The field crew was unsuccessful at retrieving 10 feet of the drill string and the borehole was again abandoned. In May 2002, the borehole S1BH1 was re-drilled a total depth of 230.8 feet bgs by U.S. Army Corps of Engineers (USACE) and completed as well S1MW1 (referred to as FEW1-MS02-1 on log). Soil cuttings and excess soil samples were spread on the ground surface near the boreholes. Well completion log is included in Appendix B. Well development and sample forms are included in Appendix C.

3.2.2 Site 4 SI Sampling Procedures

3.2.2.1 Hand Auger Boreholes

Two boreholes were hand augered at Site 4. The Final WP indicated that boreholes would be drilled to a depth of 10 feet bgs at the sewage lagoon (S4HA01) and where the intermittent stream exits the eastern boundary of the site (S4HA02). Due to the presence of cobbles and very hard soil, the total depths of boreholes S4HA01 and S4HA02 were 3.0 feet bgs and 2.5 feet bgs, respectively. The field crew attempted to move boreholes to several locations but was unable to penetrate any deeper.

3.2.2.2 Hollow Stem Auger Boreholes

The Final WP indicated that there would be three boreholes drilled downgradient of burnout pit #1, burnout pit #2, and burnout pit #3 at Site 4. The drilling program at Site 4 would begin at burnout pit #1, which appeared to be the furthest downgradient location on site and most likely to encounter soil or groundwater contamination. The borehole at burnout pit #1 would be drilled into the shallow water bearing zone, to auger refusal, or to a total depth of 120 feet bgs.

Upon mobilizing to the site, visual observations indicated that burnout pit #3 would be the furthest downgradient location of all site operations. Burnout pit #3 also was topographically the lowest of the drill locations and appeared to be a better location to reach shallow groundwater within 120 feet bgs. Therefore, the field program was adjusted to begin with borehole S4BH03.

The borehole logs are included in Appendix A. On April 1 and 2, 2002, borehole S4BH03 was drilled to a total depth of 65 feet bgs. The drilling conditions at S4BH03 were very hard with large cobbles and boulders. The drill string was tripped from the hole on two occasions to replace the drill bit teeth. At a depth of 65 feet bgs the drill string broke. The field crew was unsuccessful at retrieving 20 feet of drill string from the borehole and the borehole was abandoned.

Boreholes S4BH01 and S4BH02 were drilled to total depths of 32.5 feet bgs and nine feet bgs, respectively. At S4BH01, the drill string broke a depth of 32.5 feet bgs and the borehole was abandoned. The drill crew attempted to move the borehole but encountered auger refusal before reaching 10 feet bgs. The drill crew attempt to move and re-drill S4BH02 at several locations but encountered auger refusal.

In May 2002, the borehole S4BH01 (referred to as FEW1-MW02 on logs) was re-drilled to a depth of 85 feet bgs by the USACE and completed as well S4MW01. The soil cuttings and excess soil samples were spread on the ground surface near the boreholes. The well completion log is included in Appendix B. Well development and sample forms are in Appendix C.

3.2.3 SI Sample Handling and Analysis

All soil and groundwater sampling was conducted according to the Final WP, SOPs, QA/QC Plan, and HSP. Soil and groundwater samples were placed directly into appropriately labeled and preserved laboratory containers, logged on a chain-of-custody form, and preserved on ice for overnight delivery to the Test America, Inc. laboratory located in Nashville, Tennessee.

Near surface soil samples (0 to 0.5 feet bgs) collected for the SI at Sites 1 and 4 were analyzed for PCBs by EPA Method 8082 and the 13 priority pollutant metals by EPA Method 6010. The subsurface soil samples were analyzed for VOCs by EPA Method 8260 and total petroleum hydrocarbons (TPH) by EPA Method 8015B (gasoline and diesel range organics; GRO/DRO).

Groundwater samples collected from the monitoring wells were analyzed for VOCs by EPA Method 8260.

3.3 FIELD QA/QC

As a check on field sampling and transport, four field duplicates, three trip blanks, two field blanks, and two rinseate blanks were submitted for analysis according to the procedures outlined in the Phase I WP, Final WP, and QA/QC Plan. The following list the primary and duplicate samples collected for the SI:

1. Sample P4913P was a duplicate sample for P4912P;
2. Sample S1W-A was a duplicate sample for S1W-1943P;
3. Sample S1HAA was a duplicate sample for sample S1HA03A collected at a depth of 9.5 to 10 feet bgs; and
4. Sample S4HAA was a duplicate sample for S4HA02 from a depth of 2 to 2.5 feet bgs.

The laboratory data sheets and chain-of-custody forms for QA/QC samples are included in Appendix F. There were no detected concentrations of any compound in the primary or duplicate samples, trip blanks, field blanks, or rinseate blanks.

The results of laboratory QA/QC indicated that all matrix spike recoveries, matrix spike duplicate recoveries, surrogate recoveries, and spike recoveries were within the target ranges. There also were no target compounds detected in laboratory blanks.

SECTION 4.0 GROUNDWATER PATHWAY

4.1 HYDROGEOLOGY

The following discussion of the hydrogeology for Sites 1 and 4 was prepared from the results of visual observations of soil samples collected from the boreholes drilled, groundwater samples collected and from previously published hydrogeologic studies and reports. The discussion is divided into regional geology and hydrogeology and more specific Sites 1 and 4 geology and hydrogeology. The majority of the studies and reports reviewed were the result of the development and wellhead protection programs for the City of Cheyenne wellfields (Figure 1). The following lists the studies and reports referenced for the hydrogeology discussion:

- Borie Wellfield Trichloroethene (TCE) Assessment Project FY-2000, Section 319 Funding Proposal, City of Cheyenne Board of Public Utilities (BOPU) Water Department, April 2000;
- Cheyenne Wellhead Protection Plan, M.S. thesis and consultant's report submitted to the Cheyenne BOPU Water Department by Weston Engineering, 1998;
- Localized Potentiometric-Surface Map of the High Plains Aquifer in Wyoming 1984, Charles Avery and Robert A. Pettijohn, 1984;
- Cheyenne Ten Well Rehabilitation Project, Weston Engineering, Inc. 1996; and
- Utilizing Watershed Management in Conjunction with Wellhead Protection in the Cheyenne Board of Public Utilities Borie Wellfield, Laramie County Wyoming; Benjamin J. Jordan, W. Todd Jarvis, and Dr. Peter Huntoon; 1998.

4.1.1 Regional Geology

Sites 1 and 4 are located in the northwestern portion of the Denver-Julesburg north-south oriented synclinal structural basin. The sediments underlying the sites dip gently to the east/northeast. Near Sites 1 and 4, the western edge of the Denver-Julesburg Basin is defined by the Laramie Range, which is the result of displacement along the Hecla Thrust Fault (City of Cheyenne BOPU Water Department, 1998). A northeast trending fault systems has been suggested by northeast-trending lineaments predominant in Precambrian Rocks of the Laramie Range (Weston, 1996) and the northeast striking Miocene Whalen and Wheatland Fault Zones.

The Tertiary rocks near Sites 1 and 4 include the Pliocene Ogallala Group, Pliocene Arikaree Group, and Oligocene White River Group. The Tertiary rocks in the Cheyenne area are exposed on and around the Cheyenne Table, a series of bluffs and rolling hills that extends from the edge of the Laramie Range on the west and into Nebraska on the east. It is bounded to the north and south and partly on the west by escarpments (Weston, 1996). The Cheyenne Table is capped by

the Ogallala Group. The Arikaree Group is exposed below the Ogallala Group along the northern escarpment of the Cheyenne Table but is reported to pinch out near Townships 14 and 15 north (Weston, 1996), which is approximately 10 miles south of Site 1 and approximately 12 miles north of Site 4. Therefore, the Arikaree Group is probably not present beneath Site 4.

The White River, Arikaree, and Ogallala Groups are well-defined stratigraphically. However, lithologic correlation of the Tertiary units is difficult. The depositional environment for the Tertiary rocks making up the three groups are fluvial and reworked eolian deposits which were formed by different river systems. Therefore, the characteristics of individual rock units vary, but similar rock types occur repeatedly both laterally and vertically in each group.

The regional stratigraphy consists of thin layers (0 to 20 feet thick) of Quaternary Alluvium clays and sands at the surface. The Ogallala Group, which underlies the alluvium, is primarily of alluvial origin. The depositional environment of the Ogallala Group is alluvial fans directed from the Laramie Range transitioning into braided streams to the east. The Ogallala Group southwest of Cheyenne was deposited as an alluvial fan centered on Lone Tree Creek. Regionally, the Ogallala Group is composed of well- to poorly-sorted, fine- to very coarse-grained sandstone and conglomerates, siltstone, and minor beds of claystone, volcanic ash, and limestone. The Ogallala Group observed in the Cheyenne wellfields is clay rich, variably calcite-cemented, very fine- to medium-grained sandstone with some coarse sand, cobbles, and boulders (Weston 1996). The thickness of the Ogallala Group is greater than 150 feet beneath Site 1 and apparently pinches out just west of Site 4 at the base of the Laramie Range.

The Arikaree Group lies beneath the Ogallala Group at Site 1 and is not present at Site 4. The Arikaree Group is primarily of eolian origin with minor amounts of fluvial deposits. East and northeast trending paleovalleys have been identified in the Arikaree Group near Cheyenne. The Arikaree Group is buff to light brown and is composed primarily of well to moderately sorted, very fine- to fine-grained sandstone and siltstone. The sandstones are calcite cemented and friable. The thickness of the Arikaree Group observed in outcrops north of Site 1 along Chugwater Creek ranged from 500 feet to 1,000 feet. The thickness of the Arikaree Group beneath Site 1 is unknown.

The White River Group lies beneath the Arikaree Group at Site 1 and the Ogallala Group at Site 4. The White River Group is primarily of eolian origin with fluvial deposits occurring throughout but most common in the lower part (Weston, 1996). As with the Arikaree Group, east and northeast trending paleovalleys have been identified in the White River Group near Cheyenne. The White River Group consists predominantly of pale, fine-grained rocks with a high percentage of volcanic ash. The White River Group is divided into two formations: the upper Brule Formation and the lower Chadron Formation. The Brule Formation is composed primarily of siltstones, mudstones, and volcanic glass and minor amounts of sandstone, limestone and conglomerate. The thickness is approximately 200 feet beneath the sites. The Chadron Formation is composed of siltstone, mudstone, claystone and conglomerate. The Chadron Formation is not present beneath Site 4 and was reported to be approximately 100 feet

thick in water wells drilled in the Federal Wellfield approximately seven miles southwest of Site 1 (Cheyenne BOPU Water Department, 1998).

4.1.2 Regional Hydrogeology

The hydrogeology of the Tertiary units is complex due to the paleovalleys, fluvial, and reworked eolian depositional environments that formed discontinuous sediments both laterally and vertically within each and among the defined groups. The majority of the Cheyenne Wellfields are developed in the Ogallala Group and White River Group. The water-bearing zones in the units have not been mapped on a regional scale. The regional groundwater flow direction is to the east/northeast (USGS, 1984).

The aquifers in the Ogallala Group near Cheyenne occur in alluvial fans. The discontinuous water-bearing zones primarily occur in the coarse-grained and well-sorted sediments. Weston (1996) reports that the extreme lateral and vertical heterogeneity evident from the wells in the Cheyenne Wellfields might also suggest severe segmentation of hydrologic units (Weston, 1996).

Stream channel deposits are the most likely aquifers in the White River and Arikaree Groups. East and northeast trending paleovalleys have been recognized in both groups. However, the locations of the paleovalleys are difficult to map due to the similarity of the rock units and lack of well density. The location of the paleovalleys do not coincide with the location of modern day valleys (Weston, 1996). It is also reported that fractured permeability (fracture flow) in the Ogallala, Arikaree, and White River Groups may be a controlling factor in depth to groundwater, water movement, and well productivity (Weston, 1996).

4.1.3 Site 1

4.1.3.1 Site 1 Geology

Based on the inspection of soil samples from two boreholes (depths ranging to 90 feet bgs), Site 1 is predominantly underlain by reddish brown to brown, fine- to medium-grained gravelly sand with lenses of reddish brown gravelly clay and occasional cobbles. A 1.5 feet thick reddish brown, weathered, claystone lense was observed at a depth of 44 feet bgs in borehole S1BH01. The observed sediments in boreholes S1BH01 and the re-drill of S1BH01 appear to be consistent with the alluvial fan depositional environment of the Ogallala Group. The borehole logs are in Appendix A.

4.1.3.2 Site 1 Hydrogeology

The total depth of groundwater wells near Site 1 based on the well permits on file at the Wyoming State Engineer's Office ranged between 20 feet bgs to 765 feet bgs. The shallow wells, located north/northeast of Site 1 near Horse Creek, appear to be completed in the saturated alluvium of Horse Creek or possibly in perched water bearing zones in the Ogallala Group. The total depth of the majority of the 11 permitted wells located within a one-mile radius of Site 1

ranged from 250 feet bgs to 465 feet bgs, which suggests the wells are predominantly completed in the Ogallala/White River Group aquifers. The groundwater in the Ogallala/White River Groups exists under confined conditions.

One monitoring well was completed to a depth of 230 feet bgs in the first water-bearing zone at Site 1 (Appendix C). Groundwater rose to a measured depth of 178.1 feet during well sampling. Based on a groundwater rise of 52 feet, the shallow groundwater at Site 1 is considered under confined conditions.

4.1.4 Site 4

4.1.4.1 Site 4 Geology

Based on the inspection of soil samples from four boreholes (depths ranging up to 85 feet bgs), Site 4 is underlain by interbedded sand, cobbles, boulders, clayey sand, silt, and sandy clay. The sediments at Site 4 are coarser grained than observed at Site 1 with abundant cobbles and boulders observed in the drill cuttings. The cobbles and boulders are up to 1.5 feet in diameter. The observed sediments at Site 4 appear to be consistent with the descriptions of the alluvial fan deposits in the Ogallala Group.

The material observed appears to be heterogeneous and generally unstratified. The sandstone was reddish brown to brown, fine- to medium-grained with minor amounts of pinkish to green pebbles. The cobbles and boulders are brown and angular, which indicates that the drill bit was breaking them up downhole. The claystone is reddish- to light-brown, stiff, with sand and gravel to a depth of 85 feet bgs.

4.1.4.2 Site 4 Hydrogeology

The main aquifers near Site 4 are the Ogallala and White River Groups. Site 4 is within the Lone Tree Creek Drainage Basin. Lone Tree Creek is reported to be a gaining stream as it flows out of the Laramie Range west of Site 4 and becomes a losing stream as it passes over the Ogallala and White River Groups (Jordan, 1998). The total depth of groundwater wells located within the well search for Site 4 ranged from five feet bgs to 645 feet bgs. The total depth of the majority of the 55 permitted wells was predominantly greater than 200 feet bgs. The wells appear to be springs permitted as beneficial use water wells; wells completed in the saturated alluvium of Lone Tree Creek; and wells completed in water bearing zones of the Ogallala Group. With the exception of a spring completed as a beneficial use well, the total depth of wells within a one-mile radius of Site 4 ranged from 110 feet bgs to 640 feet bgs.

The static water level listed on well permits for the wells within a one-mile radius of Site 4 ranged from flowing at the ground surface to 56 feet bgs suggesting that the groundwater in the area exists under confined and artesian conditions. The differences in well depths, water quality, well productivity, and water levels in wells near Site 4 suggest that there are multiple aquifers present in the area. As described in Section 4.1.2, fracture flow may be a controlling factor in depth to groundwater and in well productivity.

Monitoring well S4MW01 was drilled to a depth of 85.1 feet bgs at the furthest downgradient point at Site 4 (Appendix B). The depth to groundwater measured prior to well development on May 15, 2002 was 61.26 feet bgs, which indicates that the shallow groundwater beneath Site 4 exists under confined conditions.

As indicated, Site 4 is within the Lone tree Creek drainage area. Based on the Jordan (1998) report, Lone Tree Creek is a gaining stream west of Site 4 and a losing stream east of Site 4. The elevation of the shallow groundwater at Site 4 compared to the elevation of Lone Tree Creek suggests groundwater flow toward the creek from the site. The creek passes within one mile of the City of Cheyenne's Borie Wellfield. In October 1996, flow in the stream was estimated at 235 gallons per minute (gpm) as the Lone Tree Creek flowed out of the Laramie Range and zero just west of the Borie Wellfield. Jordan (1998) concluded that Lone Tree Creek is recharging the Ogallala and White River aquifers at a rate of 235 gpm east of Site 4. The water wells in the Borie Wellfield, located approximately seven miles east and hydraulically downgradient of Site 4, are completed in the Ogallala and White River Group.

Jordan (1998) reported that in the area of Site 4 groundwater flows, via fractures, in a narrow "pipeline flow" and transitions to flow within a porous media near the Borie Wellfield. Jordan (1998) reports that it takes less than seven days for water to flow from the headwaters of Lone Tree Creek at the Laramie Range to the Borie Wellfields (a distance of 23 miles) and water from the stream takes approximately six years to migrate laterally into the Tertiary aquifers in the vicinity of the Borie Wellfield.

There are groundwater seeps along the valley walls of Lone Tree Creek near Site 4. A groundwater seep was identified approximately 0.5 miles northeast of Site 4 on the north valley wall of the Lone Tree Creek. There were no other seeps observed for approximately one mile downstream of Site 4 in the Lone Tree Creek valley.

4.2 TARGETS

Private water wells, the Cheyenne wellfields, the Coastal Chem wells, and reported groundwater seeps near Sites 1 and 4 are groundwater targets that may have been impacted by releases associated with previous site operations. Selected private water wells were investigated as part of this PA/SI. Previous investigations have identified groundwater contamination in the Borie Wellfield and Coastal Chem wells potentially sourced at Site 1 and/or Site 4. The groundwater seeps have not been investigated.

4.2.1 Private Water Wells Downgradient of Sites 1 and 4

Private water wells located downgradient of Sites 1 and 4 are targets for releases to groundwater from operations at the missile sites. The objectives of the water well survey was to identify water wells in the vicinity of Sites 1 and 4 that may have been impacted by past operations associated with the sites. LTE prepared an inventory of water wells using the Wyoming State Engineer's database of all water well permits on file within the defined areas. The database

includes all well permits on file as of October 24, 2001. The following sections provide the inventory of water wells for Sites 1 and 4.

4.2.1.1 Inventory of Water Wells for Site 1

Table 1 presents the inventory of water wells for a seven mile radius around Site 1. Site 1 is located in Section 11 and the southern half of Section 2, Township 16 North, Range 68 West in Laramie County, Wyoming. The primary objective was to inventory the water wells located in the immediate vicinity of the site. A total of 46 permitted water wells were identified from the Wyoming State Engineer's database in the Site 1 well search area. The wells included five domestic use wells, five domestic/stock use wells, 23 stock use wells, three stock/irrigation use wells, two industrial/domestic use wells, three industrial use wells, and five monitoring/miscellaneous use wells.

4.2.1.2 Inventory of Water Wells for Site 4

Table 2 presents the inventory of water wells for Site 4. Site 4 is located in the northern half of Section 20, Township 13 North, Range 69 West in Laramie County, Wyoming. The well search area was approximately one mile hydraulically upgradient and cross-gradient of Site 4 and approximately seven miles downgradient of Site 4. The well inventory was expanded to include all water wells within the area located downgradient of Site 4 and the upgradient extent of the Borie and Happy Jack Wellfields (Figure 1). A total of 55 permitted water wells were on file at the Wyoming State Engineer's Office for the Site 4 well search area. The wells included four domestic use wells, 17 stock use wells, five municipal use wells, six domestic/stock use wells, two irrigation use wells, one stock/irrigation use well, one domestic/irrigation use well, one industrial/domestic use well, nine miscellaneous use wells, one miscellaneous/domestic use well, two monitoring wells, two monitoring/miscellaneous use wells, and four test wells.

Two additional upgradient water wells were added to the Site 4 well inventory (Table 2). These wells were recently installed at the Willadsen Estates subdivision located approximately one mile east of Site 4. These wells were not listed in the Wyoming State Engineer's well database in October 2001. The wells (Permit Numbers 137863 and 138285) are domestic/stock use wells located upgradient of Site 4 (Figure 4). In June 2002, water samples were collected from the wells by the owner and submitted for laboratory analysis. Based on preliminary reports from the landowner, TCE was not detected in either upgradient well (WDEQ, 2002).

4.2.2 Cheyenne Wellfields and Coastal Chem, Inc. Wells

The Borie and Federal Wellfields are located approximately seven miles downgradient of Site 4 (Figure 1). The Borie Wellfield contains four wells (Borie 1, Elkar 7, Weber 1, and Finnerty 2) and produces 15 percent of the annual water supply for the City of Cheyenne. The wells are relied upon to meet water requirements during the summer months when demand exceeds the capacity of surface water treatment plants (City of Cheyenne BOPU, April 2002). TCE has historically been detected at concentrations ranging from 1.0 microgram per liter ($\mu\text{g/L}$) to 13

µg/L in all four wells at the Borie Wellfield (WDEQ, 2002). The well locations, historical TCE concentrations, and sampling dates are shown in Figure 4.

The Coastal Chem wells are located approximately 10 miles downgradient of Site 4. These wells provide drinking water to local residents near the Coastal Chem facility on Otto Road, water for stock tanks, and process water for the facility. In May and June 2002, concentrations of TCE in groundwater samples collected from wells ranged from 0.9 µg/L to 23 µg/L in six (Wycon 8A, Coastal 16A, Wycon 17, Wycon 22, Wycon 23, and Coastal 27) of eleven wells (WDEQ, 2002). The well locations, TCE concentration, and date sampled are shown in Figure 4.

4.2.3 Groundwater Seeps

There are seeps reported along the valley walls of Lone Tree Creek. One groundwater seep located approximately 0.5 miles northeast of Site 4 on the north valley wall of Lone Tree Creek, was confirmed during this SI. Contaminants from Site 4 could have and may still potentially enter the Lone Tree Creek surface drainage via groundwater seeps on the south valley wall. Seeps in the Site 1 area were not investigated during this SI.

4.3 SAMPLE LOCATIONS

4.3.1 Site 1 Sample Locations

The groundwater sample locations for Site 1 are listed in Table 3 and shown in Figure 5. Groundwater samples were collected from four private water wells located downgradient of Site 1. A groundwater sample was also collected from monitoring well (S1MW01) installed at the furthest downgradient position on site.

4.3.2 Site 4 Sample Locations

The sample locations for Site 4 are listed in Table 4 and shown in Figure 4. Groundwater samples were collected from six private water wells located downgradient of the Site 4. A groundwater sample was collected from a monitoring well (S4MW01) installed at the furthest downgradient location on site and from an on site water hydrant.

The source of the groundwater seep on the north Lone Tree Creek valley wall is most likely north of the creek. Visual inspections of the Lone Tree Creek drainage did not identify seeps on the south valley wall within one mile downstream of the site. Therefore, no groundwater seeps were sampled during the SI.

4.4 RESULTS

4.4.1 Site 1 Results

The analytical data sheets are included as Appendix F. The analytical results for groundwater samples are summarized in Table 5. The distribution of TCE in water wells at Site 1 is shown in Figure 5.

In January 2002, TCE was detected at a concentration of 2.0 µg/L in well P40632U near Site 1 (Figure 5). The depth of the pump and therefore the water sample in the well is unknown. The detected concentration is below the WDEQ standard for TCE in groundwater of 5.0 µg/L. In April 2002, well P40632U was resampled and TCE was reported as below the laboratory detection of 2.0 µg/L. There were no other concentrations of VOCs detected above the reporting limit in sampled private water wells in the vicinity of Site 1 or in the on site monitoring well S1MW01.

TPH-DRO was detected at a concentration of 174 µg/L in monitoring well S1MW01 confirming the presence of impacted groundwater at Site 1. There were no other detected concentrations of TPH-DRO in groundwater samples collected for the investigation at Site 1. The sample was obtained from an estimated depth of 220 feet to 230 feet bgs, which is the first groundwater, encountered at the location. The detected concentration of TPH-DRO is below the WDEQ standard for TPH-DRO of 1,100 µg/L.

4.4.2 Site 4 Results

The analytical data sheets are included as Appendix F. The analytical results for groundwater samples are summarized in Table 6. The distribution of TCE in water wells at and downgradient of Site 4 is shown in Figure 4.

TCE was detected at a concentration of 46 µg/L in well P322W (Figure 4). The groundwater sample was collected at a depth of 240 feet bgs. Because there are no well completion data for this well, it is unknown if this concentration is representative of the groundwater at the depth the sample was collected or if TCE is entering the well from another horizon. The well is located approximately 0.5 miles northeast of Site 4. Timnath Farms uses well P322W as a water supply for cattle at the Rim Pasture, which is located approximately 10 miles south of Site 4. The water is transported to the Rim Pasture through a pipeline that has four spurs. One of the spurs connects to the original water distribution system at Site 4. TCE was detected at a concentration of 33.1 µg/L in a sample collected from a water hydrant connected to this system on Site 4.

TCE was detected at a concentration of 167 µg/L in the on site monitoring well S4MW01 at a depth of 75 feet to 85 feet bgs (estimated). There were no other detected concentrations of VOCs in groundwater samples collected at or downgradient of Site 4 during this PA/SI. The detected concentration of 167 µg/L is the highest concentration of TCE detected during this SI

and is greater than any TCE concentration historically detected in the Borie Wellfield or Coastal Chem wells.

Other than the sample from well P322W, TCE was below laboratory detection limits in groundwater samples collected from water wells immediately downgradient of Site 4 and upgradient of the Borie Wellfield. As suggested in Section 4.1.3.2, the groundwater flow near Site 4 occurs as a narrow "pipeline flow". Therefore, the active water wells located outside the narrow flow would unlikely be impacted. Furthermore, the wells downgradient of Site 4 are completed at various depths and have water levels ranging from flowing at the ground surface to 56 feet bgs, which suggests that multiple aquifers are present in the vicinity of Site 4 and the wells may be completed in different horizons.

4.5 CONCLUSIONS

Based on the results of groundwater samples collected for the SI at Sites 1 and 4, LTE has concluded the following.

4.5.1 SITE 1

There may be a low concentration of TCE in a target groundwater well P40632U located approximately 1.5 miles downgradient of Site 1. In January 2002, TCE was detected at the laboratory detection limit of 2.0 µg/L. However, TCE was below the laboratory detection limit in a second sample collected from the well in April 2002. The concentration of TCE was below laboratory detection limit in the one on site monitoring well S1MW1. The possible presence of TCE in a downgradient water well warrants further investigation to determine if the source of the TCE is Site 1.

TPH-DRO was detected at a concentration of 174 µg/L in monitoring well S1MW01 installed at the furthest downgradient location on site. The concentration is below the WDEQ standard for TPH-DRO in groundwater. The detected concentration of TPH-DRO is indicative of an existing source for hydrocarbons at Site 1. Therefore, further investigation is warranted to confirm the detection of TPH-DRO and determine the source of hydrocarbons and if levels exceed WDEQ standards in both soil and groundwater near the source.

4.5.2 SITE 4

Based on the groundwater potentiometric head comparison groundwater at Site 4 appears to flow toward the Lone Tree Creek, which is located approximately 1 mile northeast of the site. The creek passes within one mile of the Borie Wellfield. Lone Tree Creek is reported to be a gaining stream as it flows east out of the Laramie Range and a losing stream east of Site 4 as it passes over the Ogallala and White River Groups. Jordan (1998) reports that groundwater flows in a narrow "pipeline flow" zone in the area near Site 4 and transitions to flow within a porous media near the Borie Wellfield. Jordan (1998) also reported that the creek is recharging the Tertiary aquifers downstream of Site 4 at a rate of 235 gpm.

Concentrations of TCE were detected at levels exceeding the WDEQ standard for TCE at a depth of 75 feet to 85 feet bgs in the first groundwater penetrated on site in monitoring well S4MW01 (167 µg/L) and at a depth of 240 feet bgs in target water well P322W (46 µg/L). The former sample is the highest concentration of TCE reported in this SI and appears to be from the shallowest water-bearing zone at Site 4. The TCE concentration in well S4MW01 is also greater than any concentration of TCE that has historically been detected in water samples collected from the Borie Wellfield and Coastal Chem wells. Preliminary data indicates that TCE was not detected in two wells located immediately upgradient of Site 4 (WDEQ, 2002).

Based on the regional hydrogeologic framework and results of environmental samples collected for this SI, the samples collected from the Borie Wellfield and Coastal Chem wells, and upgradient groundwater water samples, Site 4 appears to be a source of TCE and should be considered a primary source of TCE detected in the Borie Wellfield and Coastal Chem wells.

The extent of TCE in groundwater was not defined by this PA/SI and warrants further investigation. The hydrogeologic data indicates there are multiple aquifers in the area. TCE is a dense non-aqueous phase liquid (DNAPL) which tends to migrate vertically downward and in free phase may follow structural or stratigraphic pathways while the dissolved phase will migrate with the groundwater pathway.

Finally, the data from numerous reports and this PA/SI indicates a very complex hydrogeology in the vicinity of Site 4. Therefore, further investigations should focus on defining the hydrogeologic regime, in supporting the determination of the lateral and vertical extent of TCE in groundwater.

A TCE concentration of 33.1 µg/L, which exceeds the WDEQ standard for TCE, was detected in a sample collected from a water hydrant connected to a pipeline system and well P322W. The pipeline extends over 10 miles and presently is used to supply water to numerous cattle pastures and tanks that store water for cattle and fire protection. The conditions surrounding the distribution system warrants further investigation

SECTION 5.0 SOIL PATHWAY

5.1 PHYSICAL CONDITIONS

Sites 1 and 4 are vegetated by sage, grass and weeds. Both sites are in rural locations and fenced with locked gates.

5.2 SOIL TARGETS

No people live at Sites 1 or 4. The total population within one mile of the Site 1 or Site 4, as determined by visual observations, is less than 100 people. There are no workers at Site 1. Timnath Farms ranch hands are occasional workers at Site 4. Their work includes feeding and watering cattle, repairing and constructing on fences, and repairs to the water distribution pipeline system.

The most likely impacts to soil from operations at Site 1 and 4 include releases to near surface and subsurface soils at the former sewage lagoons, USTs, waste channels, and burnout pits. In 1993, the USACE closed the USTs at Sites 1 and 4. Petroleum hydrocarbons were detected in soil near the USTs at Sites 1 and 4 but were below the WDEQ action levels. Therefore, the WDEQ granted closure with no NFA for all USTs. Visual observation of the sewage lagoons and burnout pits at Sites 1 and 4 indicate they are unlined. The unlined waste channels discharge into the northern intermittent stream. The near surface and subsurface soil in these areas are potential targets which may have been impacted by operations at the missile sites.

5.3 SOIL SAMPLE LOCATIONS

5.3.1 Site 1 Soil Sample Locations

The soil sample locations for Site 1 are listed in Table 3 and shown in Figure 6. Near surface and subsurface soil samples were collected from the two sewage lagoons, one of two burnout pits, and from the discharge point of the southern waste channel into the northern intermittent stream.

5.3.2 Site 4 Soil Sample Locations

The soil sample locations for Site 4 are listed in Table 4 and shown in Figure 7. Near and subsurface soil samples were collected from the sewage lagoon, three burnout pits, and from the intermittent stream where it exits the site.

5.4 RESULTS

5.4.1 Site 1 Soil Sample Results

The analytical data sheets are included in Appendix F. The analytical results for metals are summarized in Table 7.

There were no detected concentrations of VOCs, TPH GRO/DRO, or PCBs in soil samples. The metals were compared to the background concentrations from the Assessment of Geochemical variability and a Listing of Geochemical Data for Surface Soils in the Front Range (Severson, 1996). The analytical results for metals indicated that all concentrations were in the low expected range for background soil concentrations.

5.4.2 Site 4 Soil Sample Results

The analytical data sheets are included in Appendix F. The concentrations of metals in soil samples are listed in Table 8. The analytical results for metals when compared with Front Range surface soils suggest that all concentrations were in the low expected range for background soil concentrations.

Acetone was detected at a concentration of 0.06020 milligrams per kilogram (mg/kg) in the 34 feet to 36 feet bgs soil sample from the site borehole S4BH03 (Table 9 and Appendix F). Acetone is a common laboratory contaminant. However, there were no detected concentrations of acetone in the laboratory blanks associated with the analysis of the sample. Benzene, toluene, ethylbenzene, and total xylenes (BTEX) were also detected at concentrations of 0.00360 mg/kg, 0.0021 mg/kg, 0.0049 mg/kg, and 0.0019 mg/kg in the 34 feet to 36 feet bgs soil sample for S4BH03. There were no other detected concentrations of VOCs in soil samples.

5.5 CONCLUSIONS

Based on the results of soil samples collected for the SI at Sites 1 and 4, LTE has concluded the following.

No impacted soil was identified at Site 1 based on the limited sampling program.

BTEX and possibly acetone were identified in a deep soil sample (34 feet to 36 feet bgs) near the eastern edge of Site 4. There was no indication of impacted soils in the soil horizons above this sample location. Therefore, the detection of BTEX in the deep soil sample located away from potential sources may indicate that these compounds migrated to this area in a former or existing perched water-bearing zone. Further investigation is warranted to determine the source and extent of the hydrocarbon release.

SECTION 6.0 SUMMARY AND CONCLUSIONS

6.1 SITE 1

Site 1 is located approximately 16 miles north and six miles west of Cheyenne, Wyoming in Sections 2 and 11, Township 16 North, Range 68 West. The 900-acre parcel was acquired by purchase and condemnation between 1959 and 1961. Site 1 is currently owned by Whitaker East Limited Partnership and is used for cattle grazing. There are six abandoned launch buildings that exist as hollowed and partially demolished structures. Each former launch facility has an associated waste channel that was designed to collect quench liquid generated during missile launch operations. The site has two burnout pits that retained the quench liquid from the waste channels for separation prior to water being discharged into the northern intermittent stream. The site also has two former lagoons previously used for disposal of sewage generated from facility operations.

Based on the site reconnaissance conducted, the waste channels, burnout pits, and intermittent streams are likely source areas for TCE and residual RP-1 fuels previously released during readiness operations. The sewage lagoons may be sources of PCBs, other unknown hazardous wastes, and waste TCE used during normal facility operations. Private water wells near Site 1 are groundwater targets that may have been impacted by releases of contaminants associated with site operations. Soil targets at Site 1 include the unlined waste channels, burnout pits, and sewage lagoons.

Auger drilling operations proved to be difficult at Site 1 due to the presence of large cobbles and boulders in the alluvium and the competent bedrock units of the Ogallala Group. The first groundwater was encountered at a depth of 230 feet bgs. Groundwater was measured at a depth of 178.8 approximately two weeks after well installation indicating that the aquifer is confined. Regionally, groundwater flows to the east/northeast.

Groundwater samples were collected from one newly installed monitoring well on site and five water wells downgradient of Site 1. The limited sampling identified dissolved hydrocarbons in the on site monitoring well at a concentration of 174 µg/L (TPH-DRO) and low levels of TCE (at the detection limit) in off site water well P40632U. The limited on site shallow soil sampling, which was restricted due to the presence of the cobbles, did not define any specific source areas.

The detected concentration of TPH-DRO in the groundwater near the downgradient edge of Site 1 may be indicative of an existing source for hydrocarbons on Site 1. The presence of low levels of TCE in a water well 1.5 miles downgradient from Site 1, with no other obvious source, suggests that Site 1 should be considered the primary source. Further on site investigation to confirm the presence of and determine the source or sources for these contaminants is warranted.

6.2 SITE 4

Site 4 is located approximately 15 miles west of Cheyenne, Wyoming in Section 20, Township 13 North, Range 69 West. The site, purchased between 1959 and 1961 by the DOD, covers approximately 111 acres with an average elevation of 7,240 feet global amsl. The site is currently owned by Timnath Farms and is used for cattle ranching. Surface water runoff is to the east via an intermittent stream that drains into Lone Tree Creek approximately one mile northeast of Site 4.

There are three abandoned and partially demolished launch buildings at Site 4 with associated waste channels that drained into an unlined earthen burnout pit. Site 4 has three existing water wells located northeast of the site, one of which is presently used by the Timnath Farms. Connected to the water well is a water pipeline that supplies water through four spurs to pastures east of the site, on site stock tanks and on site fire suppression water.

Similar potential sources as described for Site 1 exist on Site 4. The private water wells near Site 4, the Borie Wellfield directly west of the City of Cheyenne, and Coastal Chem wells are groundwater targets. Soil targets include the unlined waste channels, burnout pits, and sewage lagoons.

As with Site 1, drilling was difficult with extensive boulders and cobbles encountered directly beneath the surface. The first groundwater encountered was at a depth of approximately 75 feet to 85 feet bgs. The groundwater level measured approximately one week after well installation was 61.14 feet bgs indicating that the first encountered groundwater is confined.

Based on the groundwater potentiometric head comparison, shallow groundwater at Site 4 flows toward the Lone Tree Creek, which is located approximately 1 mile northeast of the site. The creek passes within one mile of the Borie Wellfield. Lone Tree Creek is reported to be a gaining stream as it flows east out of the Laramie Range and a losing stream east of Site 4 as it passes over the Ogallala and White River Groups. Jordan (1998) reports that groundwater flows in a narrow "pipeline flow" zone in the area near Site 4 and transitions to flow within a porous media near the Borie Wellfield. Jordan (1998) also reported that the creek is recharging the Tertiary aquifers downstream of Site 4 at a rate of 235 gpm.

The wells in the vicinity of Site 4 are completed at various depths and have water levels ranging from flowing to hundreds of feet below the ground surface. The well data suggests that multiple aquifers are present in the vicinity of Site 4. Fracture flow may be a controlling factor in the depth to groundwater, water quality, and well productivity. Shallow groundwater seeps most likely derived from zones in the alluvium and shallow Ogallala Group have been identified in the Lone Tree Creek Drainage.

Groundwater samples were collected from one newly installed monitoring well on site and seven water wells downgradient of Site 4. Concentrations of TCE were detected at a depth of 75 feet bgs in the first groundwater penetrated on site in monitoring well S4MW01 (167 µg/L) and at levels exceeding the WDEQ standard for TCE at a depth of 240 feet bgs in target water well

P322W (46 µg/L) located approximately 1 mile downgradient of Site 4. The concentration of TCE in well S4MW01 is the highest concentration of TCE reported in this SI and is greater than any concentration of TCE that has historically been detected in water samples collected from the Borie Wellfield and Coastal Chem wells. Preliminary data indicates that TCE was not detected in two wells located immediately upgradient of Site 4 (WDEQ, 2002). Therefore, Site 4 appears to be a source of TCE in groundwater and should be considered a primary source of TCE detected in the Borie Wellfield and Coastal Chem wells.

Further investigation is warranted to determine both the horizontal and vertical extent of TCE in groundwater and the impacts the TCE has on the Borie Wellfield and Coastal Chem wells. The investigation should also focus on defining the complex hydrogeology of the region including defining the specific recharge for the multiple groundwater horizons, extent of the “pipeline flow” zone, mapping the subsurface features with seismic or other methods, and determining the well completion details of water wells in the vicinity of Site 4.

Other than well P322W, TCE was reported below laboratory detection limits in the groundwater samples collected for this SI immediately downgradient of Site 4. Groundwater flow occurs in a narrow “pipeline flow” zone in the vicinity of Site 4. Therefore, the water wells located outside the narrow “pipeline flow” may not be impacted. Furthermore, the wells immediately downgradient of Site 4 are completed at various depths and have water levels ranging from flowing at the ground surface to 56 feet bgs suggesting completion of wells in multiple aquifers.

TCE was detected in groundwater samples collected from various depths and potentially from different groundwater aquifers. TCE is a DNAPL that tends to migrate vertically downward and in free phase may follow structural or stratigraphic pathways while the dissolved phase will migrate with the groundwater flow. Therefore, further investigations should focus on defining the hydrogeologic regime on site and to the east. Understanding the complex geologic framework should support determining the on site source(s) and mapping of the lateral and vertical extent of the TCE in groundwater.

TCE was also detected at a concentration of 33.1 µg/L in a sample collected from a water hydrant connected to well P322W suggesting impacted groundwater is being supplied to the Timnath Farm’s pastures. The conditions surrounding the distribution system warrants further investigation.

Low levels of acetone and BTEX compounds were detected in a soil sample obtained from a depth of 34 feet to 36 feet bgs in on site borehole S4BH03. The concentrations of BTEX and acetone should be confirmed. However, the presence of these compounds in a deep soil sample near the downgradient site boundary may suggest migration via a former or existing perched water-bearing zone from an unknown on site source. Further investigation is warranted to confirm the presence of these compounds and determine the source and extent of the hydrocarbon release, if necessary.

SECTION 7.0 RECOMMENDATIONS

Based on the SI completed at Sites 1 and 4, LTE recommends the following.

7.1 SITE 1

As stated, further investigation is warranted to identify the source(s) of hydrocarbons on site. Potential sources which require additional investigation include the burnout pits, the waste channels, possibly the sewage lagoon.

Further investigation is warranted to identify the source and vertical and lateral extent of TCE in groundwater on site and downgradient of the site. The well completion details for the Stone well (P40632U) should be determined. Additional samples should be collected from the bottom of the well to determine if concentrations increase with depth in the well. The Stone well should be monitored for four quarters over a one year time period. Due to the presence of gear oil on groundwater in well P7806W, a groundwater sample was not collected from this well. Well P7806W appears to be located downgradient of Site 1. The gear oil should be removed from groundwater within well P7806W and a groundwater samples should be collected from the well.

7.2 SITE 4

The hydrogeology of the area extending from the missile site to the Borie and Coastal wellfields is very complex. Surface elevation and depth to water varies widely in this area. The surface elevation ranges from 7,250 ft AMSL to 6,400 ft AMSL. The depth to water in various wells ranges from flowing at the surface to 400 feet bgs. The reported groundwater fracture flow and narrow "pipeline flow" will heavily influence the migration of contaminants in the vicinity of Site 4. Further investigation should focus on defining the complex hydrogeology of this area including defining the specific recharge for the multiple groundwater horizons, determining the extent of the "pipeline flow" zone, mapping the subsurface features with seismic or other methods, and determining the well completion details of water wells in the vicinity of Site 4.

TCE was detected in groundwater samples collected from various depths and potentially from different stratigraphic horizons. TCE is a DNAPL that tends to migrate vertically downward and in free phase may follow structural or stratigraphic pathways while the dissolved phase will migrate with the groundwater pathway. Therefore, further investigations should focus on defining the complex hydrogeology on site and to the east. Understanding the complex geologic framework should support determining the on site source(s) and mapping of the lateral and vertical extent of the TCE in groundwater.

Consideration should be given to additional investigation of groundwater seeps and surface water along the Lone Tree Creek downgradient of Site 4.

TCE was detected at a concentration of 46 µg/L in a groundwater sample collected from a depth of 248 feet bgs in well P322W. Because there are no well completion data, it is unknown if this concentration is representative of the depth the sample was collected or if TCE is entering the well from another depth. The well completion details for P322W and possibly the other wells associated with Site 4 should be determined by conducting downhole video surveys.

The presence of the BTEX and acetone in soil will require additional investigation to confirm the presence of these compounds and determine if there are sources that remain a potential risk.

Further investigation of the Timnath Farms water well (P322W) should be completed with the possibility of removing the impacted well from service.

SECTION 8.0 REFERENCES

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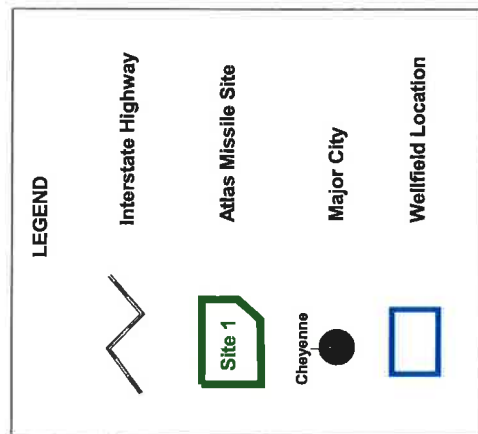
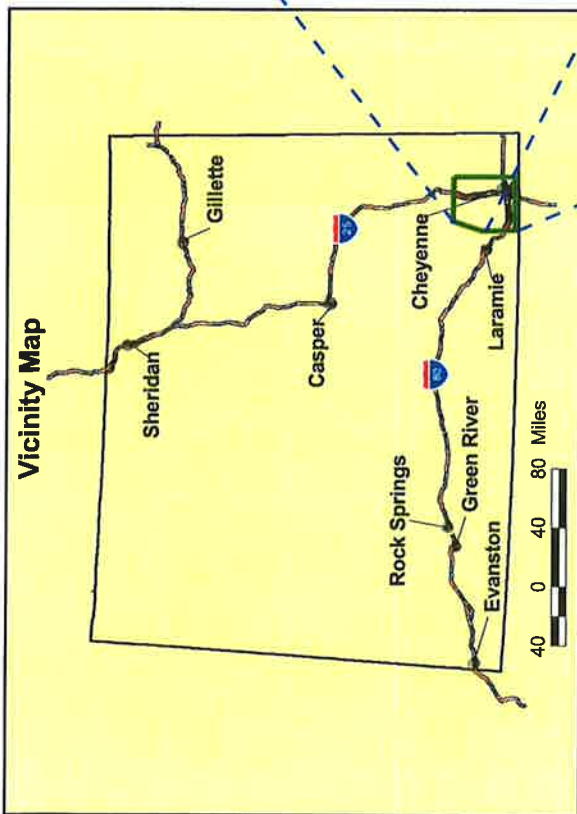
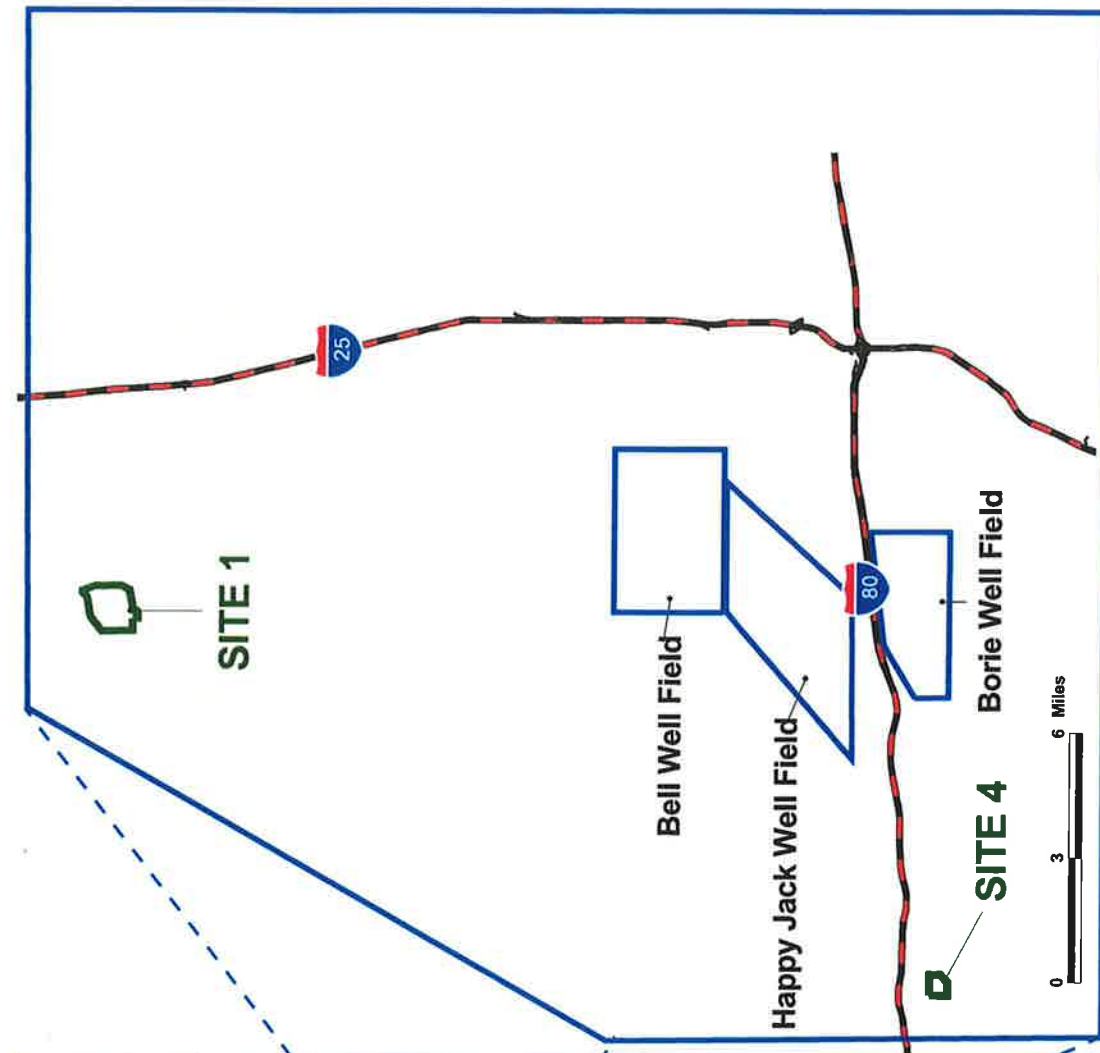
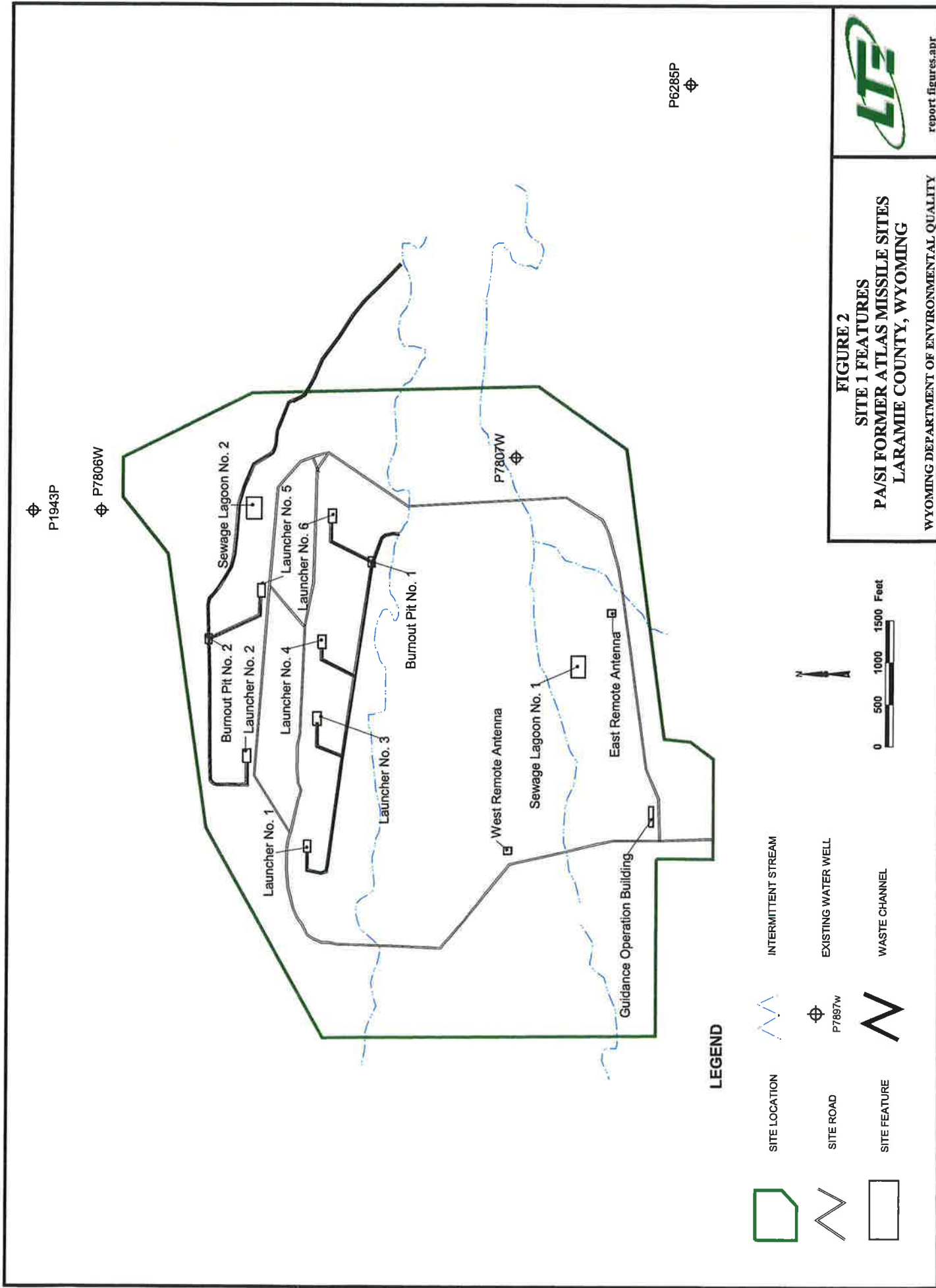
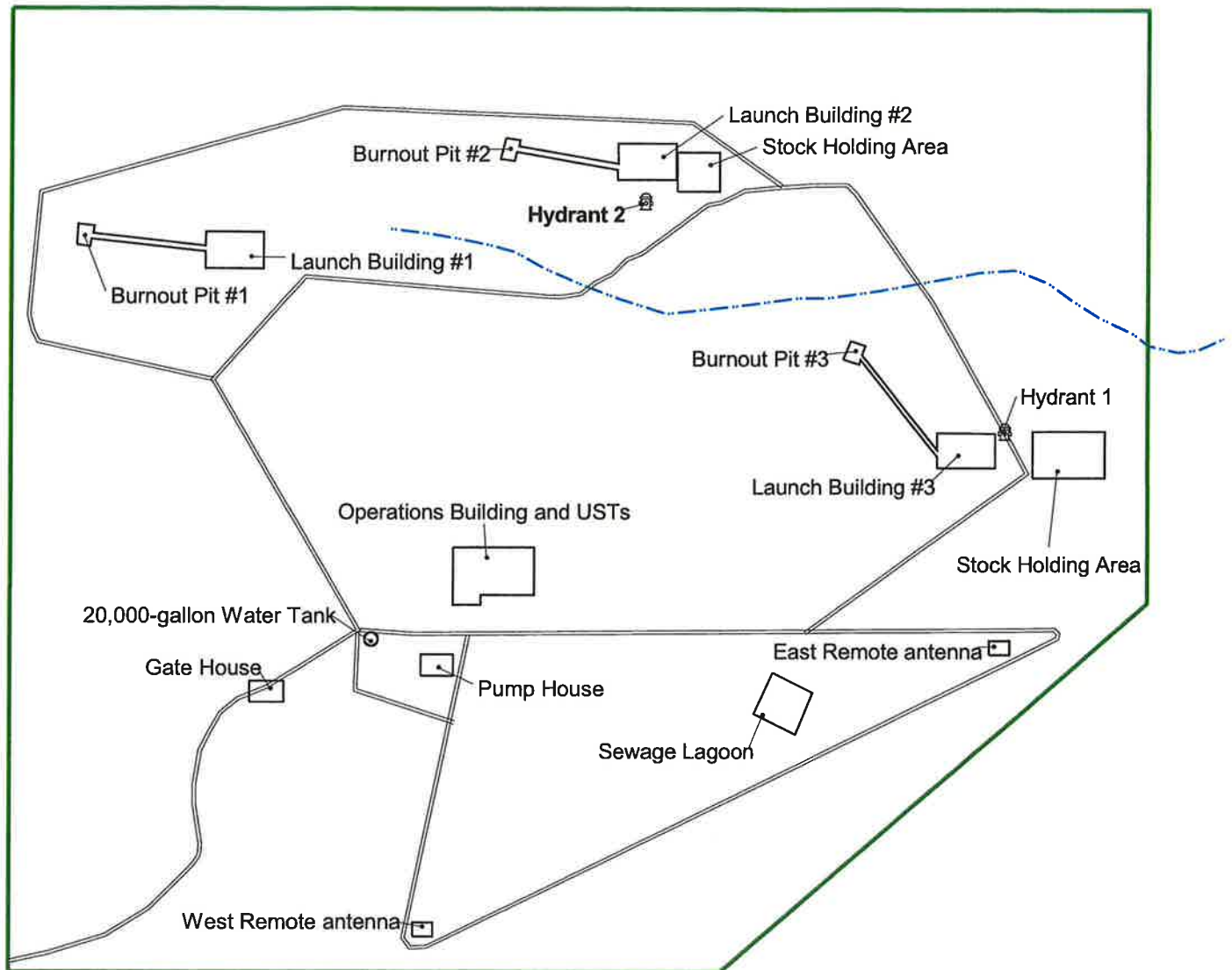


FIGURE 1
SITES 1 AND 4 LOCATION
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY







LEGEND



SITE LOCATION



SITE ROAD



SITE FEATURE



INTERMITTENT STREAM



WATER STORAGE TANK



WATER HYDRANT



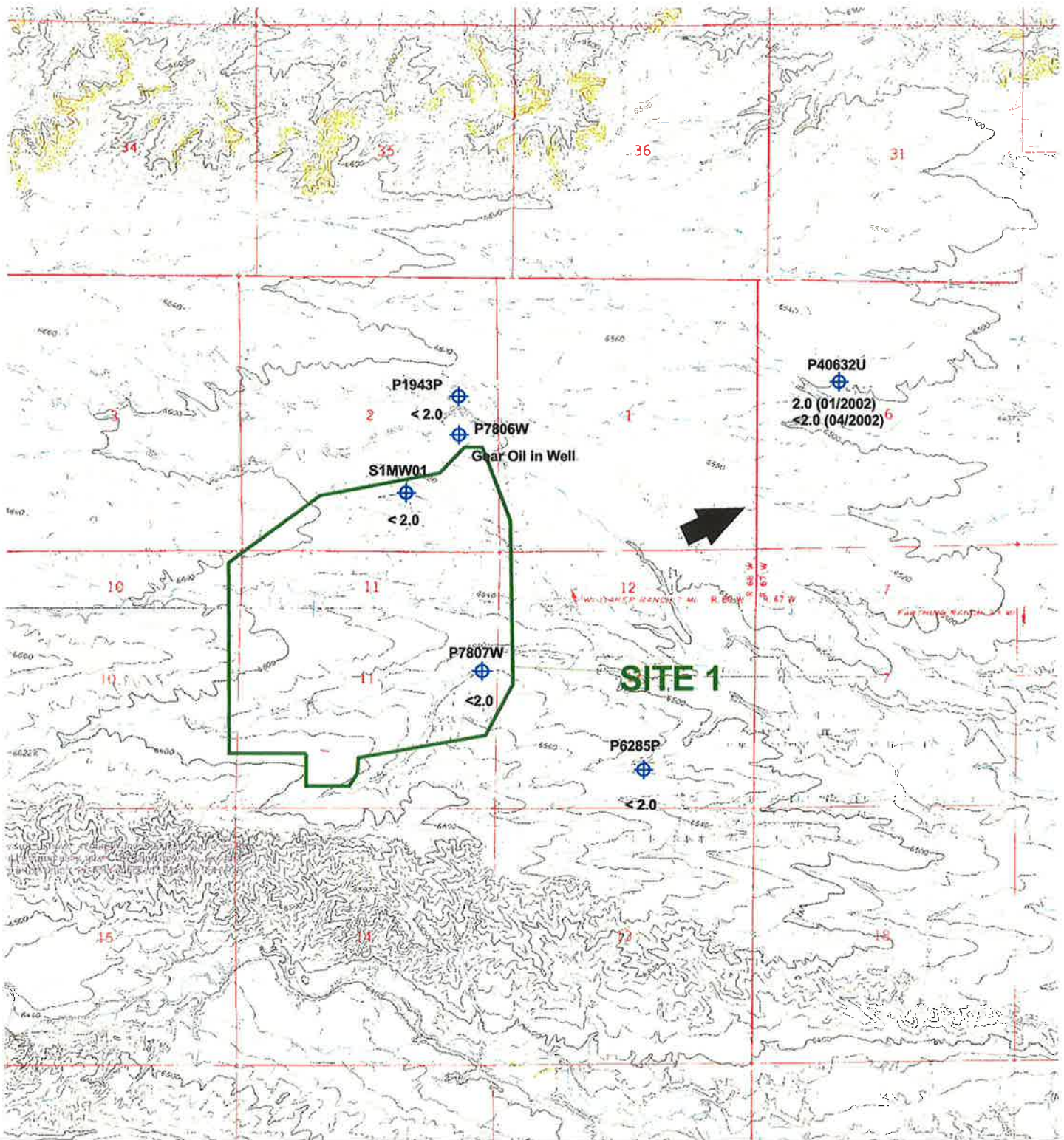
200 0 200 400 Feet

FIGURE 3
SITE 4 FEATURES
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY



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0 0.5 1 Miles

NOTE: WELL P40632U WAS SAMPLED IN JANUARY 2002 AND APRIL 2002

MAP SOURCE: USGS 7.5' QUADRANGLES
NIMO RANCH, WYOMING - 1962; REVISED 1991
FARTHING RANCH, WYOMING - 1961; REVISED 1991

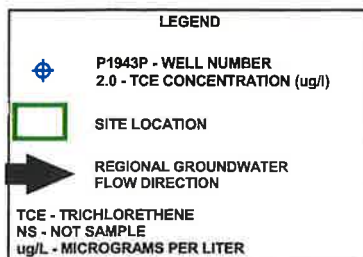
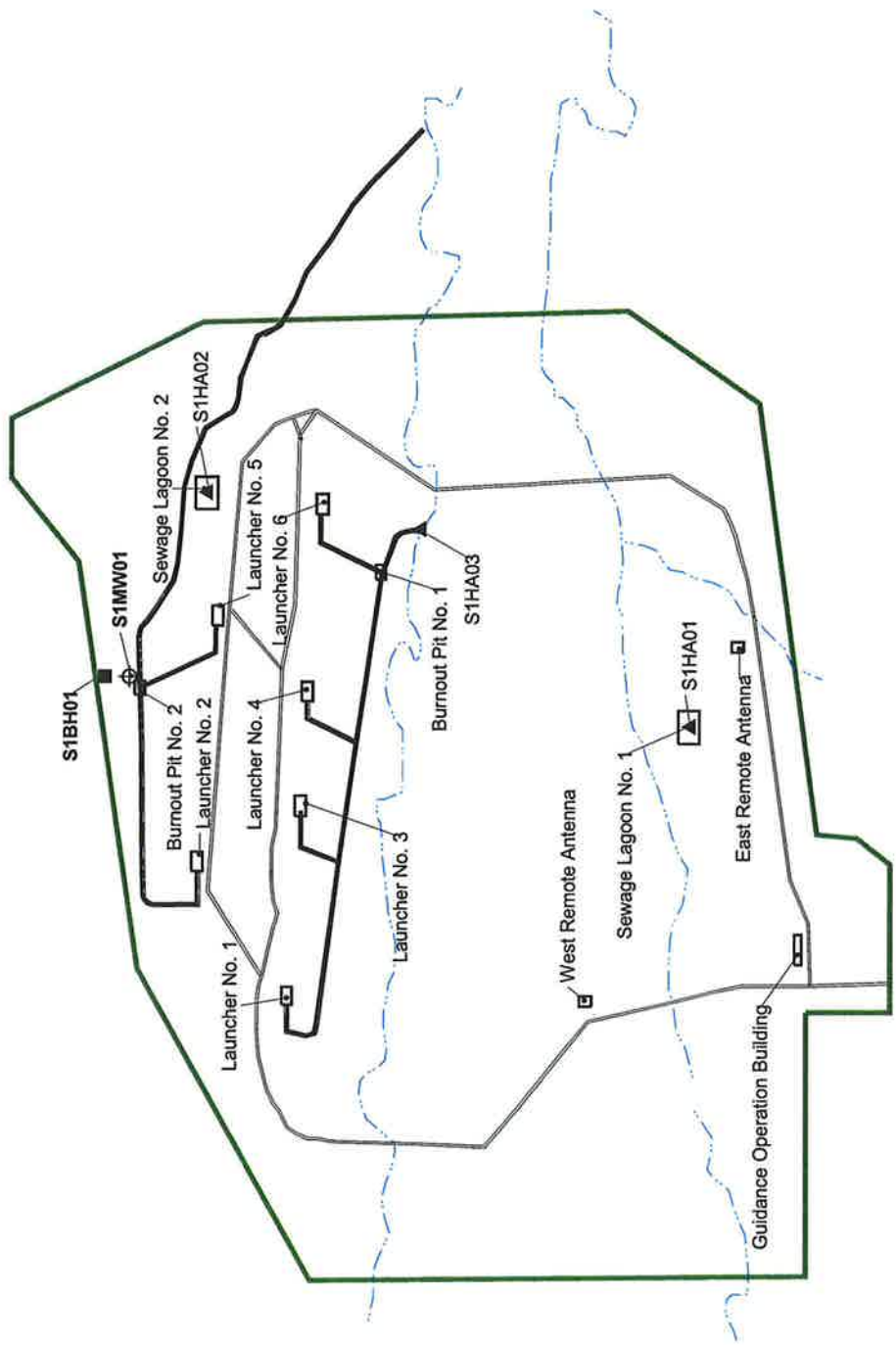


FIGURE 5
CONCENTRATION OF TCE IN PPB IN SITE 1 WATER WELLS
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY



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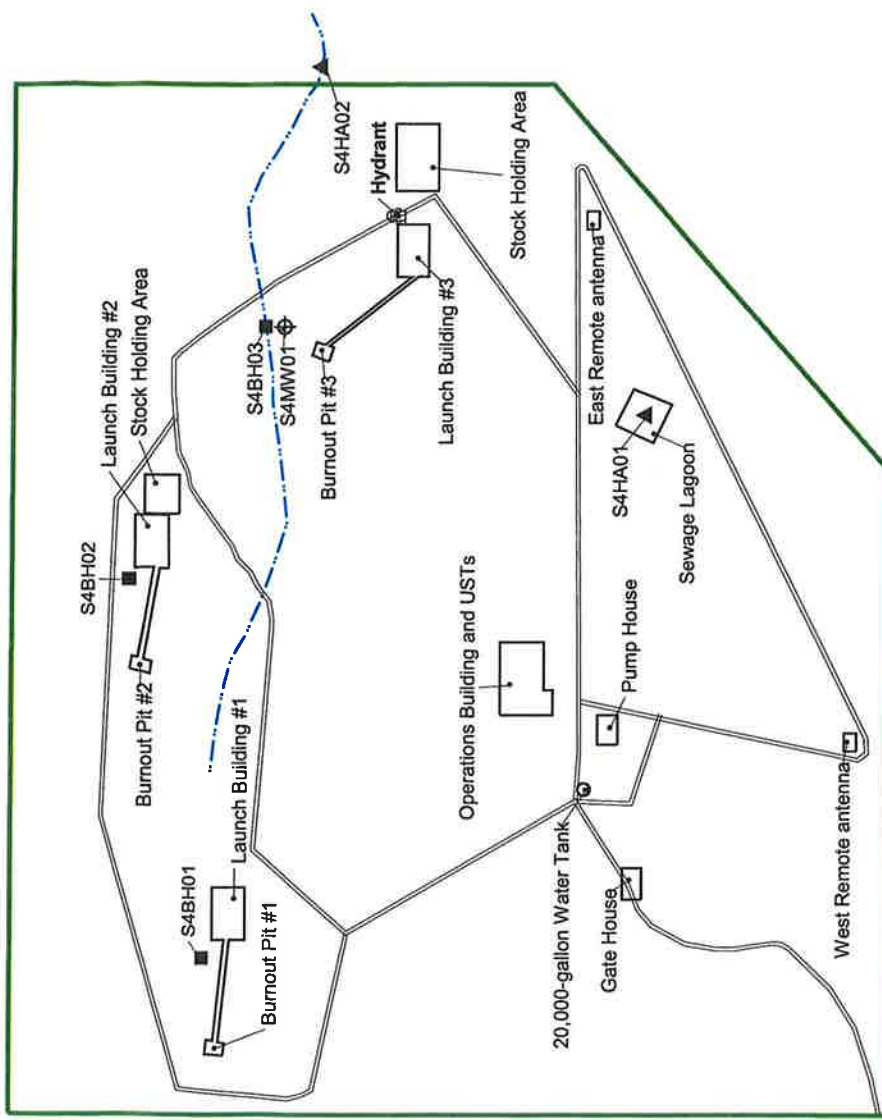
- SITE BOUNDARY
- ROAD
- SITE FEATURE
- MONITORING WELL
- INTERMITTENT STREAM
- WASTE CHANNEL
- HAND AUGER BOREHOLE
- BOREHOLE/MONITORING WELL



FIGURE 6
SITE 1 SOIL SAMPLE LOCATIONS
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY





LEGEND

- | | | | |
|--|---------------------|--|----------------------------|
| | SITE BOUNDARY | | INTERMITTENT STREAM |
| | ROAD | | WASTE CHANNEL |
| | SITE FEATURE | | MONITORING WELL |
| | HAND AUGER BOREHOLE | | HOLLOW STEM AUGER BOREHOLE |
| | WATER HYDRANT | | |



FIGURE 7
SITE 4 SOIL SAMPLE LOCATIONS
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING



TABLE 1
INVENTORY OF PERMITTED WATER WELLS
FORMER ATLAS MISSILE SITE 1
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

PERMIT NUMBER	QUARTER/ QUARTER/	SECTION	TOWNSHIP	RANGE	WELL USE ^{a/}	APPLICANT	WELL DEPTH (Feet, bgs) ^{e/}	STAT DEPTH (Feet, bgs)	MWBZ TOP ^{d/} (Feet, bgs)	MWBZ BOT ^{d/} (Feet, bgs)
P6283P	NENW	2	16 N	68 W	STO	WHITAKER EAST LIMITED PARTNERSHIP	370	Unknown	Unknown	Unknown
P7806W	NESE	2	16 N	68 W	STO,IRR	MARY C. WEPPNER**ELIZABETH C. MC NIFF	Unknown	Unknown	Unknown	Unknown
P776G	NESE	2	16 N	68 W	IND,DOM	U. S. CORPS OF ENGINEERS	459	137	137	450
P26171W	NESE	2	16 N	68 W	STO,IRR	MARY C. WEPPNER**ELIZABETH C. MCNIFF	Unknown	Unknown	Unknown	Unknown
P6287P	SENW	3	16 N	68 W	STO	WHITAKER EAST LIMITED PARTNERSHIP	365	150	Unknown	Unknown
P6291P	NENE	5	16 N	68 W	STO	ELIZABETH S. WHITAKER TRUST	190	170	Unknown	Unknown
P6289P	NWNW	7	16 N	68 W	STO	ELIZABETH S. WHITAKER TRUST	260	210	Unknown	Unknown
P6286P	NWNW	9	16 N	68 W	STO	WHITAKER EAST LIMITED PARTNERSHIP	268	213	Unknown	Unknown
P7807W	SENE	11	16 N	68 W	STO,IRR	MARY C. WEPPNER**ELIZABETH C. MC NIFF	Unknown	Unknown	Unknown	Unknown
P777G	SENE	11	16 N	68 W	IND,DOM	U. S. CORPS OF ENGINEERS	465	124	124	405
P6285P	SWSE	12	16 N	68 W	STO	WHITAKER EAST LIMITED PARTNERSHIP	360	310	Unknown	Unknown
P5900P	NWNW	19	16 N	68 W	STO	SHARON F. TUCK	Unknown	0	Unknown	Unknown
P5902P	NENE	23	16 N	68 W	STO	SHARON F. TUCK	Unknown	Flowing	Unknown	Unknown
P5899P	NESE	29	16 N	68 W	STO	SHARON F. TUCK	260	258.8	Unknown	Unknown
P7755P	NWNE	21	17 N	68 W	DOM	MARY WHITAKER CALDWELL WEPPNER**ELIZABETH WELLS CALDWELL MCNIFF	50	Unknown	Unknown	Unknown
P6282P	NWSE	21	17 N	68 W	DOM	MARY WHITAKER CALDWELL WEPPNER**ELIZABETH WELLS CALDWELL MCNIFF	Unknown	Flowing	Unknown	Unknown
P7754P	NWNW	22	17 N	68 W	DOM	WHITAKER EAST LIMITED PARTNERSHIP	320	130	260	300
P6288P	NWNW	31	17 N	68 W	STO	ELIZABETH S. WHITAKER TRUST	300	150	Unknown	Unknown
P1017W	SWSE	31	17 N	68 W	IND	CORAL PRODUCTION CO	746	746	200	Unknown
P1032W	SESE	31	17 N	68 W	IND	MOBIL OIL CO.	765	Unknown	Unknown	Unknown
P1031W	SESE	31	17 N	68 W	IND	CORAL PRODUCTION CO	616	40	Unknown	Unknown
P97580W	NWSE	33	17 N	68 W	STO	WHITAKER EAST, LIMITED PART.	415	360	365	400
P6284P	NESW	34	17 N	68 W	STO	WHITAKER EAST LIMITED PARTNERSHIP	300	150	Unknown	Unknown
P40634W	NESW	28	17 N	67 W	STO	MARILYN KAY COLE	125	50	Unknown	Unknown
P62092W	SWSW	28	17 N	67 W	MON,MIS	ERTEC WESTERN INC.	Unknown	Unknown	Unknown	Unknown
P4805P	NENE	29	17 N	67 W	STO	MARY A. MOYERS	20	3	Unknown	Unknown
P4806P	NENE	29	17 N	67 W	STO	TRUE RANCHES	140	75	Unknown	Unknown
P4804P	NENW	29	17 N	67 W	DOM,STO	MARY A. MOYERS	70	15	Unknown	Unknown
P40633W	SESE	29	17 N	67 W	DOM,STO	MARILYN KAY COLE	190	150	Unknown	Unknown
P21312P	SWNW	31	17 N	67 W	STO	TRUE RANCHES, A WYOMING PARTNERSHIP	280	245	Unknown	Unknown
P9538P	NESE	32	17 N	67 W	DOM,STO	DANIEL J. AND MARY A. PRY	225	Unknown	Unknown	Unknown
P62175W	NENW	33	17 N	67 W	MON,MIS	WYOMING STATE ENGINEER'S OFFICE	350	90	Unknown	350
P5751P	SESE	4	16 N	67 W	STO	FLOYD R. HOLMES	180	150	Unknown	Unknown
P40632W	NESW	6	16 N	67 W	STO	MARILYN KAY COLE	250	120	Unknown	Unknown
P5911P	NWNW	8	16 N	67 W	STO	SHARON F. TUCK	233	211.92	Unknown	Unknown
P28126P	NESW	8	16 N	67 W	STO	CARL L. & BEVERLY M. FEDERER	170	150	Unknown	Unknown
P44077W	SWSW	8	16 N	67 W	DOM	RICHARD KERSEY	360	150	Unknown	Unknown

TABLE 1 (CONTINUED)
INVENTORY OF PERMITTED WATER WELLS
FORMER ATLAS MISSILE SITE 1
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

PERMIT NUMBER	QUARTER/ QUARTER/	SECTION	TOWNSHIP	RANGE	WELL USE ^{a/}	APPLICANT NAME	WELL DEPTH (Feet, bgs) ^{e/}	STAT DEPTH ^{b/} (Feet, bgs)	MWBZ TOP ^{c/} (Feet, bgs)	MWBZ BOT ^{d/} (Feet, bgs)
P5912P	SWNE	19	16 N	67 W	DOM	SHARON F. TUCK	Unknown	Unknown	Unknown	Unknown
P62094W	NESE	20	16 N	67 W	MON,MIS	ERTEC WESTERN INC.	Unknown	Unknown	Unknown	Unknown
P62176W	NWNW	21	16 N	67 W	MON,MIS	ERTEC WESTERN INC.	350	65	Unknown	350
P28088W	SENW	21	16 N	67 W	DOM,STO	SHARON F. TUCK	180	160	Unknown	Unknown
P62093W	NWSW	21	16 N	67 W	MON,MIS	ERTEC WESTERN INC.	Unknown	Unknown	Unknown	Unknown
P56751W	NWSE	8	16 N	67 W	DOM,STO	DENNIS MOODY	314	120	250	314
P5909P	SENW	17	16 N	67 W	STO	SHARON F. TUCK	156	136.06	Unknown	Unknown
P5910P	NWNE	18	16 N	67 W	STO	SHARON F. TUCK	280	190	Unknown	Unknown
P5905P	SWSW	31	16 N	67 W	STO	SHARON F. TUCK	170	35	Unknown	Unknown

^{a/} Description of well use codes:

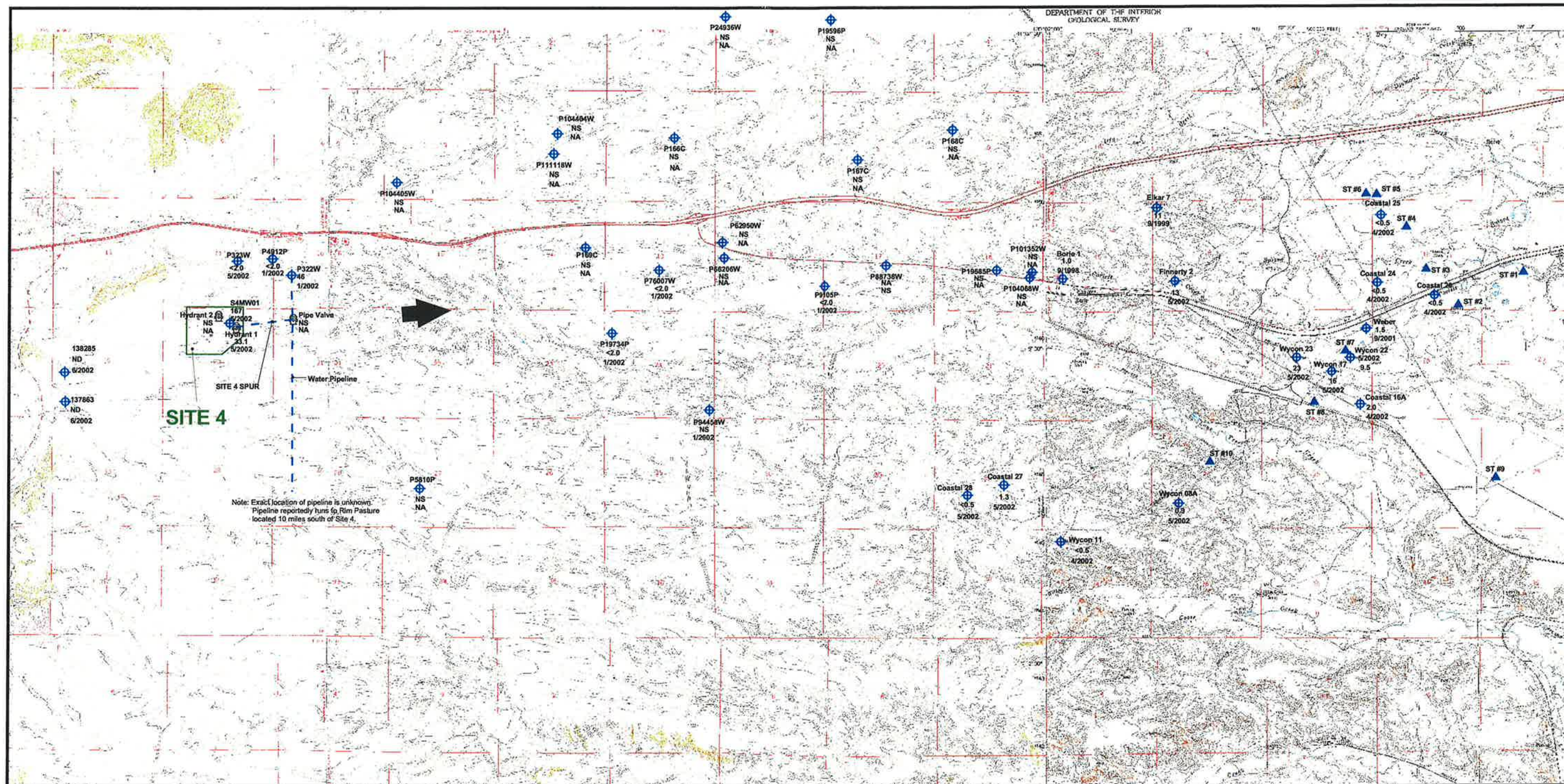
COM = Commercial
DOM = Domestic
IND = Industrial
IRR = Irrigation
MIS = Miscellaneous
MON = Monitoring
MUN = Municipal
STO = Stock
TST = Test

^{b/} Static Depth = Static depth of water within well casing.

^{c/} MwbzTop = Depth to main water bearing zone.

^{d/} MwbzBot = Depth to bottom of main water bearing zone (within the drilled/cased zone).

^{e/} Feet, bgs = Feet below ground surface.



LEGEND

P322W - WELL NUMBER
46 - TCE CONCENTRATION (ug/l)
5/2002 - DATE SAMPLED

ST #1 - STOCK TANK NUMBER

REGIONAL GROUNDWATER FLOW DIRECTION

SITE LOCATION

ROAD LOCATION

Hydrant 1 - PIPELINE HYDRANT
33.1 - TCE CONCENTRATION (ug/l)

NS - NOT SAMPLED
 NA - NOT APPLICABLE
 ND - NOT DETECTED
 ug/L - MICROGRAMS PER LITER
 TCE - TRICHLOROETHENE

MAP SOURCE: USGS 7.5' QUADRANGLES
EMKAY, WYOMING - 1956; REVISED 1978
GRANITE, WYOMING - 1956; REVISED 1978
BORIE, WYOMING - 1960; REVISED 1994

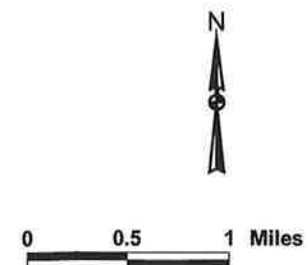


FIGURE 4
CONCENTRATION OF TCE IN PPB IN SITE 4 WATER WELLS
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

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TABLE 2
INVENTORY OF PERMITTED WATER WELLS
FORMER ATLAS MISSILE SITE 4
PA/SI FORMER ATLAS MISSILE SITES
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

PERMIT NUMBER	QUARTER/ QUARTER/	SECTION	TOWNSHIP	RANGE	WELL USE ^{a/}	APPLICANT NAME	WELL DEPTH (Feet, bgs) ^{e/}	STAT DEPTH ^{b/} (Feet, bgs)	MWBZ TOP ^{c/} (Feet, bgs)	MWBZ BOT ^{d/} (Feet, bgs)
P19596P	SWNW	5	13 N	68 W	STO	JERRY A. & ANN F. KING	265	245	Unknown	Unknown
P24936W	SWNW	6	13 N	68 W	DOM,STO	HAPPY JACK CORP.	450	375	415	435
P167C	NWSW	8	13 N	68 W	STO	BERT MCGEE	238	170	Unknown	Unknown
P168C	SWNW	9	13 N	68 W	STO	BERT MCGEE	165	140	140	165
P19585P	NWSE	16	13 N	68 W	STO	STATE OF WYOMING**JERRY KING**A. L. KING	265	125	Unknown	Unknown
P104068W	NESE	16	13 N	68 W	MON	CHEYENNE BOARD OF PUBLIC UTILITIES	300	142	Unknown	Unknown
P291C	NESE	16	13 N	68 W	MUN	CHEYENNE BOARD OF PUBLIC UTIL.	352	131	Unknown	Unknown
P113668W	NESE	16	13 N	68 W	MUN	WYO BOARD OF LAND COMMISSIONERS** CITY OF CHEYENNE/BOARD OF PUBLIC UTILITIES	352	131	Unknown	Unknown
P113668W	NESE	16	13 N	68 W	MUN	WYO BOARD OF LAND COMMISSIONERS** CITY OF CHEYENNE/BOARD OF PUBLIC UTILITIES	352	131	Unknown	Unknown
P101352W	NESE	16	13 N	68 W	MUN	WYO BOARD OF LAND COMMISSIONERS** CITY OF CHEYENNE	352	131	Unknown	Unknown
P291C	NESE	16	13 N	68 W	MUN	CHEYENNE BOARD OF PUBLIC UTIL.	352	131	Unknown	Unknown
P94555W	NESE	16	13 N	68 W	MON,MIS	CHEYENNE BOARD OF PUBLIC UTILITIES	360	Unknown	Unknown	Unknown
P108836W	NWSW	16	13 N	68 W	TST	CHEYENNE BOARD OF PUBLIC UTIL.**WYO BOARD OF LAND COMMISSIONERS	Unknown	Unknown	Unknown	Unknown
P88738W	NWSE	17	13 N	68 W	DOM,STO	TAYLOR H. HAYNES	400	200	Unknown	Unknown
P66206W	NWSW	18	13 N	68 W	DOM	DALLON COULSON**SARA E. COULSON	580	400	500	520
P62950W	SWNW	18	13 N	68 W	DOM	CANDELARIO HERNANDEZ	645	470	470	645
P73798W	NWNW	18	13 N	68 W	MIS	INC. WYOMING PSYCHIATRIC INSTITUTE	Unknown	Unknown	Unknown	Unknown
P71932W	SWNW	18	13 N	68 W	DOM	INC. AVCO FINANCIAL SERVICES	Unknown	Unknown	Unknown	Unknown
P108837W	SENE	20	13 N	68 W	TST	CHEYENNE BOARD OF PUBLIC UTIL.**WYO BOARD OF LAND COMMISSIONERS	Unknown	Unknown	Unknown	Unknown
P108839W	SENE	21	13 N	68 W	TST	CHEYENNE BOARD OF PUBLIC UTIL.	Unknown	Unknown	Unknown	Unknown
P108838W	NWNW	21	13 N	68 W	TST	CHEYENNE BOARD OF PUBLIC UTIL.	Unknown	Unknown	Unknown	Unknown
P164C	SWSW	10	13 N	69 W	STO	BERT MCGEE	110	70	70	110
P104405W	SWSW	10	13 N	69 W	IRR	THUNDER BASIN LAND & LIVESTOCK	540	80	450	580
P165C	SWNE	11	13 N	69 W	STO	BERT MCGEE	360	190	Unknown	Unknown
P104404W	SWNE	11	13 N	69 W	IRR	THUNDER BASIN LAND & LIVESTOCK	480	130	440	470
P111118W	NWSE	11	13 N	69 W	STO	THUNDER BASIN LAND & LIVESTOCK	Unknown	Unknown	Unknown	Unknown
P86627W	SWNE	12	13 N	69 W	MIS	THUNDER BASIN LAND & LIVESTOCK	500	190	Unknown	Unknown
P166C	SWNE	12	13 N	69 W	STO	THUNDER BASIN LAND & LIVESTOCK	500	190	Unknown	Unknown
P9105P	SWSE	12	13 N	69 W	STO	TIMNATH FARMS, INC.	30	Unknown	Unknown	Unknown
P76007W	NWSE	13	13 N	69 W	DOM,STO	BYRON L. SWANN	500	180	Unknown	Unknown
P225G	NWSE	13	13 N	69 W	STO,IRR	BERT MCGEE	500	180	285	300
P34995W	NENE	13	13 N	69 W	DOM	J. L. HUNNICUTT	620	375	390	620
P9107P	NWSE	13	13 N	69 W	STO	A. H. WILLADSEN**ELIZABETH P. WILLADSEN	Unknown	Unknown	Unknown	Unknown
P41678W	NENE	13	13 N	69 W	MON,MIS	J. L. HUNNICUTT	Unknown	Unknown	Unknown	Unknown
P169C	SENE	14	13 N	69 W	STO	BERT MCGEE	365	200	Unknown	Unknown
P4912P	NWSW	16	13 N	69 W	STO	TIMNATH FARMS, INC.	315	0	Unknown	Unknown
P100917W	NWSW	16	13 N	69 W	MIS	TIMNATH FARMS, INC.	315	0	300	315
P101774W	NWSW	16	13 N	69 W	MIS	TIMNATH FARMS, INC.	315	0	300	315

TABLE 2 (CONTINUED)
INVENTORY OF PERMITTED WATER WELLS ON FILE
AT THE WYOMING STATE ENGINEERS OFFICE
FORMER ATLAS MISSILE SITE 4
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

PERMIT NUMBER	QUARTER/ QUARTER/	SECTION	TOWNSHIP	RANGE	WELL USE ^{a/}	APPLICANT NAME	WELL DEPTH (Feet, bgs) ^{e/}	STAT DEPTH ^{b/} (Feet, bgs)	MWBZ TOP ^{c/} (Feet, bgs)	MWBZ BOT ^{d/} (Feet, bgs)
P100916W	NWSW	16	13 N	69 W	MIS	TIMNATH FARMS, INC.	428	8.85	230	Unknown
P4913P	NESE	17	13 N	69 W	STO	TIMNATH FARMS, INC.	230	Unknown	Unknown	Unknown
P14196P	NESE	17	13 N	69 W	STO	TIMNATH FARMS, INC.	555	6	Unknown	Unknown
P323W	NESE	17	13 N	69 W	MIS,DOM	USA CORPS OF ENGINEERS	555	6	410	Unknown
P119470W	NWNE	18	13 N	69 W	MON	GRANITE CANYON QUARRY	110	110	Unknown	Unknown
P8843W	NWNW	18	13 N	69 W	MIS	MORRISON-KNUDSEN COMPANY, INC.	260	20	60	100
P101500W	NWNW	18	13 N	69 W	MIS	GRANITE CANYON QUARRY	260	20	60	100
P37860W	NENE	18	13 N	69 W	DOM,STO	SUTHERLAND BROTHERS RANCH	5	2.5	Unknown	Unknown
P83803W	NWSW	18	13 N	69 W	MIS	LARAMIE COUNTY SCHOOL DISTRICT #1**A. H. AND ELIZABETH WILLADSEN	640	56	374	640
P37861W	NENE	18	13 N	69 W	DOM,STO	SUTHERLAND BROTHERS RANCH	Unknown	Unknown	Unknown	Unknown
P110043W	NENW	18	13 N	69 W	MIS	GRANITE CANYON QUARRY	Unknown	Unknown	Unknown	Unknown
P19734P	NWNW	24	13 N	69 W	DOM,STO	MARY H. GUFFEY	242	200	Unknown	Unknown
P94458W	SESE	24	13 N	69 W	STO	TIMNATH FARMS, INC.	600	250	Unknown	Unknown
P77W	NWSW	16	13 N	69 W	IND,DOM	USA CORPS OF ENGINEERS	315	Flowing	300	Unknown
P322W	NWSW	16	13 N	69 W	DOM,IIR	USA CORPS OF ENGINEERS	428	5	230	
P4914P	NWSW	16	13 N	69 W	STO	TIMNATH FARMS, INC.	428	8.85	Unknown	Unknown
P5810P	NESW	27	13 N	69 W	STO	TIMNATH FARMS, INC.	195	145	Unknown	Unknown
137863	SWSW	19	13 N	69 W	DOM,STO	GRANITE DEVELOPMENT, LLC	850	122	525	575
138285	NWSW	19	13 N	69 W	DOM,STO	GRANITE DEVELOPMENT, LLC	480	210	210	213

^{a/} Description of well use codes:

COM = Commercial
DOM = Domestic
IND = Industrial
IRR = Irrigation
MIS = Miscellaneous
MON = Monitoring
MUN = Municipal
STO = Stock
TST = Test

^{b/} Static Depth = Static depth of water within well casing.

^{c/} MwbzTop = Depth to main water bearing zone.

^{d/} MwbzBot = Depth to bottom of main water bearing zone (within the drilled/cased zone).

^{e/} Feet, bgs = Feet below ground surface.

TABLE 3
SI SAMPLE SUMMARY

**PA/SI FORMER ATLAS MISSILE SITE 1
LARAMIE COUNTY, WYOMING
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY**

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	SAMPLE LOCATION/ OBJECTIVE	NORTHING	EASTING	SAMPLE DEPTH (feet, bgs)
P7807W	1/4/2002	10:35	Groundwater	Site 1 water well located on eastern boundary of site. Determine if operations may have adversely impacted groundwater at Site 1.	4,579,766	503,055	140
P40632U	1/3/2002	14:20	Groundwater	Domestic and Stock use well located approximately 1.5 miles east of Site 1. Determine if operations at Site 1 have adversely impacted groundwater downgradient of the site.	4,581,489	505,285	Unknown
SIW-P40632U	4/8/2002	16:49	Groundwater	Resample well P40632U to confirm the analytical results of the sample collected on January 13, 2002.	4,581,489	505,285	Unknown
SIW-P6285P	4/8/2002	15:25	Groundwater	Stock use well located approximately 1 mile southeast of Site 1. Determine if operations at Site 1 have adversely impacted groundwater downgradient of the site.	4,579,148	504,069	160
SIW-1943P	4/8/2002	14:37	Groundwater	Stock use well located approximately 0.25 mile northeast of site. Determine if operations at Site 1 have adversely impacted groundwater downgradient of the site.	4,581,497	502,902	25
SIW01	5/16/2002	11:15	Groundwater	Monitoring well installed downgradient of Burnout Pit #2 and furthest downgradient location on site. Determine if operations have adversely impact groundwater at the site.	4,580,951	502,580	178
SIW01 0-0.5	4/4/2002	9:56	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if Burnout Pit #2 is a source of contamination to near surface soil on site.	4,580,951	502,580	0-0.5
SIW01 60-62	4/9/2002	16:59	Soil	Soil sample collected from a depth of 60 feet to 62 feet bgs. Determine if Burnout Pit #2 is a source of contamination to subsurface soil on site.	4,580,951	502,580	60-62

TABLE 3 (Continued)
SI SAMPLE SUMMARY
PA/SI FORMER ATLAS MISSILE SITE 1
LARAMIE COUNTY, WYOMING
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	SAMPLE LOCATION/ OBJECTIVE	NORTHING	EASTING	SAMPLE DEPTH (feet, bgs)
SIHA01 0-0.5	4/9/2002	10:38	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if Sewage Lagoon 1 is a source of contamination to near surface soil on site.	4,579,535	502,487	0-0.5
SIHA01 4-4.5	4/9/2002	11:17	Soil	Soil sample collected from a depth of 4.0 feet to 4.5 feet bgs. Determine if Sewage Lagoon 1 is a source of contamination to subsurface soil on site.	4,579,535	502,487	4-4.5
SIHA02 0-0.5	4/4/2002	7:51	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if Sewage Lagoon 2 is a source of contamination to near surface soil on site.	4,580,708	502,917	0-0.5
SIHA02 4.5-5	4/4/2002	8:21	Soil	Soil sample collected from a depth of 4.5 feet to 5 feet bgs. Determine if Sewage Lagoon 2 is a source of contamination to subsurface soil on site.	4,580,708	502,917	4.5-5
SIHA03 0-0.5	4/4/2002	9:10	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if contaminants are present in near surface soil in intermittent stream from operations at site.	4,580,191	502,849	0-0.5
SIHA03 0.5-1.0	4/4/2002	9:15	Soil	Soil sample collected from a depth of 0.5 feet to 1.0 feet bgs. Determine if contaminants are present in subsurface soil in intermittent stream from operations at site.	4,580,191	502,849	0-0.5
SIHA03A 0-0.5	4/9/2002	7:35	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if contaminants are present in near surface soil in intermittent stream from operations at site.	4,580,191	502,849	0-0.5
SIHA03A 9.5-10	4/9/2002	9:25	Soil	Soil sample collected from a depth of 9.5 feet to 10 feet bgs. Determine if contaminants are present in subsurface soil in intermittent stream from operations at site.	4,580,191	502,849	0.0-5

HA - Hand Auger Borehole.
BH - Hollow Stem Auger Borehole.
MW - Monitoring Well.
bgs - Below Ground Surface.
Northing and Easting are listed in meters - UTM NAD 1927, Zone 13.

TABLE 4
SI SAMPLE SUMMARY

PA/SI FORMER ATLAS MISSILE SITE 4
LARAMIE COUNTY, WYOMING
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	LOCATION	NORTHING	EASTING	SAMPLE DEPTH (feet, bgs)
P4912P	1/13/2002	9:30	Groundwater	Original Facility 4 water well located approximately 1.5 miles northeast of site. Well is currently a stock use well. Objective to determine if operations at Site 4 have adversely impacted groundwater downgradient of the site.	488,690	4,549,126	Flowing Well
P322W	1/3/2002	9:40	Groundwater	Original Facility 4 water well located approximately 1.5 miles northeast of site. Well is currently a stock use well. Well is connected to a pipeline to fill stock tanks located up to 10 miles away. Objective to determine if operations at Site 4 have adversely impacted groundwater downgradient of the site.	488,967	4,548,889	240
P76007W	1/3/2002	12:00	Groundwater	Private stock and domestic use well located approximately 4.5 miles east of Site 4. Objective is to determine if groundwater is impacted downgradient of Site 4.	494,332	4,548,958	Unknown
P19734P	1/4/2002	9:35	Groundwater	Private stock and domestic use well located approximately 4 miles east of Site 4. Objective is to determine if groundwater is impacted downgradient of Site 4.	493,643	4,548,026	Unknown
P9105P	1/3/2002	11:35	Groundwater	Private stock use well located approximately 4.5 miles east of Site 4. Objective is to determine if groundwater is impacted downgradient of Site 4.	496,783	4,548,722	Unknown
S4P323W	4/3/2002	9:53	Groundwater	Site 4 water well located approximately 1.5 miles northeast of site. Well is currently permitted for stock use but is not in use. Objective to determine if operations at Site 4 have adversely impacted groundwater downgradient of the site.	488,183	4,549,097	100

TABLE 4 (Continued)
SI SAMPLE SUMMARY

PA/SI FORMER ATLAS MISSILE SITE 4
LARAMIE COUNTY, WYOMING
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	LOCATION			SAMPLE DEPTH (Feet, bgs)
S4MW01	5/16/2002	13:30	Groundwater	Groundwater monitoring well installed downgradient of Burnout Pit #3 and the furthest downgradient location on site. Objective is to determine if operations at Site 4 have adversely impacted groundwater exiting the site.	488,069	4,548,181	61
Hydrant 1	5/16/2002	14:45	Groundwater	Water sample from a hydrant located near Launch Building 3. The hydrant is attached to water pipeline from well P322W. Objective is to determine if TCE detected in well P322W is present in the water flowing through the pipeline.	488,161	4,548,116	NA
S4BH01 0-0.5	4/2/2002	14:57	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if Burnout Pit #2 is a source of contamination in near surface soil.	487,570	4,548,268	0-0.5
S4BH01 19-21	4/2/2002	16:00	Soil	Soil sample collected from a depth of 19 feet to 20 feet bgs. Determine if Burnout Pit #2 is a source of contamination in subsurface soil.	487,570	4,548,268	19-21
S4BH02 0-0.5	4/2/2002	13:45	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if Burnout Pit #1 is a source of contamination in near surface soil.	487,872	4,548,329	0-0.5
S4BH02 5-7	4/2/2002	14:17	Soil	Soil sample collected from a depth of 5.0 feet to 7.0 feet bgs. Determine if Burnout Pit #1 is a source of contamination in subsurface soil.	487,872	4,548,329	5-7
S4BH03 0-0.5	4/1/2002	14:44	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if Burnout Pit #3 is a source of contamination in near surface soil.	488,073	4,548,218	0-0.5

TABLE 4 (Continued)
SI SAMPLE SUMMARY

PA/SI FORMER ATLAS MISSILE SITE 4
LARAMIE COUNTY, WYOMING
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	LOCATION			SAMPLE DEPTH (Feet, bgs)
S4BH03 34-36	4/1/2002	17:18	Soil	Soil sample collected from a depth of 34 feet to 36 feet bgs. Determine if Burnout Pit #1 is a source of contamination in subsurface soil.	488,073	4,548,218	34-36
S4HA01 0-0.5	4/3/2002	15:47	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if the sewage lagoon is a source of contamination to near surface soil.	488,003	4,547,918	0-0.5
S4HA01 2-3	4/3/2002	15:57	Soil	Soil sample collected from a depth of 2.0 feet to 3.0 feet bgs. Determine if the sewage lagoon is a source of contamination to subsurface soil.	488,003	4,547,918	2-3
S4HA02 0-0.5	4/3/2002	7:20	Soil	Soil sample collected from a depth of 0 to 0.5 feet bgs. Determine if contaminants are present in near surface soil in the intermittent stream from operations at site.	488,279	4,548,176	0-0.5
S4HA02 2-2.5	4/3/2002	8:21	Soil	Soil sample collected from a depth of 2.0 feet to 2.5 feet bgs. Determine if contaminants are present in subsurface soil in the intermittent stream from operations at site.	488,279	4,548,176	2-2.5

HA - Hand Auger Borehole.
BH - Hollow Stem Auger Borehole.
MW - Monitoring Well.
bgs - Below Ground Surface.



TABLE 5
LABORATORY ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES

PA/SI FORMER ATLAS MISSILE SITE 1
LARAMIE COUNTY, WYOMING
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

Sample Name	Lab Number	Date	TPH-DRO (ug/L)	TCE (ug/L)
1943P	02-A56890	4/8/2002	NA	< 2.00
1943P (Dup)	02-A56891	4/8/2002	NA	< 2.00
P40632U	02-A1179	1/3/2002	NA	2.00
P40632U	02-A56889	4/8/2002	NA	< 2.00
P6285P	02-A56888	4/8/2002	NA	< 2.00
P7807P	02-A1178	1/4/2002	NA	< 2.00
S1MW01	02-A81879	5/16/2002	174	< 2.00
WDEQ Regulatory Standard			1,100	5

- Notes: 1. ug/L - micrograms per Liter
2. NA - Not Analyzed/Not Available
3. TPH-DRO - Total Petroleum Hydrocarbons (Diesel Range Organics)
4. TCE - Trichloroethene



TABLE 6
LABORATORY ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES

PA/SI FORMER ATLAS MISSILE SITE 4
LARAMIE COUNTY, WYOMING
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

Sample Name	Lab Number	Date	TCE (ug/L)
HYDRANT	02-A81881	5/16/2002	33.1
P19734P	02-A1177	1/4/2002	< 2.00
P322W	02-A1254	1/3/2002	46.00
P323W	02-A53974	4/3/2002	< 2.00
P323W (Dup)	02-A53975	4/3/2002	< 2.00
P4912P	02-A1173	1/3/2002	< 2.00
P4912P (Dup)	02-A1174	1/3/2002	< 2.00
P76007W	02-A1176	1/3/2002	< 2.00
P9105P	02-A1175	1/3/2002	< 2.00
S4MW01	02-A81880	5/16/2002	167
WDEQ Regulatory Standard			5

Hydrant
done
5/2
5/2
5/2
done
done
done

- Notes: 1. ug/L - micrograms per Liter
2. NA - Not Analyzed/Not Available
3. Hydrant sample was collected from a water pipeline connected to well P322W.



TABLE 7
CONCENTRATIONS OF METALS DETECTED IN SOIL SAMPLES

PA/SI FORMER ATLAS MISSILE SITE 1
LARAMIE COUNTY, WYOMING

Sample Name	Lab Number	Date	Arsenic (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
S1BH01-S-0-0.5	02-A55319	4/4/2002	2.9	10.5	3.9	9.0	5.8	33.1
S1HA01A-S-0-0.5	02-A56894	4/9/2002	1.7	4.8	3.5	4.4	3.7	21.2
S1HA02-S-0-0.5	02-A55318	4/4/2002	2.1	4.5	2.5	4.9	3.7	18.3
S1HA03-S-0-0.5	02-A55320	4/4/2002	4.0	10.3	3.4	8.5	8.7	37.6
S1HA03A-S-0-0.5	02-A56893	4/9/2002	3.6	16.2	7.1	8.7	8.5	42.6
Background Range: <0.10-35 2-300 1-200 10-700 <5-70 12-1350								

Notes:

1. Mg/kg - milligrams per kilogram
2. NA - Not Analyzed/Not Available
3. Thirteen RCRA metals were analyzed. Only those detected at least once are shown.
4. Background Concentrations from: Assessment of Geochemical Variability and listing of Geochemical Data for Surface Soil of the Front Range Urban Corridor, Colorado. R.C. Severson and H.A. Tourtelot. U.S. Geological Survey, Open File Report 94-648.

TABLE 8
CONCENTRATIONS OF METALS DETECTED IN SOIL SAMPLES

PA/SI FORMER ATLAS MISSILE SITE 4
LARAMIE COUNTY, WYOMING

Sample Name	Lab Number	Date	Arsenic (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)
S4BH02-0-0.5	02-A55461	4/3/2002	3.80	12.1	2.9	5.4	5.4	31.7
S4BH01-S-0-0.5	02-A53683	4/2/2002	3.73	4.91	3.73	4.52	3.14	24.0
S4BH03-S-0-0.5	02-A53682	4/1/2002	3.59	16.7	3.98	4.58	6.97	30.7
S4HA01-S-0-0.5	02-A55463	4/3/2002	5.44	10.5	3.43	2.22	5.85	28.2
S4HA02-S-0-0.5	02-A55464	4/3/2002	3.31	9.94	2.53	5.65	3.90	69.6
Background Range: <0.10-35 2-300 1-200 10-700 <5-70 12-1350								

Notes:

1. Mg/kg - milligrams per kilogram
2. NA - Not Analyzed/Not Available
3. Thirteen RCRA metals were analyzed. Only those detected at least once are shown.
4. Background Concentrations from: Assessment of Geochemical Variability and listing of Geochemical Data for Surface Soil of the Front Range Urban Corridor, Colorado. R.C. Severson and H.A. Tourtelot. U.S. Geological Survey, Open File Report 94-648.

TABLE 9
CONCENTRATIONS OF VOCs IN SOIL SAMPLES

PA/SI FORMER ATLAS MISSILE SITE 4
LARAMIE COUNTY, WYOMING

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

Sample Name	Lab Number	Date	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl benzene (mg/kg)	Xylenes (mg/kg)	Acetone (mg/kg)	TCE (mg/kg)	TPH-DRO (mg/kg)
S4BH01-S-19-21	02-A55460	4/2/2002	< 0.00200	< 0.00200	< 0.00200	< 0.00200	< 0.05000	< 0.00200	< 9.88
S4BH02-S-5-7	02-A55462	4/3/2002	< 0.00200	< 0.00200	< 0.00200	< 0.00200	< 0.05000	< 0.00200	< 9.80
S4BH03-S-34-36	02-A53681	4/1/2002	0.00360	0.00490	0.00210	0.00190	0.06020	< 0.00200	NA
S4HA01-S-2.0-3.0	02-A55465	4/3/2002	< 0.00200	< 0.00200	< 0.00200	< 0.00200	< 0.05000	< 0.00200	< 9.80
S4HA02-S-2.0-2.5	02-A55466	4/3/2002	< 0.01000	< 0.01000	< 0.01000	< 0.01000	< 0.2500	< 0.01000	< 10.0
S4HA02-S-2.0-2.5 (Dup)	02-A55467	4/3/2002	< 0.01000	< 0.01000	< 0.01000	< 0.01000	< 0.2500	< 0.01000	< 10.0
WDEQ Regulatory Standards:			NA	NA	NA	NA	NA	NA	2,300

Notes: mg/kg - milligrams per kilogram
NA - Not Analyzed/Not Available



Appendices may be requested from RMC Consultants, Inc. at 303-980-4101.